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# Liberty Global's Investment in Europe

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An economic impact assessment

Prepared for  
Liberty Global

27 May 2017

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## Summary

The digital economy is expanding at a rate seven times that of the rest of the economy,<sup>1</sup> meaning that high-quality broadband networks are critical to modern economies. As well as providing consumers with communication and entertainment services, fast and reliable broadband increases the productivity of businesses and provides individuals with access to substantial information and learning resources. This importance is set to increase over time as demand for high-speed digital services grows, with new applications such as ultra-high-definition and 4k video streaming, virtual reality, cloud services and the Internet of Things (IoT) driving higher demand for bandwidth.

Liberty Global has made significant investment in the reach and capability of its broadband cable network in the four years since the start of 2013.<sup>2</sup> Oxera has conducted an economic impact assessment of these investments to better understand and quantify the economic effects on consumers, employees and businesses in Europe.

We find the Liberty Global's cable broadband investments are generating significant benefits with the speed, productivity and competition benefits generating 49% social return<sup>3</sup> in the EU.

### Measure of economic footprint

The scale of Liberty Global's investment can be measured in different ways. In simple monetary terms, Liberty Global has invested €14.5bn<sup>4</sup> in total capital expenditures across all of its European operations since the start of 2013 in new and existing infrastructure, customer equipment and business support. 3.9m additional premises have been added to the company's high speed cable network, through new build and acquisition.

This investment in Europe's communications infrastructure requires supply chains which have a multiplier effect through the wider economy. The total economic footprint of Liberty Global's investment includes the activity of Liberty Global's suppliers, and of the suppliers to those suppliers, and so on up the value chain. The total economic value of this activity is estimated to be around €23.7bn.

The economic footprint of the investment in each country is set out in the table below.

### Economic footprint of Liberty Global investment, 2013–Q1 2017

| Country | Total investment (€bn) | Total Liberty Global jobs (average) | Economic activity (€bn) |
|---------|------------------------|-------------------------------------|-------------------------|
| AT      | 0.4                    | 918                                 | 0.7                     |
| DE      | 2.2                    | 2,561                               | 3.9                     |
| CH      | 0.9                    | 1,551                               | 1.5                     |
| BE      | 1.9                    | 2,631                               | 3.1                     |

<sup>1</sup> European Commission (2014), 'Digital Agenda for Europe', November.

<sup>2</sup> In the report, we review an investment period from 2013 to March 2017 (i.e. 4.25 years in total).

<sup>3</sup> Returns on the investment generates for consumers and businesses, ignoring any profits or losses made by Liberty Global itself or its competitors.

<sup>4</sup> The €14.5 billion investment is total capital expenditures, including customer premises equipment, new build and upgrades, capacity, capital costs associated with maintaining and supporting the business, and products and enablers, of Liberty Global's consolidated European operations from the beginning of 2013 through March 31, 2017, adjusted for inflation.

|              |             |               |             |
|--------------|-------------|---------------|-------------|
| NL           | 1.9         | 4,033         | 3.1         |
| IE           | 0.3         | 780           | 0.4         |
| UK           | 5.9         | 13,394        | 9.4         |
| CZ           | 0.2         | 893           | 0.3         |
| HU           | 0.2         | 1,070         | 0.3         |
| RO           | 0.2         | 1,646         | 0.3         |
| SK           | 0.0         | 236           | 0.1         |
| PL           | 0.4         | 1,448         | 0.6         |
| <b>Total</b> | <b>14.5</b> | <b>31,161</b> | <b>23.7</b> |

Note: All monetary results shown in 2017 real net present value terms. All results are total for the period 2013 to Q1 2017, excluding the Netherlands (2013–16 only). Currency conversions use a single exchange rate calculated as the simple average of the daily rate across the period considered, sourced from Thomson Reuters Datastream.

Source: Oxera analysis of Liberty Global data.

### Measure of net benefits to consumers and businesses

Separate from the economic footprint of Liberty Global's investment, we have also estimated the resulting net benefits for its customers (domestic and commercial)—i.e. the incremental benefits that they derive from accessing Liberty Global's new and/or enhanced infrastructure over and above the benefits they would have received without the investment.

Consumers and businesses benefit from the following.

- **Speed benefits**—high quality broadband networks can benefit consumers in terms of Internet connection speed and reliability. Where customers are able to enjoy greater speeds as a result of switching to a Liberty Global service, this allows them to access a broader range and quality of Internet services. For example, this might be a new interactive or high-quality service, such as virtual reality using binaural sound, 360° live streaming of events, or multiple members of a household being able to stream HD content simultaneously. Based on the evidence that we have reviewed as part of this study, we estimate the speed benefit from Liberty Global's investment to its European consumers and businesses to be worth around €5.0bn over the period considered.
- **Productivity benefits**—businesses and home workers will also benefit from Liberty Global's investment through better productivity. Taking advantage of Liberty Global's investment in enhanced business broadband services, small businesses will be able to communicate through video conferencing and collaborate in real time on projects using cloud-based services. They could save costs through better multi-tasking and having smaller premises. Based on our analysis, we estimate these benefits to be worth €1.5bn across the Europe over the period considered.
- **Price benefits**—when Liberty Global introduces cable broadband to a new area, this increases competition in the market for high-speed broadband services. Importantly, such a change often introduces network competition to an area for the first time, where consumers and businesses previously had access only to services provided over the incumbent's network. Academic evidence shows this competition puts downward pressure on prices for a given level of service, resulting in cost savings, and thus a

monetary benefit, to consumers. We have estimated these benefits to be €0.5bn across Europe.<sup>5</sup>

In total, the estimated benefits of Liberty Global's investment in cable broadband are expected to be worth €7.1bn to customers and businesses in Europe, equating to a social return of 49%. A breakdown of the benefits by country is provided in the table below.

**Breakdown of economic benefits of Liberty Global's investment by country, 2013–Q1 2017 (€m)**

| Country      | Speed benefits | Productivity benefits | Price benefits | Total benefit |
|--------------|----------------|-----------------------|----------------|---------------|
| AT           | 187            | 20                    | 12             | 219           |
| DE           | 1,328          | 225                   | 56             | 1,609         |
| CH           | 49             | 47                    | 36             | 132           |
| BE           | 255            | 405                   | 31             | 691           |
| NL           | 736            | 370                   | 5              | 1,110         |
| IE           | 50             | 27                    | 44             | 122           |
| UK           | 1,332          | 124                   | 263            | 1,719         |
| CZ           | 211            | 41                    | 10             | 263           |
| HU           | 249            | 52                    | 25             | 326           |
| RO           | 196            | 95                    | 18             | 309           |
| SK           | 50             | 3                     | 6              | 59            |
| PL           | 385            | 96                    | 30             | 510           |
| <b>Total</b> | <b>5,028</b>   | <b>1,505</b>          | <b>536</b>     | <b>7,070</b>  |

Note: All monetary results shown at 2017 real net present value terms. All results are total for the period 2013–Q1 2017 (except the Netherlands, 2013–16 only).

Source: Oxera analysis of Liberty Global data.

<sup>5</sup> These benefits are calculated over a longer time period (fifteen years) as they are expected to endure substantially beyond the life of the investment.

