

## DIGITAL ECONOMY

# Access and availability of ICT in European households: a comparative study

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## 1. Introduction

The spread of Internet access is a key aspect for explaining the changes in modern economies and societies. The services offered by the Internet contribute to growth and employment, as well as to productivity, savings (public and private) and consumers' well-being. The Internet is increasingly present in more and more sectors of the economy, and the digital economy contributes to the development of industry, providing the necessary infrastructure for the creation and growth of businesses. Despite the continuing adverse economic situation in Europe, Information and Communication Technology (ICT) has contributed to job creation, providing five new jobs for every two that it destroys<sup>1</sup>. In fact, forecasters say that Europe could increase its GDP by around 4% by 2020 if it stimulates the creation and development of a digital single market. Moreover, the public authorities could reduce their costs by between 15% and 20% thanks to the development of the electronic administration<sup>2</sup>.

As regards the telecommunications market in the European Union (EU), it lags behind its international competitors. Despite the efforts made and the proposed Digital Agenda for Europe<sup>3</sup>, one of the main obstacles is the continuing lack of a digital single market, because the present market is fragmented by national borders, with 28 markets co-existing, each with different laws, restrictions and ways of operating. This leads to significant inefficiency in the development of the European digital economy. The lack of a single digital market hits consumers directly in their pockets, since they have to pay roaming rates when crossing borders if they need to use mobile networks. Since May 2016 new rules have been in force on neutrality in Internet connection, reducing roaming charges for calls, SMS and data usage, and in June 2017 these charges will be eliminated completely<sup>4</sup>.

The European telecommunications sector is notable for its lack of transparency and the small number of operators acting supranationally, which leads to higher prices. Moreover, the fragmentation of the European market acts as a brake on competitiveness and innovation, hampering efforts to stimulate demand since there is no free circulation of on-line content and services.

The EU must intensify investment in infrastructure and advanced communication networks in order to be able to provide satisfactory services to both firms and consumers. R&D expenditure on ICT in Europe is just 40% of the equivalent US figure. So it is not surprising that Europe's broadband coverage and speed should evolve more slowly than those of other parts of the world, as well as the second generation broadband (e.g. fibre optic), which covered only 1% of European households in 2009 and 5% in 2013. In contrast, South Korea and Japan went from around 13% in 2009 to more than 40% in 2013. Even so, the ICT sector was directly responsible for 5% of Europe's GDP in 2009 (€660 billion), with about 20% of its contribution to overall productivity coming directly from the ICT sector and 30% from other sectors' investments in ICT<sup>5</sup>.

1: See McKinsey's Global SME Survey (2010).

2: See Ron Davies (2015), Using technology to improve public service and democratic participation, European Parliament.

3: For further details, see: <https://ec.europa.eu/digital-single-market/>

4: According to the European Commission (2015), from May 2016 roaming usage must be deducted from the domestic volume (this was not previously the case), and the maximum limits on roaming charges are reduced from €0.19 to €0.05 per minute for outgoing calls, from €0.06 to €0.02 per outgoing SMS and from €0.20 to €0.05 per megabyte of data download. These figures do not include VAT.

5: European Commission (2010), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM/2010/0245 final.

Another aspect with room for improvement in the EU is the average speed of mobile data. In the US, South Korea and Japan, 4G networks account for 88% of subscribers, while in Europe the percentage is barely 6%. Europe's lagging behind its competitors in network technology is particularly worrying, since the ever increasing number of digital innovations requires high, reliable and generalised connection speeds. The limited powers the member states grant mobile operators leads to unequal results among countries. These differences are particularly notable with regard to access to 3G mobile networks.

The effective use of digital technology could provide European citizens a better quality of life, reflected in improved healthcare, better and safer transport networks, new opportunities in the field of the media, greater ease of interaction with governments and easy access to cultural content, as well as a more favourable environment. It is estimated that the current inefficient use of ICT costs as much as €100 billion a year (equivalent to 0.9% of the European GDP)<sup>6</sup>.

The absence of a digital single market, the inefficient adaptation of policies and the limited use made by some industries of the possibilities offered by Internet have led to Europe being left behind. For all these reasons it is considered necessary to develop the enormous potential of the continent, with a domestic market of 500 million people, to drive growth and competitiveness and thus once again occupy the lost leadership in this sector, in which in 2013 only ten European companies dedicated to the ICT sector were among the world's top 50 and none of them in the top ten<sup>7</sup>. For this purpose in March 2010 the European Commission (EC) started up the Europe 2020 strategy, with the objective of preparing the European economy for the challenges of the next decade. The economic crisis has destroyed years of economic and social progress and has left the structurally weak points of the European economy exposed. To return to the right path, three options are discerned: work harder, work longer or work smarter. The last option is the only one that guarantees an improved standard of living for Europeans, and it brings an increasingly digital society and economy.

The Digital Agenda for Europe initiative is one of the seven pillars of the Europe 2020 Strategy, and its purpose is to define the essential enabling function that the use of ICT must perform if Europe is to realise its ambitions for 2020. By 2020 digital content and applications are expected to be delivered almost exclusively by Internet. The roll-out and adoption of faster networks open the way to more innovative services capable of making a better use of the higher speeds.

The actions of the Digital Agenda for Europe are based on the need to address seven problematic matters affecting the development of the digital economy and forming part of one of the main objectives for the attainment of the Europe 2020 strategy:

- Fragmented digital markets
- Lack of interoperability
- Rise in cyber-crime and risk of low trust in networks
- Lack of investment in networks
- Insufficient research and innovation efforts
- Lack of digital literacy and skills
- Missed opportunities in addressing societal challenges

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6: European Commission (2013), Europe's digital challenge, Contribution to the European Council meeting.  
7: See Fortune 500 Rankings (2013).

The main objective of this study is to address the question of access to ICT by households, through a series of indicators that can quantify and evaluate the state of play in the various countries of Europe. For this, we have information provided by Eurostat and collected by the statistics institutions of the participating countries. These are uniform surveys carried out on households and individuals, offering information from the demand side on access to and the use of ICT in the countries of Europe, not only the EU. The period of study is from 2008 to 2013.

Our purpose is threefold: to identify the countries that stand out in terms of access to technology and others that are behind, and thus to assess the degree of disparity existing within Europe in this area; to characterise the socio-economic variables that may influence households' having access to the Internet and the latest technology available on the market; and to establish a comparison among the regions of Europe in order to see whether there are also differences within countries.

The results show a favourable trend in computer and Internet access in European households, with average computer access of 77% and Internet access of 76% in 2013. We see that the barriers to Internet access are varied and complex. The significance of the type of barrier is largely a function of the degree of Internet democratisation among citizens. Particularly, the barriers associated with self-exclusion (42%) and lack of skills (34%) stand out. Access costs also become relevant in countries where the level of prosperity is below the European average.

In general, the majority of European households have broadband connection. Access to mobile networks increased considerably between 2010 and 2013, although few households select this method of connection as their first choice. The results suggest that the countries that are last to adopt ICT are also more likely to adopt the latest technology directly. The other countries introduce it more gradually, replacing older technology with it or running both in parallel for a certain time. The economic level and location of households, depending on the degree of urbanisation, are decisive factors for access to both the Internet and technology available on the market.

The Northern and Central regions of Europe are far ahead of the Southern and Eastern regions as regards Internet access. In most regions broadband is the main method of connection (90% of households), with some minor exceptions such as Turkey. However, second generation broadband is not so uniformly distributed, with North-eastern Europe and Portugal standing out in terms of new technological access facilities. There are no differences among the regions inside any single country in terms of access to mobile networks, but there are among countries.

The rest of the study is organised as follows. In Section 2, we describe the main aspects of the database used for the study. We comment on the variables of interest in the document, and on the means whereby they are handled and constructed in Section 3. In Section 4, we summarise and explain the main results obtained. We present some of the main conclusions drawn from the study in Section 5. In the Appendix, we provide information of interest, such as the definition of the variables affecting access to the Internet and to the technology used, as well as the socio-economic characteristics of the households.

## 2. Survey on the Information Society

The statistical data on the use of ICT can be found in the survey entitled Community Statistics on the Information Society (CSIS), and are produced on the basis of Regulation (EC) No. 808/2004 of the European Parliament and of the Council concerning Community statistics on the information society.

The information is gathered each year by Eurostat and the national statistics institutes of all EU member states<sup>8</sup>, two EFTA countries (Iceland and Norway) and EU candidate countries and associates. The national statistics institutes use a standard questionnaire developed by Eurostat and harmonised at EU level<sup>9</sup>. Each national statistics institute is responsible for providing statistically reliable and representative data.

The information is provided annually, and some is available on Eurostat's website from 2003, but information from micro data is available only for the years 2008 to 2013. In general, the data are sent in the first quarter of the reference year, although this can vary from one country to another.