# 1 Impact assessment and the benefits of broadband

## 1.1 Liberty Global's investment

Liberty Global is investing in its cable broadband footprint and network capability in Europe through a programme of capital spending and acquisitions. This includes €14.5 of total capital investment made between 2013 and Q1 2017 to connect more homes, deliver faster speeds to its broadband network and to provide high end communications and digital television services, as shown in Table 1.1.

**Table 1.1 Liberty Global's total investment, 2013–Q1 2017 (€bn)**

| Economic impact | Total investment (€bn) |
|-----------------|------------------------|
| AT              | 0.4                    |
| DE              | 2.2                    |
| CH              | 0.9                    |
| BE              | 1.9                    |
| NL              | 1.9                    |
| IE              | 0.3                    |
| UK              | 5.9                    |
| CZ              | 0.2                    |
| HU              | 0.2                    |
| RO              | 0.2                    |
| SK              | 0.0                    |
| PL              | 0.4                    |
| <b>Total</b>    | <b>14.5</b>            |

Note: Total investment is total capital expenditures, including customer premises equipment, new build and upgrades, capacity, capital costs associated with maintaining and supporting the business, and products and enablers, of Liberty Global's consolidated European operations from the beginning of 2013 through March 31, 2017, adjusted for inflation in 2017 real net present value terms

Source: Oxera analysis of Liberty Global data.

The European Commission estimates that the digital economy is expanding at a rate seven times that of the rest of the economy.<sup>6</sup> Investments in infrastructure are being made in this sector to meet growing demand for high-speed digital services, with new applications such as ultra-high-definition video streaming, virtual reality, cloud services, and the Internet of Things (IoT) creating greater demand for bandwidth.

The EU's Digital Agenda is one of seven pillars that form the objectives of the EU, and a key part of this Agenda is the promotion of fast and ultra-fast Internet access for all.<sup>7</sup> An overarching objective of the Commission is to create a 'Digital Single Market', which is expected to drive up to €415bn of additional growth.<sup>8</sup>

Liberty Global has commissioned Oxera to conduct an economic impact assessment of its investment in broadband, in order to understand and quantify the economic effect of European consumers, employees and businesses.

<sup>6</sup> European Commission (2014), 'Digital Agenda for Europe', November.

<sup>7</sup> European Commission, 'Europe 2020 Strategy', <https://ec.europa.eu/digital-single-market/en/europe-2020-strategy>, accessed 9 February 2017.

<sup>8</sup> European Commission (2015), 'Digital Single Market Strategy for Europe', COM (2015) 192, 6 May.

## 1.2 The value of broadband

High-quality broadband networks have become a critical to digital economies.<sup>9</sup> As well as providing consumers with communication and entertainment services, fast and reliable broadband increases the productivity of businesses and provides individuals with access to substantial information and learning resources. This importance is set to increase over time. As noted by the European Commission:<sup>10</sup>

New digital trends such as cloud computing, mobile web services, smart grids, and social media, are radically changing the business landscape, reshaping the nature of work, the boundaries of enterprises and the responsibilities of business leaders.

These trends enable more than just technological innovation. They spur innovation in business models, business networking and the transfer of knowledge and access to international markets.

Put another way, fast broadband networks deliver important, but often unquantifiable, social and environmental<sup>11</sup> benefits. By allowing people to be better connected through social media, VOIP and video services, broadband networks exhibit **network externalities**, or spillovers. As more people are connected, further developments have a greater impact, and benefits might also accrue more widely than just the subscribers and producers of such services.

Moreover, broadband is an **enabling technology** and much of the value it creates is encapsulated in the value of the applications it supports (such as social media, VOIP, cloud computing, virtual reality and other digital applications). An economy's ability to exploit an enabling technology will depend on other factors such as skills, IT infrastructure and the structure of economy.

Economic impact assessment can be used to quantify and understand the different elements of economic value created by Liberty Global's broadband investment.

## 1.3 What is impact assessment?

Economic impact assessment is a tool by which economists seek to understand how a particular industry, policy or investment affects participants in the wider economy. Economic impact assessments differ from a business case or investment appraisal. They go wider than direct financial impacts on those making or receiving the investment to capture indirect impacts on the wider economy, and factors that are valuable but not inherently monetary but which can be expressed in equivalent monetary terms.

In government and regulation, economists will commonly use impact assessment to help decide which policies or measures to continue or implement, in order to deliver the best outcomes for society overall.<sup>12</sup> Economic impact assessments can also be used to understand distributional impacts, and which groups within society benefit most from particular policies. Private sector organisations will use economic impact assessment where they want to better understand how their investment activities interact with the wider economy, or

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<sup>9</sup> Quality in broadband service includes bandwidth, reliability and measures of timeliness, such as latency and jitter.

<sup>10</sup> European Commission, 'The importance of the digital economy', [https://ec.europa.eu/growth/sectors/digital-economy/importance\\_en](https://ec.europa.eu/growth/sectors/digital-economy/importance_en), accessed 21 February 2017.

<sup>11</sup> For example, by reducing the need for commuting, printing and other physical media (as well as the packaging and shipping associated with these products).

<sup>12</sup> The importance is outlined in regulatory and government guidance on impact assessment. See, for example, European Commission (2009), 'Impact Assessment Guidelines' 15 January, or, for a UK example, HM Treasury (2011), 'The Green Book: Appraisal and Evaluation in Central Government', July.

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contribute to goals shared with other stakeholders such as governments, regulators or customer groups.

In this study we have applied economic assessment techniques to help Liberty Global understand the wider economic effects of its investment activity.

#### 1.4 Two ways of measuring economic impact

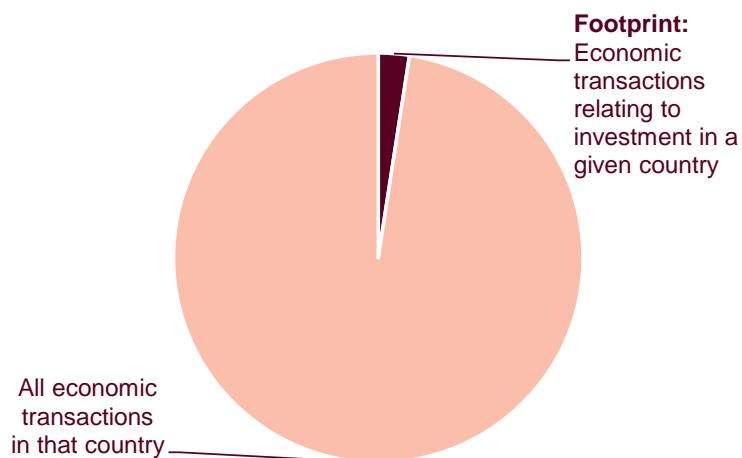
Two broad measures may be of interest when considering the economic impact of an investment, such as investment in cable broadband:

- the 'size' or quantity of resources used to deliver the project—we refer to this as the **economic footprint**;
- the benefits received from a project above that which users would have received (for example, from other providers) had the investment not been made —this is referred to as the **net economic impact**.

Typically, an economic evaluation will consider both measures of footprint and the net impact in order to get a full picture of the economic effects.

In the context of investment in digital infrastructure, considerations such as the numbers of premises connected or the value of the goods and transactions the investment generates are measures of **economic footprint**. They measure the scale of the activity. By way of illustration, suppose that delivering cable investment generates €1bn of economic transactions in a particular country. This would not imply that, without the investment, the economy would have been €1bn smaller—the funds may simply have been diverted to other areas. The concept is illustrated in Figure 1.1 below.

Figure 1.1 Illustration of economic footprint



Source: Oxera.

The **net economic impact** is the value of economic effects over and above any impact that would have arisen anyway if the project/investment had not gone ahead (the counterfactual). Understanding the net impact requires an estimate of this counterfactual situation. In the case of broadband investment, the net impact reflects the benefits enjoyed by users compared with those they would have received without the investment. This principle is illustrated in Figure 1.2.



**Figure 1.2 Illustration of net impact**



Note: The first bar represents the benefits that might have been expected to accrue had the resources used in the investment been used elsewhere; the third bar represents the economic benefits arising as a result of Liberty Global's investment; and the middle bar (representing the difference between these points) therefore shows the net economic impact or benefit of the project.

Source: Oxera.

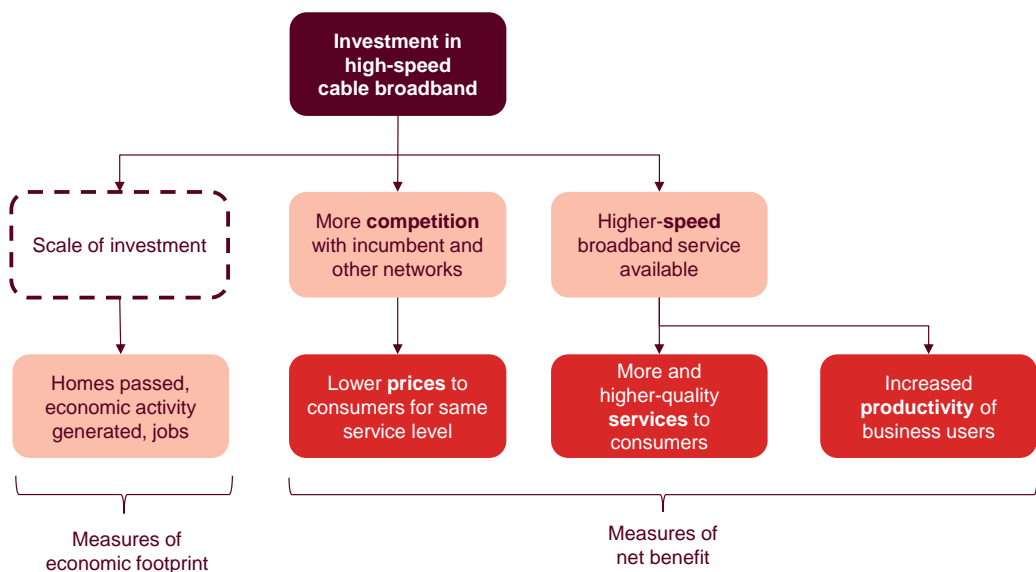
In this report, we quantify both the footprint and the net impact of Liberty Global's broadband investment.

### 1.5 The economic effects identified

Liberty Global's investment in cable broadband is likely to affect three stakeholder groups: Liberty Global and its competitors; consumers who use Liberty Global services; and businesses that use Liberty Global services. In this report, our quantification focuses on the total value that Liberty Global's investment creates externally, especially for its customers.<sup>13</sup> This approach avoids any confusion that might arise by mixing commercial and wider social returns.

The effects we consider are illustrated in Figure 1.3.

**Figure 1.3 Overview of different impacts from cable broadband**



Source: Oxera analysis.

<sup>13</sup> We also abstract from any downward impact on other operators' margins through increased competition.

We focus on the effects that are likely to be most material and can be quantified based on data available from Liberty Global, and from public sources such as national statistical agencies and published literature. We have identified three key net economic effects:<sup>14</sup>

- service benefits for consumers driven by higher broadband speeds ('**speed benefits**');
- lower like-for-like prices for consumers, driven by greater competition ('**price benefits**');
- productivity benefit to businesses from greater productivity enabled by higher speeds ('**productivity benefits**').

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<sup>14</sup> Considering the economic effects on consumers and businesses, all three most material impacts identified are benefits (rather than costs). From an economic point of view, this is not surprising. Consumers will switch to Liberty Global only if the service provided is seen to be better than the next-best alternative service or it is cheaper. Those who would not benefit from switching to Liberty Global retain the option of remaining where they are, and so are unlikely to be economically worse off than they would have been without the investment.

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## 2 Quantification of benefits

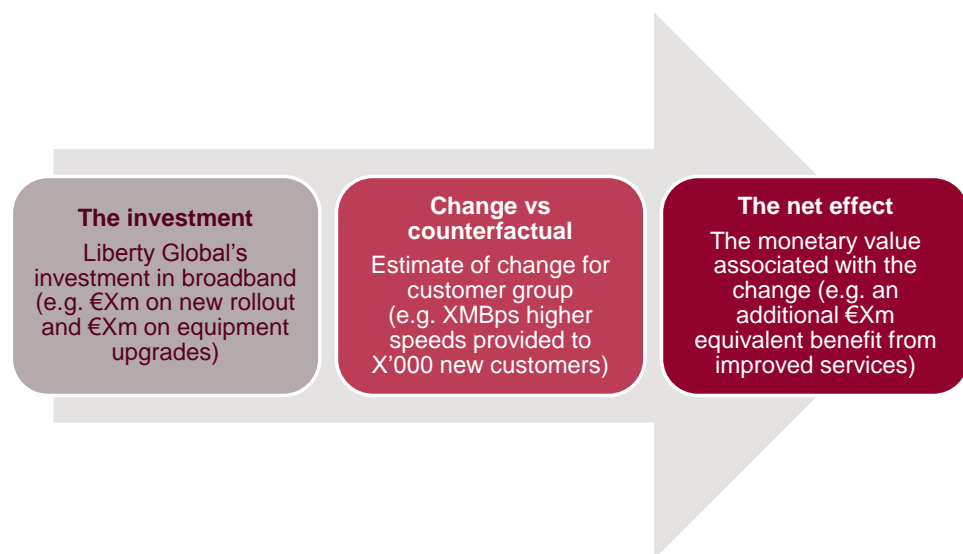
### 2.1 High-level methodology

#### 2.1.1 How Oxera has quantified these effects

The starting point for the impact assessment is the investment data provided by Liberty Global to estimate the total scale of the change for businesses and consumers, compared with a situation of no investment by Liberty Global. Results drawn from the economic literature are then used to translate this change to an equivalent monetary amount in each country. Finally, the individual benefits are added together to give an overall estimate of the net level of economic benefit resulting from the investment.

The framework is summarised in Figure 2.1.

**Figure 2.1 Estimation process for net effects**



Source: Oxera.