The statistical units are households and individuals. The study extends to households with at least one member aged between 16 and 74 and individuals subject to the same interval. The information on access to ICT is compiled at household level, whereas the use of ICT is taken at individual level. Thus the questionnaire provides information on the following common areas<sup>10</sup>:

- Selected access to ICT (households)
- Use of computer, location, frequency of use, activities (individuals)
- Use of Internet (individuals)
- E-commerce (individuals)
- Special modules in advanced services, skills, use of mobile for Internet connection, trust and security (for individuals from 2011 onward)

Since 2007 participating countries have sent the micro data to Eurostat voluntarily. The aim of the study is to provide accurate, quality information on access to and use of ICT in the EU. The results are used to support the objectives of the Digital Agenda for Europe.

## 3. General overview of the variables of interest

In this approximation to the survey data, we pay particular attention to access to ICT, barriers on access and the type of technology used in European households. For this, we have a total sample of 827,848 households distributed over the period 2008-2013. The number of countries covered by the comparison is subject to the availability of the micro data. In Table A.1 in the Appendix we show the number of households by country and year.

The model questionnaire proposed by Eurostat is used generally in the member states. However, there are some slight differences in translation, reference periods and in the treatment of questions without answers, so some results tend to be difficult to compare among countries.

It proved necessary to make some adjustments so as to establish a greater degree of uniformity and comparability. Household size was reduced to a total of five categories. Although in the great majority of countries household size is differentiated in eight categories, Austria and the Netherlands reduce this to five

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8: Germany has been excluded from this study since the survey available does not provide micro data for it.

9: For a general description and some more specific methodological characteristics of the CSIS such as the stratification and design of the sampling and the calculation of standard errors, please refer to the Methodological Manual published annually by Eurostat, which can be found at: <https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp>

10: We also study other particular matters for specific years, going more in depth into the following aspects of ICT: advanced services (2008); e-commerce and trust (2009); on-line security (2010); tools and digital literacy (2011); mobile use of the internet and ubiquitous connectivity (2012); and e-government and user satisfaction (2013).

and six categories, respectively. Individuals answering “don't know/no answer” to the questions were considered missing values to avoid affecting the results. There are also certain changes that reduce comparability as a result of the development of ICT, for example the type of Internet connection. For this reason, we differentiated between two types of connection, narrowband and broadband, before subsequently selecting in detail the variables constituting each type of connection.

In order to study the question of social inclusion, we collected a series of socio-demographic characteristics of households:

- Geographical location by level of development
- Degree of urbanisation
- Type of household
- Net monthly household income;
- Region of residence (using the NUTS 1 territorial demarcations)

In Tables A.2 and A.3 in the Appendix, we present a summary of the variables affecting access to ICT and the socio-demographic characteristics of households, together with a brief definition of these.

The decisions taken by households on the availability and use of ICT are sequential, and this is reflected in the design of the questionnaire. The use of the Internet requires an appropriate device. This device has traditionally been the computer, considered now in its many and varied forms. However, this device has greater competition among Internet users, given the growth of other well-known alternatives such as smartphones and tablets. Despite this, the availability of a computer in the home can still be considered as a good first approximation to households' use of ICT.

Regardless the device used, the key to this section lies in the implications deriving from the use of the Internet. Households may or may not have Internet access. In this context, the sequential nature of the decision-making process is determinant. This first decision determines (at least in part) the study of any subsequent decision relating to consumers (such as e-commerce, carrying out procedures with government authorities on-line or e-banking) and leads to a second necessary analysis if they do not have Internet: the barriers on Internet access.

The survey includes reasons for which the household does not have Internet access, which are identified with the barriers on access:

- No need the access to Internet
- Internet access elsewhere (other than in the home)
- Reasons associated with the cost of the equipment
- Reasons associated with the cost of access to the service
- Lack of privacy or security deriving from use of the Internet
- Lack of skills for using the service
- Other reasons not covered by the above

The variety of sources of barriers and their relative weight in the group affected largely determine the actions of a political nature. Given that two of the pillars established by the EC (2015) in the Digital Single Market Strategy emphasise improvement to consumer access to on-line goods and services, and in the interests of creating the right conditions for digital networks and services to prosper, policies centring appropriately (in time and place) on the most significant barriers will prove more effective.

Once the household has Internet access, this opens up the possibility of an ever greater variety of technologies associated with this access, which will require a third analysis. Where the household says that it has Internet access, the survey offers disaggregated information on the technologies for connecting to Internet based on an initial differentiation between:

- Narrowband Internet connection: created variable covering the options considered as such, normal telephone line and narrowband.
- Broadband Internet connection: created variable covering the options considered as such, DSL and other broadband connections.

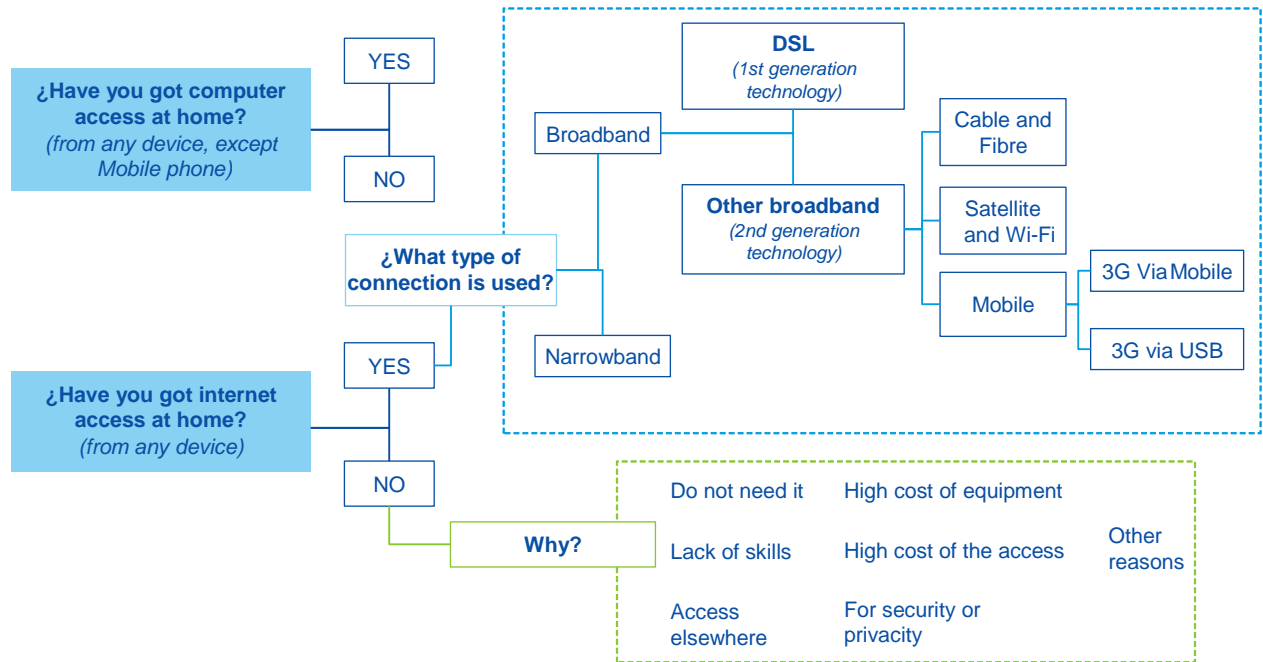
These two categories of connection give rise to further technological disaggregation:

- Internet connection through normal telephone line or ISDN.
- Internet connection through mobile narrowband, GPRS and higher, but below 3G.
- Internet connection through DSL, ADSL, SHDSL or VDSL: Considered the first generation broadband connection since it was the first connection method of this type offered on the market.
- Internet connection through other broadband type connections: Considered the second generation broadband connection since it is the latest connection method of this type offered on the market.
- Second generation broadband Internet connection: Breakdown of the aforementioned variables into three different second generation broadband connection methods, cable and fibre optics, satellite and Wi-Fi and mobile networks. The breakdown can be given only for the period 2010-2013, since this information is not available for earlier years.
- Internet connection through 3G mobile network: Breakdown of the 3G mobile network variable into different methods of mobile connection, mobile terminal (3G mobile) and USB terminal (3G USB).

This varied availability for the consumer is limited by factors relating to the barriers, such as price and lack of need, and by factors relating to supply (telecommunications companies and regulation of the telecommunications sector). The type of technology also seems to strongly influence consumers' subsequent decisions in the field of ICT on the use of the Internet in a broad sense, beyond searching for information, such as access to more complex services and on-line purchases of goods and services.

Figure 1 shows a graphic summary of the sequence of decision-making and technology availability.