#### 2.1.2 Timeframe and currency considerations

We assess the impact of Liberty Global's investment from 2013 to Q1 2017 (a total of four and a quarter years of investment). The net effect analysis compares:

- **the factual**—Liberty Global investment between 2013 and Q1 2017;
- **the counterfactual**: no Liberty Global investment since the start of 2013.

Where required, all figures have been converted into 2017 prices, in order to strip out the effects of inflation and ensure comparability of effects from different years. Figures have also been updated to 2017, using a social discount rate of 4% in order to capture the time value of money, as recommended by the European Commission.<sup>15</sup> All values are reported in euros.<sup>16</sup>

<sup>15</sup> European Commission, Better Regulation Guidance, 'The Use of Discount Rates', [http://ec.europa.eu/smart-regulation/guidelines/tool\\_54\\_en.htm](http://ec.europa.eu/smart-regulation/guidelines/tool_54_en.htm), accessed 23 February 2017.

<sup>16</sup> In order to remove the effect of exchange rate movements from the reported economic effects, where the native currency of a particular country is not Euros, the currency has been converted using a single exchange rate calculated as the simple average of the daily rate across the period considered, sourced from Thomson Reuters Datastream.

### 2.1.3 Country-specific considerations

Where possible, the same approach is applied to each country included in the study with application of data relating to the local market where appropriate (for example, in relation to local wages, competitors and output). One specific adjustment is for the **Netherlands**. In 2017 Liberty Global's Netherlands operations have become part of a joint venture with Vodafone.<sup>17</sup> We therefore exclude Q1 2017 from the analysis of the Netherlands, to ensure that our results capture only Liberty Global investment.

## 2.2 Measure of economic footprint

We apply four measures of economic footprint: i) total investment; ii) number of jobs; iii) new homes added to the network; and iv) total economic activity. The methods for measuring each of these are set out below.

### 2.2.1 Total investment

This is the sum of the total cost of the investment made by Liberty Global, and is equal to its total capital expenditure in the relevant time period and countries, adjusting for inflation. For each country considered, historical total capital expenditure investment was provided by Liberty Global for the period 2013–Q1 2017.

**Table 2.1 Liberty Global's total investment, 2013–Q1 2017 (€bn)**

| Country      | Total investment (€bn) |
|--------------|------------------------|
| AT           | 0.4                    |
| DE           | 2.2                    |
| CH           | 0.9                    |
| BE           | 1.9                    |
| NL           | 1.9                    |
| IE           | 0.3                    |
| UK           | 5.9                    |
| CZ           | 0.2                    |
| HU           | 0.2                    |
| RO           | 0.2                    |
| SK           | 0.0                    |
| PL           | 0.4                    |
| <b>Total</b> | <b>14.5</b>            |

Note: Total investment is total capital expenditures, including customer premises equipment, new build and upgrades, capacity, capital costs associated with maintaining and supporting the business, and products and enablers, of Liberty Global's consolidated European operations from the beginning of 2013 through March 31, 2017, adjusted for inflation in 2017 real net present value terms.

Total for the period 2013–Q1 2017, excluding the Netherlands (2013–16 only).

Source: Oxera analysis of Liberty Global data.

This data shows that Liberty Global has invested over €14bn in broadband and high-end communication and digital television services, since 2013.

<sup>17</sup> Liberty Global (2016), 'Liberty Global and Vodafone complete Dutch joint venture, creating a fully-converged national communications operator', Press release, 31 December.

### 2.2.2 Total jobs

It is not possible to specify precisely which jobs in Liberty Global result from the investment in broadband, and which arise from other activities. For illustration, we have included in our impact assessment a summary of the total Liberty Global jobs in each country (taken as an average over the period 2013–Q1 2017) (see Table 2.2).

**Table 2.2 Total Liberty Global jobs (average), 2013–Q1 2017**

| Country      | Total Liberty Global jobs (average) |
|--------------|-------------------------------------|
| AT           | 918                                 |
| DE           | 2,561                               |
| CH           | 1,551                               |
| BE           | 2,631                               |
| NL           | 4,033                               |
| IE           | 780                                 |
| UK           | 13,394                              |
| CZ           | 893                                 |
| HU           | 1,070                               |
| RO           | 1,646                               |
| SK           | 236                                 |
| PL           | 1,448                               |
| <b>Total</b> | <b>31,161</b>                       |

Note: Average for the period 2013–Q1 2017, excluding the Netherlands (2013–16 only).

Source: Oxera analysis of Liberty Global data.

### 2.2.3 Total premises added to the network

This is the total number of premises that were added (i.e. have had Liberty Global services newly made available to them) in the relevant period and country. These is a combination of new rollout, connecting newly constructed premises and acquisitions.

The number of premises added is estimated using data provided by Liberty Global, and captures the total number of residential and business premises that are newly able to access Liberty Global's cable broadband services as a result of the rollout, connection or acquisition (see Table 2.3).

**Table 2.3 Total Liberty Global premises added ('000), 2013–Q1 2017**

| Country | Premises added |
|---------|----------------|
| AT      | 81             |
| DE      | 348            |
| CH      | 176            |
| BE      | 128            |
| NL      | 135            |
| IE      | 119            |
| UK      | 1,083          |
| CZ      | 139            |
| HU      | 212            |
| RO      | 840            |

|              |              |
|--------------|--------------|
| SK           | 89           |
| PL           | 516          |
| <b>Total</b> | <b>3,866</b> |

Note: All results are total for the period 2013– Q12017, excluding the Netherlands (2013–16 only).

Source: Oxera analysis of Liberty Global data.

Alongside the expansion of the existing footprint, many more households will also have benefited from Liberty Global's investment in their existing network.

## 2.2.4 Total economic activity

Investment in Europe's communications infrastructure requires supply chains that have a multiplier effect through the wider economy, driven by the broad range of suppliers required to deliver large and complex engineering projects. In this sense, the footprint of Liberty Global's investment includes the activity of Liberty Global's suppliers, and the activities of the suppliers to those suppliers, and so on up the value chain.

To measure the total value of economic activity and transactions supported through the supply chain to Liberty Global's investment, we use the OECD's suite of input–output tables.<sup>18</sup> This provides information on how different sectors relate to each other: for instance, to produce €10 of output in the construction sector might require €2 of input from the (separate) metalwork sector that provides the necessary materials, €3 of input from the transport sector that helps ensure these materials are in the locations where they are required, etc.

For the purposes of this analysis, we assume that the OECD's 'Post and telecommunications' sector most accurately represents Liberty Global's investment, although we have tested other potentially relevant sectors—in particular the construction sector, which may be relevant for expansionary investment—and found that the results are of similar magnitude. The total value of economic transactions estimated to be supported by Liberty Global's investment is reported in Table 2.4.

**Table 2.4 Total economic activity generated (€bn), 2013–Q1 2017**

| Country      | Economic activity (€bn) |
|--------------|-------------------------|
| AT           | 0.7                     |
| DE           | 3.9                     |
| CH           | 1.5                     |
| BE           | 3.1                     |
| NL           | 3.1                     |
| IE           | 0.4                     |
| UK           | 9.4                     |
| CZ           | 0.3                     |
| HU           | 0.3                     |
| RO           | 0.3                     |
| SK           | 0.1                     |
| PL           | 0.6                     |
| <b>Total</b> | <b>23.7</b>             |

<sup>18</sup> See <http://stats.oecd.org/Index.aspx?DataSetCode=IOTS>.