Figure 1  
Graphic summary with the variables of interest



Source: BBVA Research and Eurostat

## 4. Results

In this section we carry out a wide-ranging study of access to ICT at country level for Europe. Following the line of argument of the previous section, we provide information on the extent of computer ownership, Internet access, barriers on access and the types of connection when it is used, i.e. the technology used in European households.

When consumers are going to acquire a new product (or technology) at a given time, we see a pattern in the cumulative adoption of an innovation which follows a typical “S” shape. As pointed out by Alonso and Arellano (2015), the speed at which the adoption takes place is related to the number of innovators and imitators. The innovators are the consumers who adopt or buy the new product or technology irrespective of other consumers’ behaviour. Their consumption preferences tend towards trying new products simply because they are new. The imitators start to consume or adopt these products when they see that the innovators derive value from consuming them and think that they may also improve by adopting the technology. The same philosophy can be applied to the countries of Europe.

This theoretical process of adoption at more aggregated level is of great importance in this document, since it will allow us to differentiate between pioneering countries in access to ICT (and therefore to the latest available technology as it is developed) and the other countries lagging behind which have acquired the latest technology due to their being followers, and which may benefit from a process of technological propagation allowing them to reduce the lead of countries habitually more inclined towards innovation.

Similarly, we identify and quantify the barriers that impede Internet access to a greater or lesser extent in European households. We also present the socio-demographic profile of the European households with the greatest access to Internet and to the latest technologies.



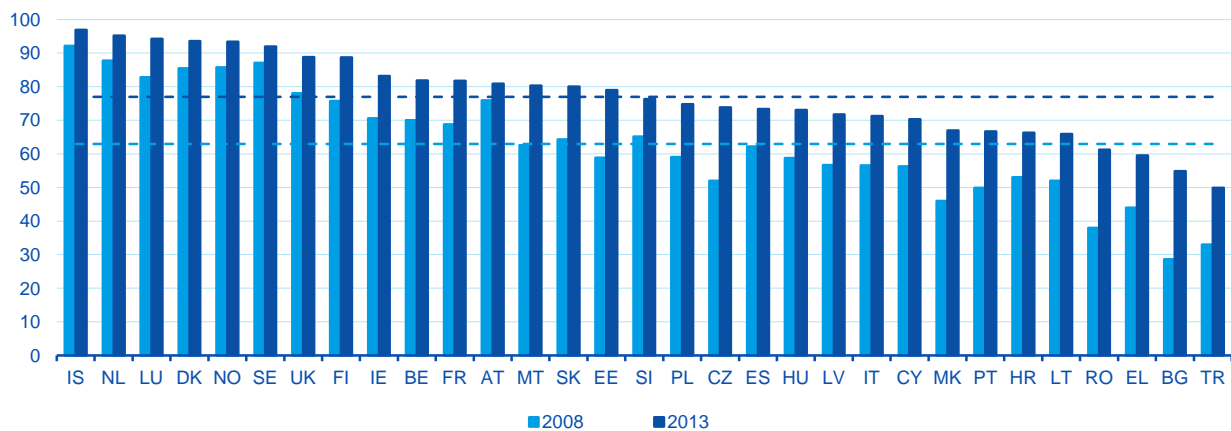
### 4.1. Access to a computer in European households

Computer ownership in European households has grown only slightly, due largely to the high starting point. In 2008, 71% of households in the EU-15 had a computer, and by 2013 this proportion had reached 82%. The European average increased by more than 10 p.p. to nearly 77% in 2013, as shown by the dotted lines in Figure 2, which shows the classification by country in descending order of percentages for 2013.

Although the gaps are narrowing, there are still large divergences between countries in the North (headed by Iceland) and West (the Netherlands, Luxembourg and the UK) and those in the East of Europe (Romania, Greece, Bulgaria and Turkey). In 2008, 92% of Icelandic households had a computer, and by 2013 this percentage covered almost the entire population (97%). In contrast, Bulgaria and Turkey are bottom of the list, with percentages in 2013 more than 10 p.p. below the European average for 2008.

All countries present increase in the percentages, although these varied from country to country, affecting the relative order. This difference in growth is not necessarily related to the initial level, and there are countries that perform better than others even though they have similar initial percentages. By way of example, there are countries with better performances than their peers, such as Bulgaria (which increased the proportion by 26 p.p. to reach 55% of households), Estonia (which grew by around 20 p.p. to 79%) and Luxembourg (which increased its proportion by 11 p.p. to 94%). At the opposite end are Greece (which grew by 16 p.p. to 60%), Spain (which grew by 11 p.p. to 73%) and Austria (which grew by 5 p.p. to 81%).

Figure 2  
Access to a computer in European households (%)

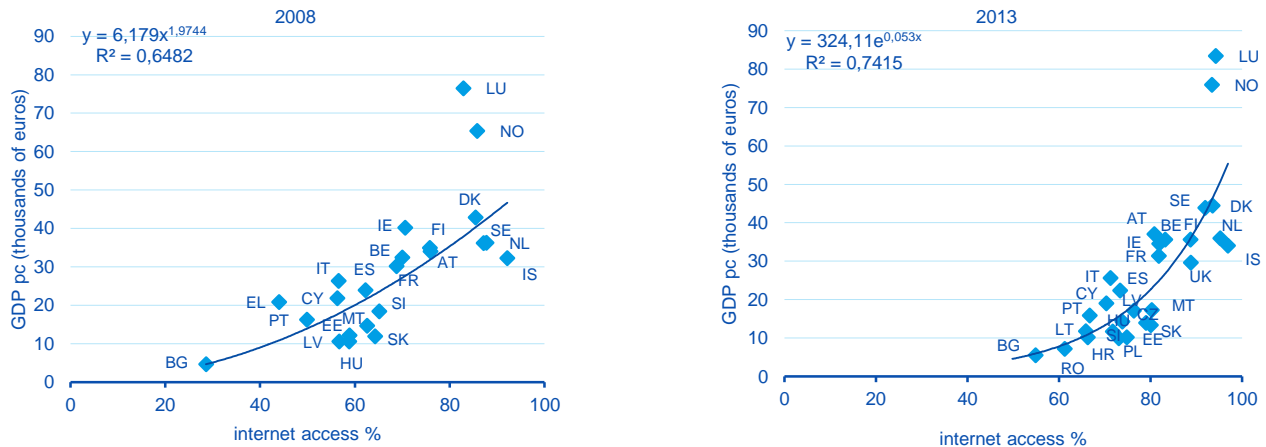


Note: The relation between code and country can be seen in Table A.1 in the Appendix.  
Source: BBVA Research and Eurostat



These differences seem to suggest the existence of a correlation between computer access and income in Europe. With a view to approximating the extent of this correlation, we present Figure 3:

Figure 3  
Access to a computer (%) and per capita GDP



Note: The relation between code and country can be seen in Table A.1 in the Appendix.  
Source: BBVA Research and Eurostat

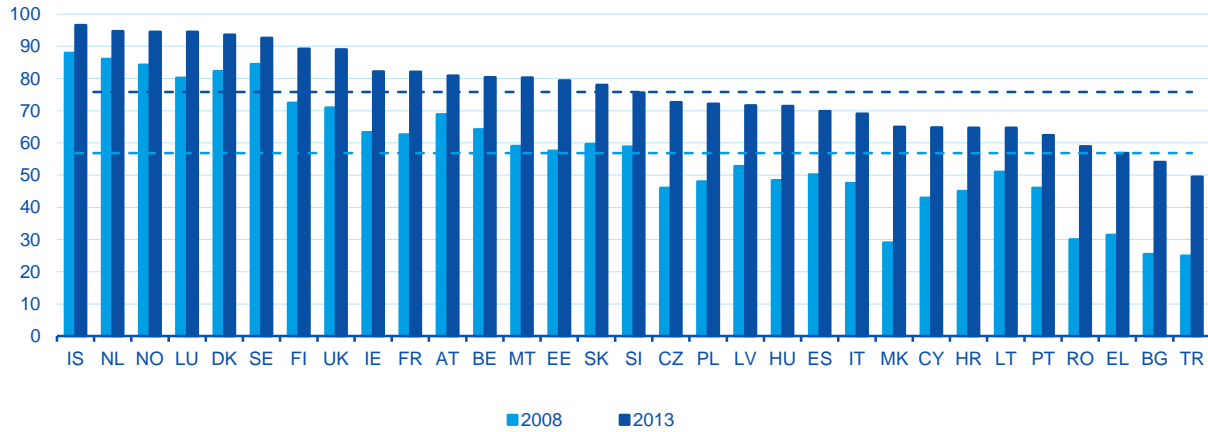
The Figures reflect the relative importance of per capita GDP for computer access in households and how it evolved during the years of economic crisis. The Figure for 2008 already shows a certain degree of maturity in the spread of this technology, following the references made in Arellano et al. (2016): the shape of the trend line in computer access is convex in 2008, and this is accentuated in 2013. This process of accentuation implies that the influence of income on access diminishes. Per capita GDP proves still to be a salient factor in having a computer at home. However, this behaviour reflects an imminent socialisation of access to the computer in all households regardless of the level of income, with the significance of per capita GDP as an influencing factor diminishing accordingly.

#### 4.2. Internet access in European households

As regards households' Internet access, the classification by countries is carried out in descending order of percentages for 2013. The results confirm that despite the economic difficulties suffered in much of Europe, deriving from the 2008-2013 crisis, the process of spreading Internet access continued, going from an average of less than 60% in 2008 to more than 70% in 2013, as shown by the dotted lines in Figure 4.

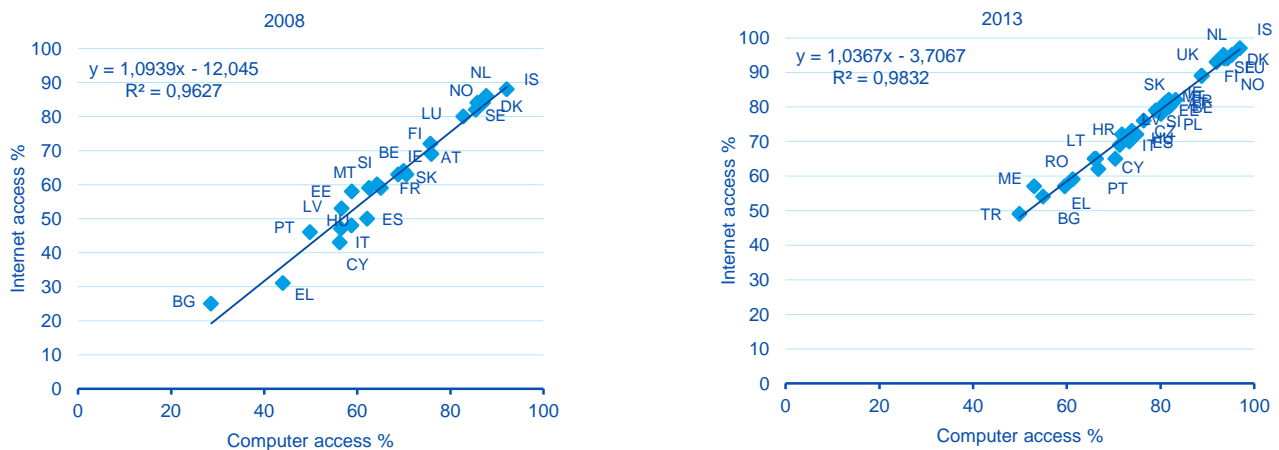
Figure 5 shows that countries in the North and West of Europe have greater Internet access, well in excess of the European average, in both 2008 and 2013. Thus, Iceland is the country with the biggest proportion of households connected to Internet, 88% in 2008 and 97% in 2013, with the same percentage of households having computer and Internet. Very close behind come the Netherlands and Norway, each with 95% of households connected. At the opposite side, Turkey and Bulgaria have the lowest percentages of households with Internet access in 2013, in neither case surpassing the European average for 2008 (57%).

Figure 4  
Internet access in European households (%)



Note: The relation between code and country can be seen in Table A.1 in the Appendix.  
Source: BBVA Research and Eurostat

Figure 5  
Access to computer and Internet (%)



Note: The relation between code and country can be seen in Table A.1 in the Appendix.  
Source: BBVA Research and Eurostat

### 4.3. Barriers on Internet access in European households

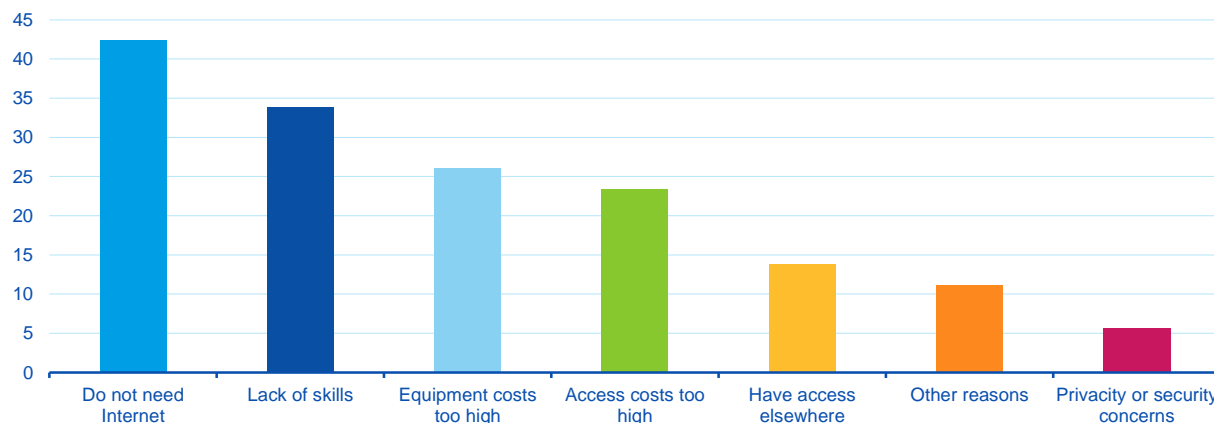
The percentage of the European population that does not access the Internet is decreasing, but in view of the EU's interest, set out by the EC (2015) in the Digital Single Market Strategy, in incorporating the entire population into ICT, the reasons for not incorporating take on particular relevance and significance. The very development of ICT directly affects the barriers to Internet access.

As a first approximation to the factors negatively influencing households and preventing them from establishing Internet access, we present Figure 6, which shows the European average for 2008-2013 of the percentage of households without Internet access that consider potential reasons for this. Each household can indicate any number of barriers on access. The main barrier is self-imposed or voluntary barriers (no need to have Internet access), chosen by 42% of households with no Internet access. Lack of skills comes second, with 34%. The third group of barriers is related to costs (cost of equipment around 26% and cost of access approximately 24%). Availability of access in places other than the home is given as the reason by

14% of households without Internet. Considerations of security and privacy represent a barrier for only 6% of households without Internet access.

Figure 6

#### Barriers on Internet access (% of households without Internet access, average 2008-2013)



Source: BBVA Research and Eurostat

This initial general overview is complemented by a comparative study by countries and types of barrier for the years 2008 and 2013, with a view to ascertaining the degree of disparity in the importance of the barriers considered and how this has evolved. Each graph in Figure 7 represents the percentages of households without Internet access in 2008 (horizontal axis) and 2013 (vertical axis) which say they perceive this barrier. In these figures we show only those countries that have this information in the two years under consideration. All graphs in Figure 7 have been adjusted to the percentages presented by the countries considered as a whole. Next to the points representing the countries, we present the bisector of the first quadrant. The countries shown below the bisector reduced the weight of the barrier in question between 2008 and 2013, whereas points above indicate an increase in the percentage.

The importance of the barriers over the period 2008-2013 diminished in line with the results of Figure 4, and this reduction also generated a change in the composition of the types of barriers. The “Internet access elsewhere” barrier is tending to fall in the majority of countries. On the other hand, “no need”, lack of skills and considerations of privacy or security seem to be increasing across the board. Reasons associated with the cost of access and of the equipment show less uniform behaviour. This general result confirms a certain development in the particular features of the group of households that still have no Internet access, centred increasingly on aspects associated with lack of interest and skills.

These general conclusions require certain particular assessments by country. This is due to the high general degree of disparity, both among countries for each barrier and among barriers for each country. In the first case, we see a certain correlation between the barriers associated with cost and economic and technological development of countries, which is maintained over time: these barriers are more significant in Estonia, Latvia and Portugal compared with Luxembourg, Denmark, Malta, and the Netherlands in 2008; for 2013 Estonia, Hungary, Slovenia and Portugal show the highest percentages, compared with the low figures of Norway, Malta, Luxembourg and Denmark. This correlation is not due only to the household income factor: it may be associated with competition policies and the extent and ease of access to technology and telecommunications markets.