Note: All results shown in 2017 real net present value terms. All results are total for the period 2013–Q1 2017, excluding the Netherlands (2013–16 only).

Source: Oxera analysis of Liberty Global data.

## 2.3 Speed benefits

Higher broadband speeds allow consumers to perform certain tasks more quickly (e.g. music downloads) or to access higher-quality services or new, more demanding applications (e.g. on-demand video).

Liberty Global's activity can increase speed in two ways:

- **network expansion benefits:** where Liberty Global expands its network to new areas not previously served, there is usually a speed increase above that being provided by competing network operators. The speed increase that a new network provides to Liberty Global's subscribers in these areas above this alternative connection speed is the benefit we measure.
- **network upgrade benefits:** Liberty Global also invests in existing network connections and infrastructure to enable upgrades to existing customers. This speed increase is a first-order benefit against a counterfactual of network speeds without Liberty Global's investment.

The example of video services illustrates the kind of improvements that speed can enable. The graphically rich, dynamic nature of video content requires a large volume of data to be transferred. Video services (for example catch-up TV) already account for a large proportion in of total traffic on broadband networks. Video services are a major driver of bandwidth demand, and video's share of total traffic set to increase in the coming years. Furthermore, the bandwidth or speed required to support video services depends on the quality and timeliness with which they are consumed. As users demand higher resolution or linear (i.e. live broadcast) services, the speed requirement increases. To illustrate this application, we have summarised the features of video demand and requirements in Appendix 1.

More broadly, the extent to which broadband speed could save time or improve the consumer experience is likely to be varied, as there are many different uses for broadband connections. Moreover, the particular services improved, enabled and demanded as a result of faster speeds will be different between countries and between households. In this study we do not quantify the benefits of any one particular service, but instead calculate an aggregate estimate of the consumer surplus impact of all these services taken together.<sup>19</sup>

### 2.3.1 Quantifying speed benefits

We estimate the speed benefit in two parts: the amount consumers would be willing to pay for a step change in broadband speed; and an estimate of the amount consumers actually pay to purchase this upgrade.

We have reviewed estimates of the overall average willingness to pay for enhanced or superfast broadband services over and above legacy DSL-based broadband services. Several papers cite a willingness to pay of €5 per month for an upgrade to fibre-based services.<sup>20</sup> The willingness to pay is likely to vary across Europe. The Body of European Regulators for Electronic

<sup>19</sup> The consumer surplus is the net benefit a consumer receives from consuming a good. It is the difference between a consumer's willingness to pay for a good and the price they actually pay for the good.

<sup>20</sup> DotEcon (2012), 'Regulatory policy and the roll-out of fibre-to-the-home networks', A report for the FTTH Council Europe, July 31; WIK-Consult (2012), 'Re-thinking the Digital Agenda for Europe (DAE): A richer choice of technologies', report for Liberty Global, October 12.

Communications (BEREC) has qualitatively described this, and identified Switzerland, the Netherlands and Slovakia as high-demand member states.<sup>21</sup>

In the regulatory context of incentivising fibre broadband rollout, Plum Consulting assumes a *price* premium of €5 per month for fibre to the curb and €10 for fibre to the home.<sup>22</sup> A regulated incumbent with wholesale access obligations is generally not able to price-discriminate and extract all of the surplus. For these price premia to hold, the increment in consumer willingness to pay would need to be higher than €5 and €10 respectively. Similarly, WiK estimated that the gross willingness to pay for cable-based services in 2011 was €82 per month, while for incumbent-based copper services it estimated €68–€77.<sup>23</sup> This would imply a willingness to pay for an upgrade from incumbent-based copper services to cable-based services of between €5 and €14. Survey evidence in the UK suggests that consumers might pay approximately £15 per month for enhanced services.<sup>24</sup>

Such figures are generally prepared as a population estimate in the context of nationwide broadband interventions. In this study, we are applying the speed benefits conditional on a subscriber purchasing the service. The subset of consumers choosing Liberty Global's superfast products are likely to have higher willingness to pay than the population at large.

We have synthesised this evidence and used it support of an assumption of €10 per month as a gross measure of willingness to pay for access to faster broadband services, applied in all countries and years where the data shows Liberty Global is successful in delivering an average speed premium compared with incumbent providers.

We estimate the additional amount consumers may need to pay for faster services using a paper by Calzada and Martinez.<sup>25</sup> Their model explains observed additional retail prices in the market for faster broadband connections in terms of the *change in speed* and the *square of the change in speed*. These metrics are obtained by the difference in Liberty Global's average speed in each country and the incumbent's average speed in each country. We use SamKnows Broadband speed reports<sup>26</sup> (considered to have a robust sampling methodology) to separate out broadband speeds by technology.<sup>27</sup>

The total speed benefits identified in each country by this method are shown in Table 2.5.

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<sup>21</sup> BEREC (2016), 'Challenges and drivers of NGA rollout and infrastructure competition' Draft report, June 2.

<sup>22</sup> Plum Consulting (2011), 'Copper pricing and the fibre transition – escaping a cul-de-sac', report for ETNO, December 7.

<sup>23</sup> WiK Consult (2011), 'Wholesale pricing, NGA take-up and competition' Study for ECTA, April 18.

<sup>24</sup> thinkbroadband.com (2012), 'The Big Broadband Survey', March, p. 62. £15.56 is the weighted average price.

<sup>25</sup> Calzada J. and Martinez, F. (2013), 'Broadband prices in the European Union: competition and commercial strategies', Research Institute of Applied Economics, Universitat de Barcelona, September, p. 14.

<sup>26</sup> SamKnows (2014), 'Quality of Broadband Services in the EU', October, report for the European Commission

<sup>27</sup> In years and countries where this data does not have coverage, we use the EC's Digital Agenda broadband speed data.



**Table 2.5** Speed benefits of Liberty Global's cable broadband rollout investment, 2013–Q1 2017 (net present value, 2017 prices, €m)

| Country      | Speed benefits |
|--------------|----------------|
| AT           | 187            |
| DE           | 1,328          |
| CH           | 49             |
| BE           | 255            |
| NL           | 736            |
| IE           | 50             |
| UK           | 1,332          |
| CZ           | 211            |
| HU           | 249            |
| RO           | 196            |
| SK           | 50             |
| PL           | 385            |
| <b>Total</b> | <b>5,028</b>   |

Note: All results shown in 2017 real net present value terms. All results are total for the period 2013–Q1 2017, excluding the Netherlands (2013–16 only).

Source: Oxera analysis of Liberty Global data.

### 2.3.2 Caveats

Three caveats apply to this quantification method.

- 1. Other operators:** with respect to cable networks, broadband competition operates across the dimensions of infrastructure (i.e. network footprint), price and quality.<sup>28</sup> Rival operators, particularly those that control infrastructure, might respond to Liberty Global's investments in either network expansion or service upgrades with investments of their own.