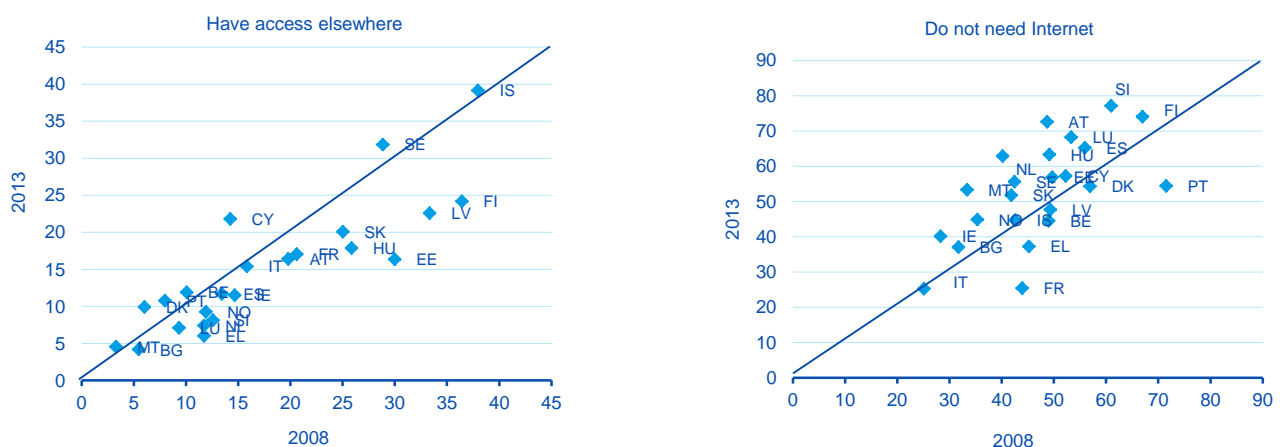
Privacy or security, and access other than in the home show a more concentrated and relatively stable trend over time in all countries, unlike the other barriers. In both cases a remarkably high percentage is shown by countries with very widespread use of the Internet, such as Iceland, Finland and Sweden, although the reasons for this behaviour may be different for each barrier. The increase in the privacy or security barrier may correspond to increased importance attached to these considerations by consumers. However, the “access elsewhere” barrier is on the decline, possibly due to technological improvement and the socialisation of Internet access.

“No need” and lack of skills are the commonest barriers in practically all European countries, although their respective importance varies among countries and the results obtained do not tell us anything about substitution or complementarity between the two reasons. The percentages of “no need” and lack of skills are particularly high in Finland and Portugal, while in Luxembourg and Austria “no need” is more common than lack of skills. On the other hand, Iceland saw a huge increase in the relative weight of lack of skills between 2008 and 2013, while the percentage of “no need” remained stable.

Despite this, the preponderance of these two barriers declined between 2008 and 2013, while the “cost of equipment” barrier increased, being placed as the second most important reason in 2013 for Estonia, Hungary and Latvia, and in first place in the case of France and Romania.

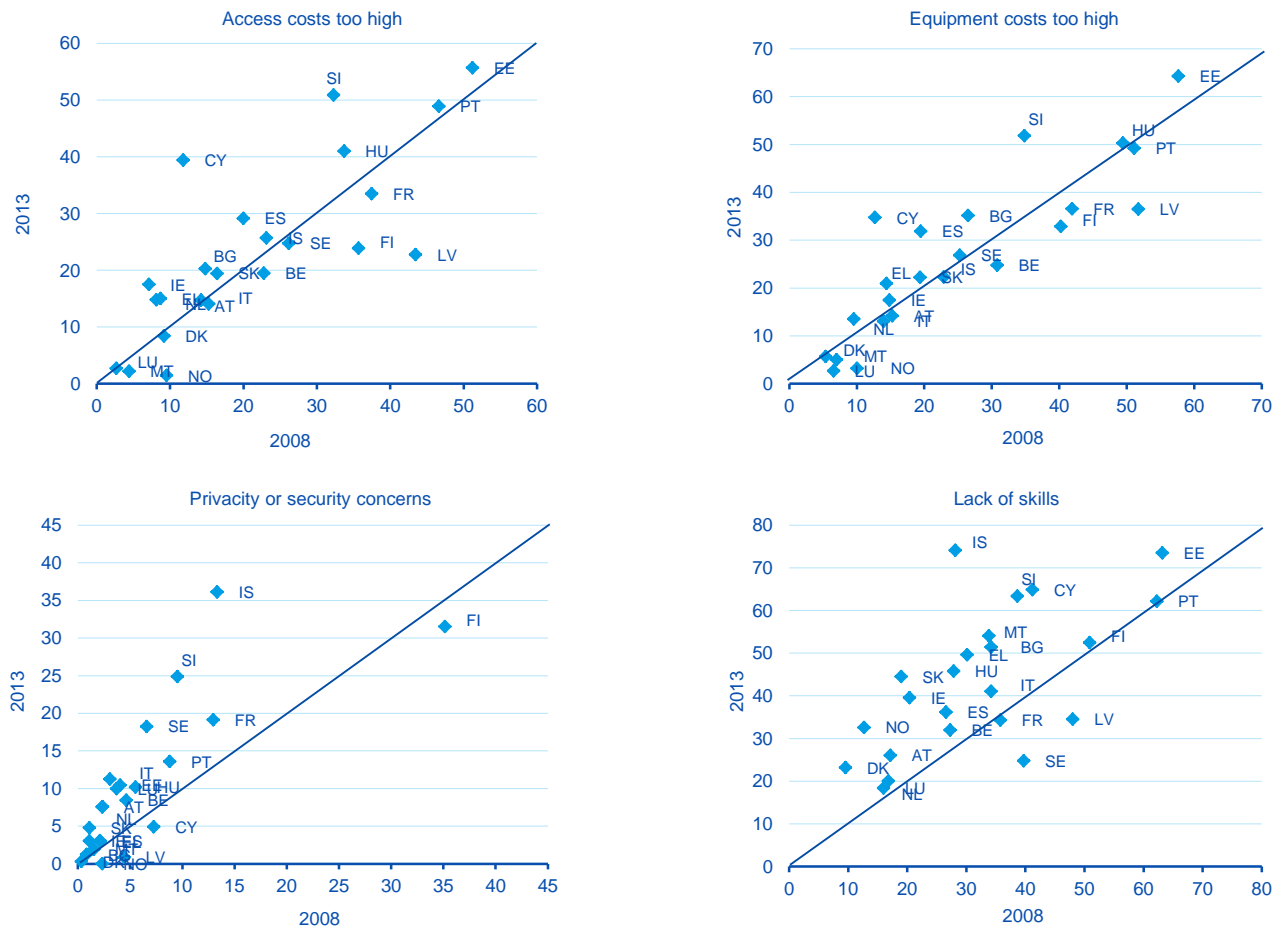
Looking at the disparities among barriers for each country, we see significant differences among countries that are apparently similar in their widespread use of the Internet, as in the case of the Nordic countries. Iceland (with one of the highest percentages of barriers in 2008 and the highest in 2013, except in the case of the “no need” and the cost-related barriers) and Finland (normally among the three highest percentages of barriers except for the cost-related one, in both 2008 and 2013) show a completely different trend from that of Denmark (which has lower-than-average percentages and the lowest percentages in half the barriers in 2008) and Norway (with lower-than-average percentages in 2008 and with the lowest percentages for some barriers in 2013). One possible explanation for this result is associated with the small size of the groups interviewed. This may influence the results, leading to an increase in disparities.

Figure 7  
**Barriers on Internet access, comparison by countries, 2008 and 2013 (%)**



The relation between code and country can be seen in Table A.1 in the Appendix.  
 Source: BBVA Research and Eurostat

Figure 7  
Barriers on Internet access, comparison by countries, 2008 and 2013 (%) (cont.)



The relation between code and country can be seen in Table A.1 in the Appendix.  
Source: BBVA Research and Eurostat

#### 4.4. Development and comparison of technological equipment in European households

The Internet disposition in European households has increased only slightly given the EU's high starting levels compared with other countries, as also shown by Arellano et al. (2016).

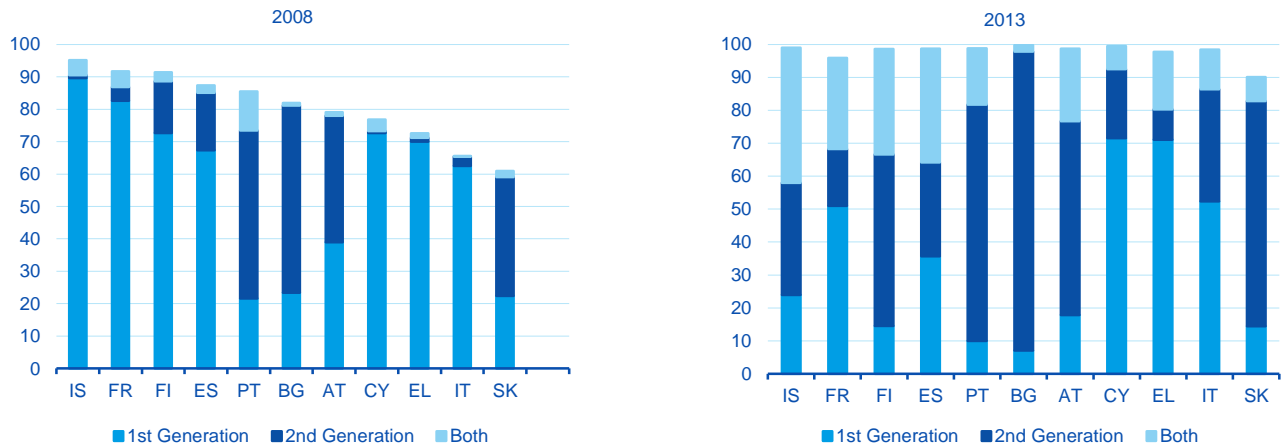
In this section we examine households' technological level for Internet access, using the methodology set out in Figure 1. We have information on the possession of connection methods based on narrowband and broadband. Similarly, we differentiate among the various types of connection within broadband, such as first generation broadband (over basic telephone line) and second generation broadband (over cable, fibre optic and high-speed mobile networks), which allows faster navigation. We analyse how household's access to the latest technology has evolved as it has become accessible to greater sections of society.