Ofcom's recent Digital Communications Review highlights that a major driver of network upgrades for the incumbent in the UK market has been the competition from cable, and that this effect has been stronger than service competition.<sup>29</sup> This implies dynamic benefits, in that Liberty Global's network expansion could benefit subscribers on other networks via the competitive response of other operators investing to compete with Liberty Global. As a conservative approach to quantification, we estimate the benefit of speed increases to Liberty Global's subscribers only; however, we would expect additional benefits to accrue to users on competing networks as well.

- 2. Different speed changes:** the studies we draw on considered the change from legacy to superfast or cable services, and therefore largely represent a single discontinuous change in speed. By contrast, Liberty Global's investments considered in this study are highly varied, and include incremental investments. However, we consider that it is appropriate to apply these results in this context, viewing speed is a proxy for quality or capability, and noting Liberty Global's stated strategy to be a market leader in speed.<sup>30</sup>

<sup>28</sup> Residential broadband market offers tend to use speed as proxy for quality.

<sup>29</sup> Ofcom (2016), 'Making communications work for everyone', Initial conclusions from the Strategic Review of Digital Communications, February 25, para 4.11.

<sup>30</sup> Liberty Global's stated strategy on Internet is 'speed leadership, including increasing the maximum speed of our connections, offering varying tiers of service, prices and a variety of bundled product offerings and a range of value added services'. See Liberty Global (2016), 'Annual report 2015', April 14.

From Liberty Global's data it can be concluded that cable services are able to offer a significant increase in speed over their incumbent rivals, providing evidence this strategy is successful.<sup>31</sup>

3. **Changes over time:** empirical evidence is not yet available to assess whether consumer willingness to pay for higher speed services is changing over time. The relationship between broadband speed and consumer willingness to pay might be discontinuous (e.g. the change from dial-up to broadband is likely to have had a large effect) and non-linear (an additional 10Mbps will affect the 2Mbps user differently to the 100Mbps user). Given that broadband speeds and consumption (or traffic) are growing rapidly over time, over 20% per year in Europe<sup>32</sup>, we assume that the willingness to pay for the service increment does not vary over the relatively short (four and a quarter years) time period considered. This is consistent with Liberty Global's strategy of maintaining a premium service compared with its competitors.

## 2.4 Greater competition

### 2.4.1 Benefits of infrastructure competition

When a provider (such as Liberty Global) launches a new product (such as cable broadband) in an area, this introduces an additional competitor in the market for high-speed broadband services. Importantly in this case, such a change will often introduce *network* competition to an area for the first time, where previously consumers had access to services provided over the incumbent's network only. Ofcom recognises that, relative to service-based competition (where providers use the incumbent's fixed network), network-based competition is:<sup>33</sup>

the best way to drive investment in high quality, innovative services for consumers.

Control over the network infrastructure allows the provider to specify the technical parameters of the network and deliver a more differentiated service relative to providers using the existing network. The presence of an alternative infrastructure means that consumers can choose to switch from incumbent services entirely, if they wish to do so.

Competition benefits are therefore expected to present themselves where Liberty Global expands its cable network. This expanded network results in it being a stronger player in the broadband market, thereby increasing competitive pressures within these markets.

### 2.4.2 Quantifying the price benefits of competition

Academic literature allows us to quantify this affect. In particular, Smith et al. (2013) found that a 10% increase in the market share of a non-DSL competitor was associated with a 1.6% fall in price in that market.<sup>34</sup>

Using data provided by Liberty Global, we estimate the projected increase in its market share each year as a result of additional homes connected due to its

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<sup>31</sup> Having reviewed weighted average speeds of Liberty Global subscribers against national average speeds, Oxera finds that they are generally significantly faster. Cable-based services have been able to offer faster than or equivalent speeds to FTTC-based networks. In many countries, full FTTP networks have relatively small take-up rates.

<sup>32</sup> Oxera analysis of Liberty Global speed data. See also the CISCO Visual Networking Index, which forecasts that broadband Internet traffic will grow twofold from 2015 to 2020, a compound annual growth rate of 20%.

<sup>33</sup> Ofcom (2016), 'Making communications work for everyone', Initial conclusions from the Strategic Review of Digital Communications, February 25.

<sup>34</sup> Smith, R., Northall, P., Ovington, T., Santamaría, J. (2013), 'The impact of intra-platform competition on broadband prices and speeds', *Journal of Information Policy*, 3, pp. 601–18.

increase in footprint. We then apply the implied price decrease from Smith et al. (2013) to the annual estimated expenditure on broadband within each country (calculated using the number of broadband subscriptions in a country, available from the World Bank<sup>35</sup>, and the average price of these subscriptions, according to the International Telecommunication Union<sup>36</sup>). This yields the estimated aggregate reduction in broadband subscription costs to consumers per year in each country considered.

Competition benefits are persistent, in that once Liberty Global has introduced its broadband network to a new area, infrastructure competition will be present in that area, irrespective of the level of subsequent investments that Liberty Global decides to make. While we consider investment from 2013 to Q1 2017 only, we include this long-term effect in the competition benefit. The long-term effect is estimated using an annuity formula terminal value on the 2016–2017 competition benefits, assuming no further benefit growth, and quantifying the benefit over a total period of 15 years, in line with European Commission impact assessment guidelines.<sup>37</sup>

The total price benefits identified in each country by this method are shown in Table 2.6.

**Table 2.6 Total price benefits of Liberty Global's cable broadband rollout investment, 2013–Q1 2017 (NPV, 2017 prices, €m)**

| Country      | Price benefits |
|--------------|----------------|
| AT           | 12             |
| DE           | 56             |
| CH           | 36             |
| BE           | 31             |
| NL           | 5              |
| IE           | 44             |
| UK           | 263            |
| CZ           | 10             |
| HU           | 25             |
| RO           | 18             |
| SK           | 6              |
| PL           | 30             |
| <b>Total</b> | <b>536</b>     |

Note: All results shown in 2017 real net present value terms. All results are total for the period 2013–Q1 2017, excluding the Netherlands (2013–16 only).

Source: Oxera analysis of Liberty Global data.

## 2.5 Productivity gains

### 2.5.1 Evidence on broadband and productivity

The link between broadband services and productivity growth is well documented at the firm level. For example, a study for the European Commission estimates that companies adopting broadband-based services see

<sup>35</sup> World Bank (2017), 'Broadband subscribers', World Development Indicators, last updated January 3.

<sup>36</sup> ITU (2016), 'ITU Yearbook of Statistics 2016', Chronological Time Series 2006-2015, 42nd edition, December 22.

<sup>37</sup> European Commission (2008), 'Guide to cost-benefit analysis of investment projects', [http://ec.europa.eu/regional\\_policy/sources/docgener/guides/cost/guide2008\\_en.pdf](http://ec.europa.eu/regional_policy/sources/docgener/guides/cost/guide2008_en.pdf), accessed 21 February 2017, Table 2.2.

an increase in employee labour productivity by 5% in the manufacturing sector and 10% in the services sector.<sup>38</sup> This is consistent with research in New Zealand finding that firm broadband adoption increases firm productivity by 7–10%.<sup>39</sup>

While the benefits of increasing broadband speed are likely to be smaller than those from initial broadband adoption, speed improvements are likely to make a positive contribution to labour productivity. This effect is more difficult to measure at the firm level, but statistically significant impacts have been identified in the growth literature for OECD countries, where a doubling of broadband speed was found to be associated with a 0.3 percentage point increase in the economic growth rate.<sup>40</sup>

For Liberty Global's business customers, such benefits take the form of being able to use Liberty Global's business broadband services for enhanced connectivity on business premises, or larger businesses benefiting through better connectivity for home workers. For example, faster broadband services might enable collaboration tools to be extended to the home worker. Some of these applications (video conferencing, screen sharing and telepresence) require high bandwidth in order to generate a richer, more immersive experience.<sup>41</sup> Certain sectors, such as media services, require high-capacity broadband links to transfer large files in order to edit or process media content.<sup>42</sup> Faster broadband links may help production flexibility or capacity in these types of application. The productivity benefits will manifest as either greater profitability of the employer or greater rewards to the employee, or a mixture of the two.

### 2.5.2 Quantifying productivity gains

In our analysis, we focus on the expected benefits to small and home offices (SoHo), applying evidence on the productivity gains per worker from faster broadband to quantify the total effect.

We take an estimate used by SQW in quantifying the productivity benefits of faster broadband in the UK.<sup>43</sup> SQW cites an increase in productivity as a result of faster broadband of 0.3%, consistent in magnitude with the macroeconomic estimates provided by Rohman and Bohlin (2012). In the Rohman and Bohlin study, the average speed within the sample was 8.3Mbps, which implies a 100% speed increase of 16.6Mbps. In this study, we observe speed increases of up to 55Mbps over the incumbent speed, with 24Mbps an approximate average increase over time and across countries. Given that the increase in levels is therefore higher, we consider the 0.3% estimate appropriate in this context.<sup>44</sup> We estimate this benefit to accrue to business users via a 0.3% increase in business output per hour, and applying this to a business valuation of the total hours worked by Liberty Global's SoHo customers.

We assume that one broadband worker is associated with a single SoHo subscription, and estimate the number of SoHo subscriptions as a proportion of

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<sup>38</sup> MICUS (2008), 'The Impact of Broadband on Growth and Productivity: A study on behalf of the European Commission (DG Information Society and Media)'.

<sup>39</sup> Grimes, A., Ren, C. and Stevens, P. (2012), 'The need for speed: impacts of Internet connectivity on firm productivity', *Journal of Productivity Analysis*, 37:2, pp. 187–201.

<sup>40</sup> Rohman, I. and Bohlin, E. (2012), 'Does broadband speed really matter as a driver of economic growth? Investigating OECD countries', *International Journal of Management and Network Economics*, 2:4, pp. 336–56.

<sup>41</sup> Some collaboration tools (e.g. Slack, Google Docs) may be cloud-based, which further increases bandwidth requirements.

<sup>42</sup> CSMG (2013), 'Research on Very High Bandwidth Connectivity', Final report for Ofcom, February 18.

<sup>43</sup> SQW (2013), 'UK Broadband Impact Study', November, p. 14.

<sup>44</sup> In addition, the use of national average speeds will mask the self-selection of users who choose Liberty Global products on the basis of speed as it extends its service into new areas.

total Liberty Global subscription in each country using data supplied by Liberty Global. We assume that business users of broadband services work 40 hours per week across a 48-week working year. Within this time, we assume that businesses have an implicit value of time representing the opportunity cost of business time to businesses. Values of time are commonly used in economic impact assessments and appraisals. Oxera has used values from a report for the European Commission<sup>45</sup> on guidelines for assessment of trans-national projects in Europe.<sup>46</sup>

The total productivity benefits identified in each country by this method are shown in Table 2.7.

**Table 2.7 Total productivity benefits of Liberty Global's cable broadband rollout, 2013–Q1 2017 (NPV, 2017 prices, €m)**

| Country      | Productivity benefits |
|--------------|-----------------------|
| AT           | 20                    |
| DE           | 225                   |
| CH           | 47                    |
| BE           | 405                   |
| NL           | 370                   |
| IE           | 27                    |
| UK           | 124                   |
| CZ           | 41                    |
| HU           | 52                    |
| RO           | 95                    |
| SK           | 3                     |
| PL           | 96                    |
| <b>Total</b> | <b>1,505</b>          |

Note: All results shown in 2017 net present value real terms. All results are total for the period 2013–Q1 2017, excluding the Netherlands (2013–16 only).

Source: Oxera analysis of Liberty Global data.

<sup>45</sup> IER (2006), 'Developing Harmonised European Approaches for Transport Costing and Project Assessment', report for the European Commission, February. As these estimates are now more than 10 years old, we have used GDP growth estimates from the World Bank to inflate these to an estimated 2016 value.

<sup>46</sup> Romanian values of time were not available in the IER study. Oxera applied the value of time for Poland as a proxy for Romania in the model. This is likely to be more conservative than applying the EU25 average of €25.2 per hour which is also referenced in the IER study.

### 3 Summary of total economic impacts

This paper has considered two elements of the economic impact of Liberty Global's investment in cable broadband infrastructure – first, the scale (footprint) of the investment and second, the effect of this investment on consumers and businesses in the relevant countries.

#### 3.1 Economic footprint

The summary of Oxera's quantitative findings relating to economic footprint is given in the table below.

**Table 3.1 Economic footprint of Liberty Global investment, 2013–Q1 2017**

| Country      | Total investment (€bn) | Total Liberty Global jobs (average) | Economic activity (€bn) |
|--------------|------------------------|-------------------------------------|-------------------------|
| AT           | 0.4                    | 918                                 | 0.7                     |
| DE           | 2.2                    | 2,561                               | 3.9                     |
| CH           | 0.9                    | 1,551                               | 1.5                     |
| BE           | 1.9                    | 2,631                               | 3.1                     |
| NL           | 1.9                    | 4,033                               | 3.1                     |
| IE           | 0.3                    | 780                                 | 0.4                     |
| UK           | 5.9                    | 13,394                              | 9.4                     |
| CZ           | 0.2                    | 893                                 | 0.3                     |
| HU           | 0.2                    | 1,070                               | 0.3                     |
| RO           | 0.2                    | 1,646                               | 0.3                     |
| SK           | 0.0                    | 236                                 | 0.1                     |
| PL           | 0.4                    | 1,448                               | 0.6                     |
| <b>Total</b> | <b>14.5</b>            | <b>31,161</b>                       | <b>23.7</b>             |

Note: All monetary results shown in 2017 real net present value terms. All results are total for the period 2013–Q1 2017, excluding the Netherlands (2013–16 only).

Our analysis has shown that the scale of Liberty Global's investment has been substantial, with the total capital investment over the period equating to an average of €123 per household<sup>47</sup> in the countries considered, and expansionary investment of on average €526 per additional home added to Liberty Global's network.<sup>48</sup> Liberty Global has been able to expand its network significantly through this investment and acquisitions, enabling it to encompass an additional 3.9m homes and increase its coverage from 41% to around 43% of the homes in the countries considered. For most of these premises, Liberty Global will be providing the first fixed-line network competition to the incumbent telecoms company.