Figure 8 shows the evolution of the connection methods used to Internet access for several countries between 2008 and 2013, as well as overlaps of more than one type of connection.

In this Figure, 100% represents all households with Internet access, and the difference between each value and the total is the percentage of households with narrowband. The column refers to the sum of first and second generation broadband, as well as households that have both types of connection or access

technology at the same time. The results are shown for the years 2008 and 2013, with countries ranked in descending order by percentage of broadband in 2008.

Figure 8  
**Breakdown of broadband into first and second generation technologies (%)**



The relation between code and country can be seen in Table A.1 in the Appendix.  
 Source: BBVA Research and Eurostat

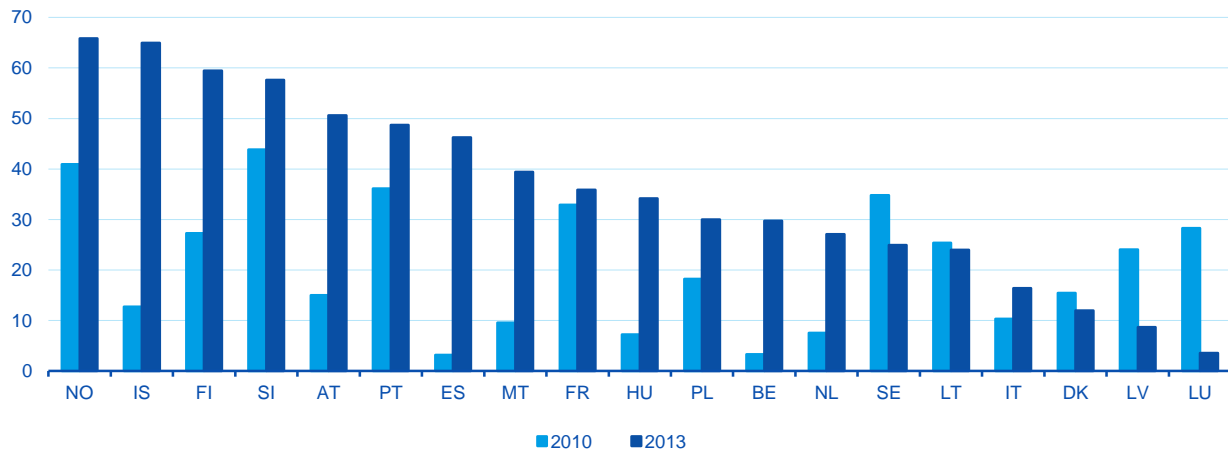
The main connection method in European countries is broadband. Although some countries have evolved favourably, there are still others that lag behind in the use of second generation broadband. The use of narrowband has been totally displaced by the new technology, accounting for barely 6% in 2013 compared with 15% in 2008.

The results show different trends in the adoption of technologies, influenced at least in part by a remarkable degree of persistence. Countries such as Bulgaria, Portugal and Slovakia have gone directly to the use of second generation broadband. This is mainly due to their relatively late arrival on the Internet scene, which allowed them to go straight to the latest connection method without having to adopt the latest available technology as and when it appeared, as happened in the case of Iceland and Finland.

These last two countries have a large number of households connected to high-speed networks (second generation broadband), and also a notable degree of overlap in methods of connection used (see Figure 9). They have been through a more classic process of transition in the adoption of technology, and have not abandoned the technology previously used when implementing the latest available technology. This behaviour has allowed the Nordic countries to react faster to technological change, obtaining the latest access technology, although they are not so quick to dispense with the technology already in place in their households, with the exception of Sweden, which also acquires the latest technology but uses it to replace that formerly in place.

On the other hand, France, Greece and Italy can be considered followers of the former group, since they react more slowly to technological changes. In 2013 the main method of connection in these countries was still first generation broadband. Spain's behaviour is more similar to that of the Nordic countries. All the foregoing can be seen more intuitively by looking at Figure 9.

Figure 9  
Households with two or more types of connection (%)



The relation between code and country can be seen in Table A.1 in the Appendix.  
Source: BBVA Research and Eurostat

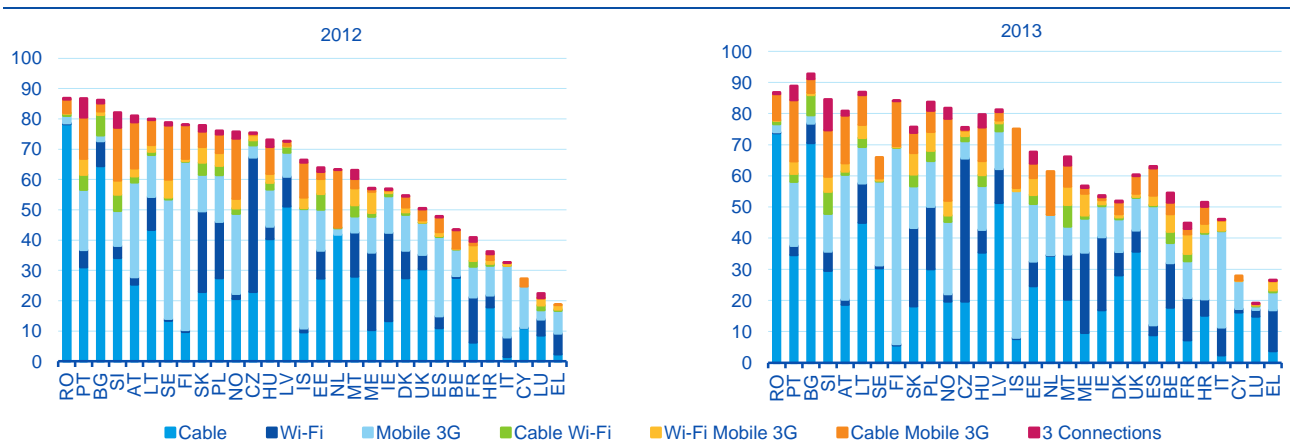
Norway, Iceland and Finland stand out among countries with the largest proportion of households having two or more types of Internet connection at the same time. There was a considerable increase between 2010 and 2013, especially in Iceland, which went from 12.7% to approximately 65%. A similar trend was seen in Spain, which went from around 3% in 2010 to just over 46% in 2013. In contrast, Sweden, Lithuania, Denmark, Latvia and Luxembourg have reduced the percentage of households with more than one type of connection. This result shows different ways of adapting to transformation in the area of ICT, with some countries running technologies in parallel and others quickly replacing old technology with new. Consequently, the technological pattern of European countries is disparate, with old technology being replaced by new at different speeds and new technology being adopted in auxiliary or complementary form.

Figure 10 shows a breakdown of second generation broadband technology into its components, ranking countries by percentage of access to second generation technology and a comparison between 2012 and 2013, these being the years for which data are available. The 100% represents all households with Internet access by means of first and second generation broadband.

Although there is no particularly sudden change in the segregation of second generation broadband technology from one year to the next, it is interesting to analyse the different types of technology of which it is composed. The distribution among methods of connection is rather disparate from one country to another. Focusing on the methods with the highest percentages, the use of cable is predominant in Romania and Bulgaria, with around 70% of households having his type of connection in both years. On the other hand, 3G mobile networks are particularly relevant (over 30% in 2012 and 40% in 2013) in Finland, Sweden, Iceland and Austria. Lastly, Wi-Fi is the most commonly connection method in the Czech Republic, Ireland and Slovakia (over 25% in both years).



Figure 10  
**Breakdown of second generation technology, 2012 and 2013 (%)**



The relation between code and country can be seen in Table A.1 in the Appendix.  
 Source: BBVA Research and Eurostat

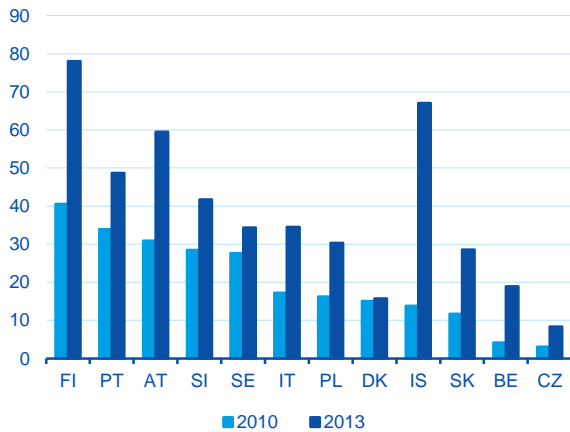
Many households have several methods of connection based on second generation broadband, which again is evidence of a certain overlap in time. Norway, Portugal, Austria and Iceland stand out among the rest in terms of the increased percentage of households with both cable-type and 3G mobile connection (over 15% in 2013 in all four countries). Norway is the country with the largest simultaneous overlap in connections, above 26%.

The case of Luxembourg is striking due to the high Internet usage and low possession of second generation technology in its households. Based on the information to hand, the way in which the surveys were constructed and the degree of uniformity that has to be assumed for the comparison, we consider it reasonable for the surveys not to take account of other more recent connection methods such as 4G mobile network connections.

Focusing on mobile networks, the greatest disparity among countries appears in the use of this type of technology, which is at different stages of roll-out in different parts of Europe. For this reason, Figures 11 and 12 present trends between 2010 and 2013 in access to 3G mobile networks for countries on which information is available, and we include a differentiation between households for which mobile connection is the only method of Internet access and those that also have other means, ranked by percentage of access to 3G mobile networks in 2010. Figures 13 and 14 also show the breakdown of 3G mobile networks (mobile, USB and both) for 2013, again differentiating between households for which this technology is the exclusive method of Internet access and those that also have other means.

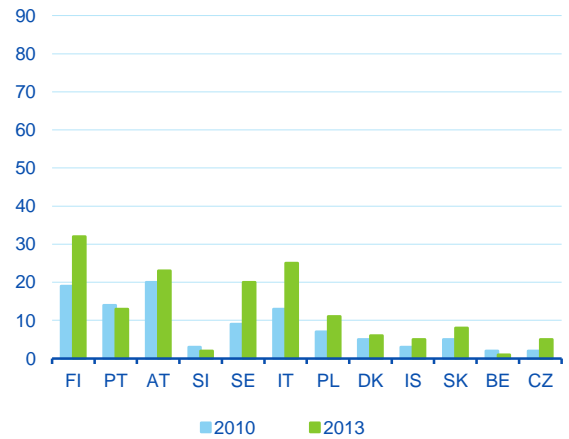
Despite the disparities in access to 3G mobile networks among European countries, the trend has been positive in all of them. We would highlight the prevalence of this type of technology in Finland, Iceland and Austria, where more than 60% of households had 3G mobile connections in 2013. These are the countries with the biggest increases in access between 2010 and 2013 (over 60% in Finland, nearly 40% in Iceland and slightly below 30% in Austria). On the other hand, Denmark, Belgium and the Czech Republic are the countries with the lowest percentages of Internet access by means of 3G networks, none of them surpassing 20%.

Figure 11  
Access to 3G mobile networks (%)



The relation between code and country can be seen in Table A.1 in the Appendix.  
Source: BBVA Research and Eurostat

Figure 12  
Exclusive access to 3G mobile networks (%)

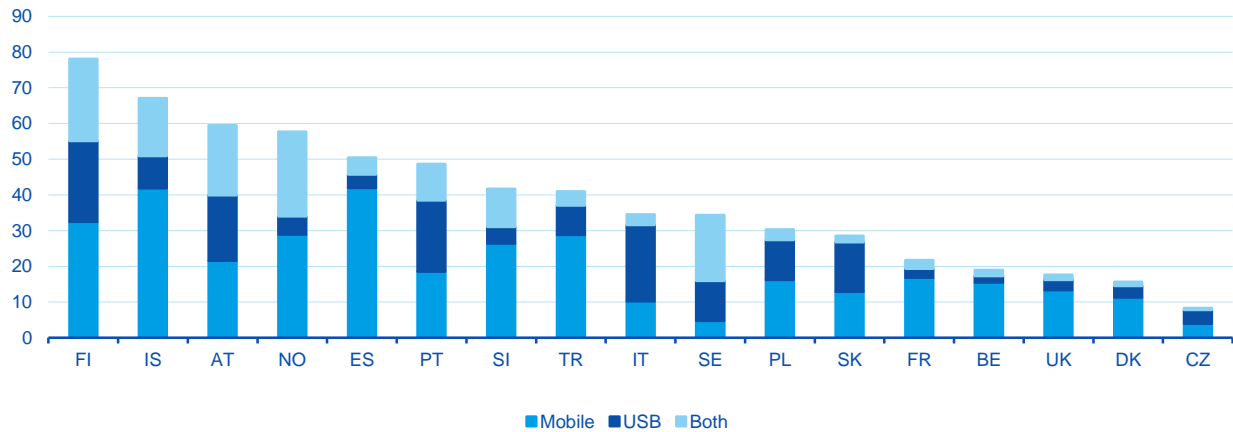


The relation between code and country can be seen in Table A.1 in the Appendix.  
Source: BBVA Research and Eurostat

As for the exclusive access, very few households use mobile networks as their main connection. They are used as auxiliary or complementary connections to fixed access network connections established before 3G networks appeared. Finland and Austria stand out as the countries with the highest percentage of households having high-speed mobile as their main connection. We also have to consider Italy in this group, since although it is not one of the outstanding countries in terms of implementation of mobile networks, it does stand out as regards their use the only connection method.

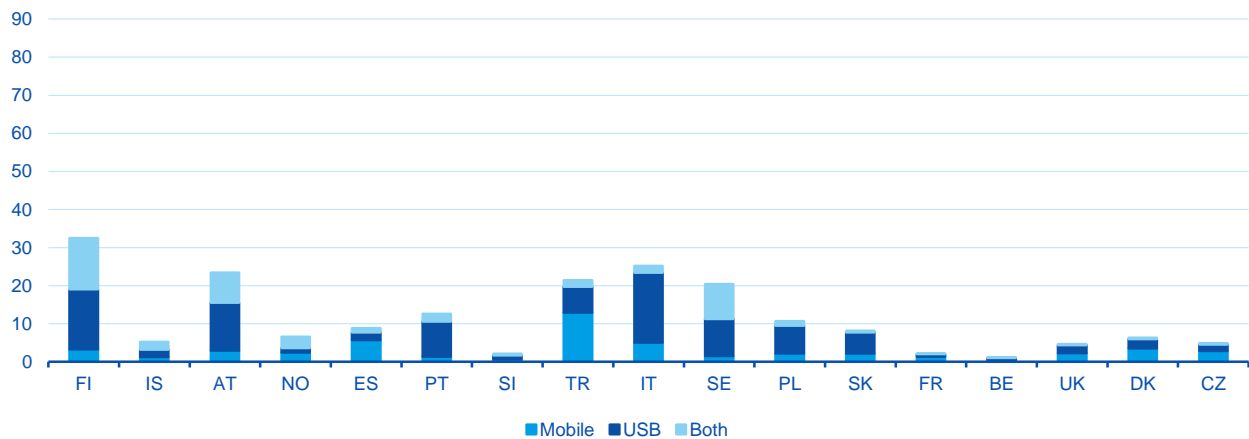
In most European countries, 3G connection by means of USB stands out as the preferred mobile technology for Internet access, although in view of the use of mobile networks as main connection, in most cases the 3G connection via mobile platform can be considered the preferred way. In short, the introduction of mobile technology has led to even more democratisation of Internet access through the second generation broadband. The basic reason is associated to cost-related barriers on access. Mobile technology, since it does not entail equipment costs and the costs associated with access are not so high as for fixed broadband networks, has allowed low-income households to obtain high-speed access to Internet (see also Table 1).

Figure 13  
Breakdown of 3G mobile networks in 2013 (%)



The relation between code and country can be seen in Table A.1 in the Appendix.  
Source: BBVA Research and Eurostat

Figure 14  
Breakdown of 3G mobile networks (2013) as sole means of connection (%)



The relation between code and country can be seen in Table A.1 in the Appendix.  
Source: BBVA Research and Eurostat

#### 4.5. Particular characteristics of the household in access to ICT

In order to establish the characteristics influencing households in their decision to access Internet and in the choice of technology used to do so, we have proposed an analysis of their socio-demographic particularities, so as to be able to particularise as regards their propensity to access Internet and a given technology, as well as to examine whether behavioural patterns vary over time and whether there are differences among regions within a country in the years 2008 and 2013.