Delivering broadband investments is a complex economic activity, dependent on a long and interconnected supply chain. Alongside the investment from Liberty Global, Oxera estimates an additional €9bn of economic activity will have been generated through the upstream supply chain. The total economic activity associated with Liberty Global's investment is therefore €23.7bn.

<sup>47</sup> Calculated as the total value of Liberty Global's investment divided by the total estimated households in each country (not only those in Liberty Global's footprint). Total households data taken from ITU (2016), 'ITU Yearbook of Statistics 2016', Chronological Time Series 2006-2015, 42nd edition, December 22.

<sup>48</sup> Calculated as the total capital expenditure in new build across the countries and time period, divided by the additional homes added to Liberty Global's network.

### 3.2 Economic benefits

The scale of the investment is the starting point of an impact assessment. However, the more important question from an economic point of view is the effect that the investment has on participants in the wider economy. For example, a large, poorly directed investment is unlikely to generate as much value for society as a small investment that is well targeted at consumer and business demand.

Our analysis identified three key areas of benefits that Liberty Global investments have generated for consumers and businesses in Europe:<sup>49</sup>

1. **speed benefits**—customers are able to get access to greater speeds, allowing them to access a greater range and quality of Internet services;
2. **productivity benefits**—increased productivity for firms and their employees arising from better connectivity for small businesses and home workers;
3. **competition benefits**—inter-network competition placing downward pressure on prices, resulting in cost savings to European consumers.

Taken together, these benefits substantially overlap with the broader connectivity and growth benefits of higher-speed connections recognised by the European Commission in its Digital Agenda.<sup>50</sup> Oxera's quantitative findings relating to these economic benefits are summarised in Table 3.2.

**Table 3.2 Economic benefits of Liberty Global investment, 2013–Q1 2017 (€m)**

| Country      | Speed benefits | Productivity benefits | Price benefits | Total benefit | Social return |
|--------------|----------------|-----------------------|----------------|---------------|---------------|
| AT           | 187            | 20                    | 12             | 219           | 61%           |
| DE           | 1,328          | 225                   | 56             | 1,609         | 73%           |
| CH           | 49             | 47                    | 36             | 132           | 14%           |
| BE           | 255            | 405                   | 31             | 691           | 37%           |
| NL           | 736            | 370                   | 5              | 1,110         | 58%           |
| IE           | 50             | 27                    | 44             | 122           | 44%           |
| UK           | 1,332          | 124                   | 263            | 1,719         | 29%           |
| CZ           | 211            | 41                    | 10             | 263           | 169%          |
| HU           | 249            | 52                    | 25             | 326           | 143%          |
| RO           | 196            | 95                    | 18             | 309           | 157%          |
| SK           | 50             | 3                     | 6              | 59            | 122%          |
| PL           | 385            | 96                    | 30             | 510           | 125%          |
| <b>Total</b> | <b>5,028</b>   | <b>1,505</b>          | <b>536</b>     | <b>7,070</b>  | <b>49%</b>    |

Note: All monetary results shown value in 2017 real at net present terms. All results are total for the period 2013–Q1 2017, excluding the Netherlands (2013–16 only).

Source: Oxera analysis of Liberty Global data

As a commercial organisation, Liberty Global will enter into investments when these are expected to bring an adequate return to the capital investment. The 'social' returns described in the table above are in addition to any commercial returns (be they profits or losses) that Liberty Global make from the investment. The value of additional social benefits created by its investments is high relative to the scale of investment, with a total of €7.1bn of social benefit generated over

<sup>49</sup> Excludes shareholder returns generated in Liberty Global and its competitors.

<sup>50</sup> European Commission (2014), 'The European Union explained: Digital Agenda for Europe', November.

the period considered. For illustration, this represents an overall 'social return'<sup>51</sup> of 49% for the investments made during this period—a material positive spillover for European consumers and businesses.

The speed benefits are the largest contributor to this, at €5bn, but material benefits are also generated through competition effects (€0.5bn) and productivity improvements for businesses (€1.5bn). The overall benefit of these investments equates to approximately €60 per household in the countries considered by this study. The average impact is highest for households that have been added to the Liberty Global as result of this investment, at €194 per additional household.

Overall, our findings show a strong positive impact of Liberty Global's broadband investments.

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<sup>51</sup> In other words, returns on the investment generates for consumers and businesses, ignoring any profits or losses made by Liberty Global itself or its competitors.

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## A1 Video services and broadband requirements

As noted in section 2, an increase in broadband bandwidth may enable a higher quality video streaming format (e.g. 4K) than what was previously available. This could provide a richer experience to the consumer, and hence consumer benefits.

Video services are an important service category, in that they currently account for well over half the traffic in most markets, with the share set to increase in the coming years as shown in Table A1.1 below.

**Table A1.1: Percentage of video services within total residential traffic**

|                | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|----------------|------|------|------|------|------|------|
| World          | 65   | 67   | 71   | 74   | 78   | 82   |
| Western Europe | 61   | 65   | 70   | 74   | 78   | 83   |
| Italy          | 59   | 63   | 68   | 72   | 77   | 82   |
| UK             | 65   | 67   | 71   | 75   | 79   | 84   |
| France         | 70   | 71   | 74   | 77   | 80   | 84   |

Source: CISCO Visual Networking Index.

The way that subscribers consume video also determines the bandwidth (and hence speed) required to deliver the service. Higher-quality formats generally require more throughput, although improvements to compression techniques mitigate this growth to some extent. Where consumers use broadband links to consume linear (or broadcast) content, this typically increases the bandwidth requirement relative to catch-up applications. Typical bandwidth requirements for video services are shown in Table A1.2 below.

**Table A1.2: Bandwidth required to carry video services**

| Definition | Type   | Throughput required (Mbps) |
|------------|--|----------------------------|
| SD         | Video on demand (time shifted via catch-up services) | 2.3                        |
| HD         | Video on demand (time shifted via catch-up services) | 3.7                        |
| 3D         | Video on demand (time shifted via catch-up services) | ~10                        |
| Ultra HD   | Video on demand (time shifted via catch-up services) | ~60                        |
| SD         | Linear (time shifted via PVRs)                       | 5.7                        |
| HD         | Linear (time shifted via PVRs)                       | 13.7                       |
| 3D         | Linear (time shifted via PVRs)                       | ~ 30                       |
| Ultra HD   | Linear (time shifted via PVRs)                       | ~250                       |

Source: Ofcom (2013), 'Review of the wholesale broadband access markets', consultation, July 11, Table 3.2.

As an example, a household upgrading from a 30Mbps to 60Mbps might be able to enjoy video on demand content in ultra HD where this was not possible previously. Additional bandwidth could allow households to do more online simultaneously with a single connection—a crucial benefit as digital households connect more devices and make more use of the Internet. In the 30Mbps to 60Mbps upgrade example, a family could watch up to four separate linear programmes in HD, such as sports or live broadcasts, where only two were previously possible.<sup>52</sup>

<sup>52</sup> Other combinations are possible, such as simultaneous use of video calling and video streaming.

[www.oxera.com](http://www.oxera.com)