Table 1

**Access by socio-demographic characteristics of the household (% of population 16-74 years)**

Variable	Predominant characteristic	2008	2013	
Internet access	Socio-economic level	Upper quartile	81.59	94.06
	Geographical density	Densely populated area	61.59	81.58
	Household size	5 members	59.78	75.69
	No. of children in the household	No intra-group differences	[54.95; 66.45]	[73.04; 80.02]
Access to second generation broadband	Socio-economic level	Upper quartile	22.65	64.94
	Geographical density	Densely populated area	23.21	64.89
	Household size	No intra-group differences	[21.27; 25.07]	[59.68; 62.66]
	No. of children in the household	No intra-group differences	[18.37; 31.15]	[60.03; 70.27]
Access to 3G mobile networks	Socio-economic level	Upper quartile	12.71	33.73
	Geographical density	No intra-group differences	[9.24; 10.26]	[28.85; 30.49]
	Household size	No intra-group differences	[8.47; 9.65]	[29.45; 31.48]
	No. of children in the household	No intra-group differences	[8.25; 9.56]	[29.57; 31.85]
Access to 3G mobile networks only	Socio-economic level	Lower quartile	7.26	14.86
	Geographical density	Sparsely populated area	4.54	11.63
	Household size	No intra-group differences	[4.16; 4.98]	[9.65; 11.21]
	No. of children in the household	No intra-group differences	[4.09; 5.01]	[9.68; 11.12]

Source: BBVA Research and Eurostat

We consider four characteristics: the household's socio-economic level; its location in terms of the geographical density of the area, its size (number of members) and the number of resident dependent children under 16 (see Table A.3 in the Appendix for further information). To assess whether the differences among the different strata are statistically significant, we obtain the 95% confidence interval, so that when there are no significant differences among groups we show the confidence interval at which all the values are to be found. Conversely, when only one value is expressed, this refers to the average of the group for which the confidence interval is significantly different from the rest. The results obtained using all countries available in the database are shown in Table 1.

The households with the greatest propensity to access Internet in both 2008 and 2013 were those with a high socio-economic level (94% for the fourth quartile in 2013), living in densely populated areas (81.6%) and of large size (5 members). The number of resident children in households proves not to be statistically significant, and no particular number of resident children seems to be related to greater Internet access. The confidence interval is between 73% and 80%.

As for the technology used by households to Internet access, we examined three cases: access to second generation broadband, access to mobile networks and access to mobile networks as the only connection in the household.

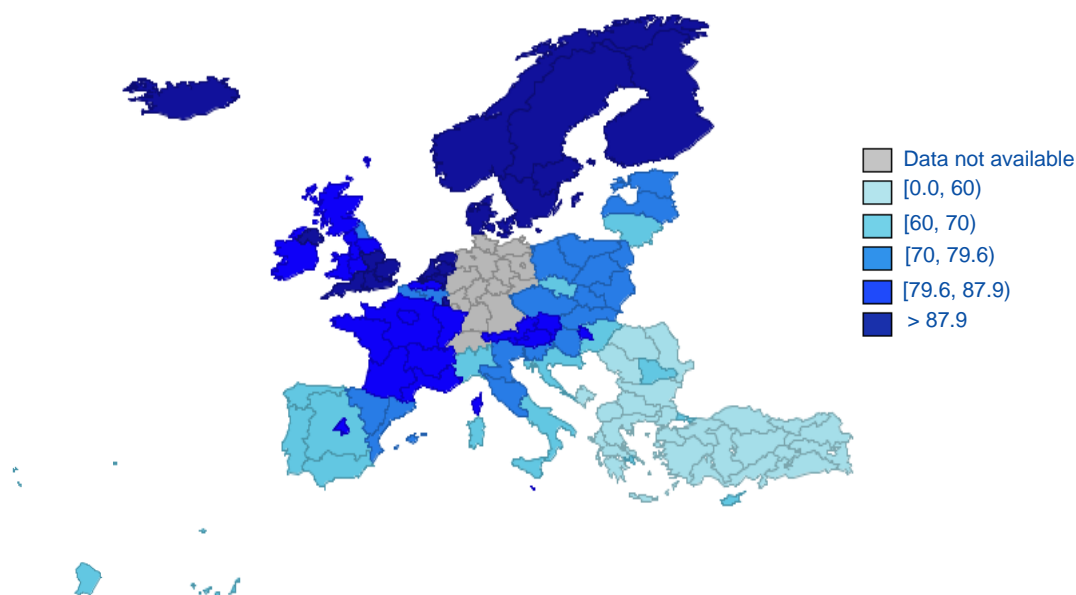
The results obtained for second generation broadband show that households in the upper income quartile (65%) located in densely populated areas (65%) have greater access to broadband, as in the previous case; moreover, the number of dependent children and the size of the household had no influence on its propensity to implement this type of technology.

In the case of access to 3G mobile networks, the households most likely to have this technology are those in the upper income quartile (33.7%). As for the remaining characteristics considered, there are no statistically

significant differences as regards access to mobile networks. Discounting households that use 3G mobile networks together with some other type of connection at the same time, the profile of the household opting for this type of technology changes radically, since households in the lowest income quartile (14.9%) and located in sparsely populated areas (11.6%) are more likely to use 3G mobile networks as their exclusive connection.

In Maps 1, 2, 3 and 4, we show the distribution by quintile of Internet access and technological equipment for European regions (in accordance with the NUTS 1 classification). Regional differences in Internet access (Map 1) are not particularly marked among the countries of Northern and Central Europe, with the majority of these countries' regions exhibiting very high levels of access. Conversely in Southern and Eastern European countries we see greater divergences among their regions, as well as lower levels of Internet access.

Map 1

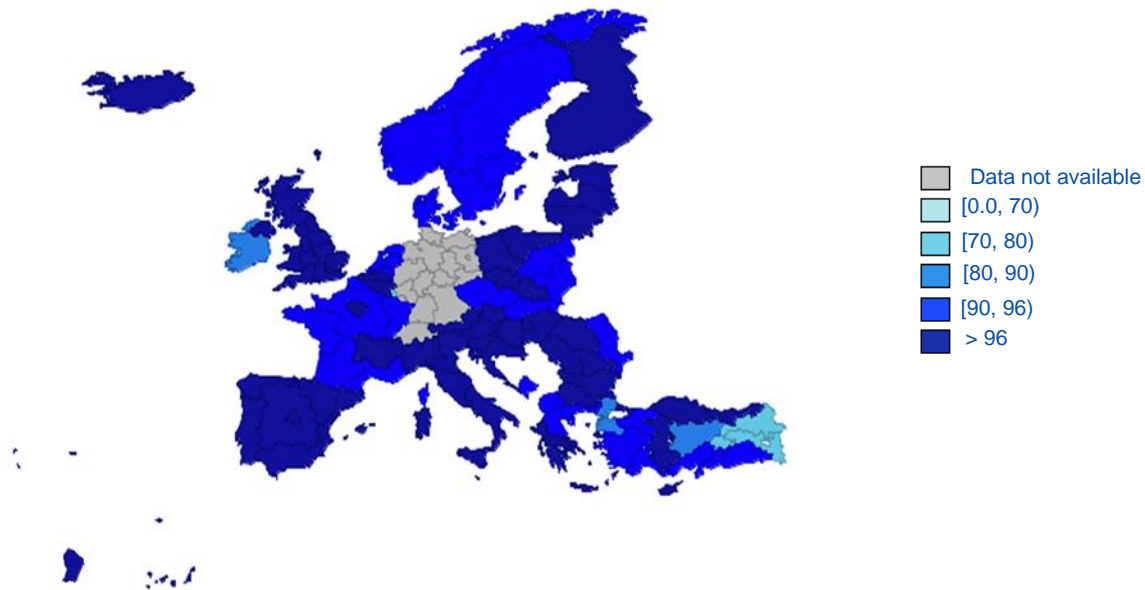
**Access to Internet (% of households) by NUTS 1 in 2013**

Source: BBVA Research and Eurostat

As for the use of broadband, presented in Map 2, with some minor exceptions such as Turkey, in most European regions this connection method is used by at least 90% of households. Looking exclusively at the regional "stock" of second generation broadband (Map 3), we see greater divergences both among countries and within them. Regions of Eastern and Northern European countries, and the regions of Portugal, stand out very strikingly from the rest, with second generation broadband usage of more than 80%. Central and Southern European countries show a lower level of technological "stock", between 40% and 60%, and the technological stock of regions differs well above that previously observed (broadband in the widest sense, first and second generation).

Map 2

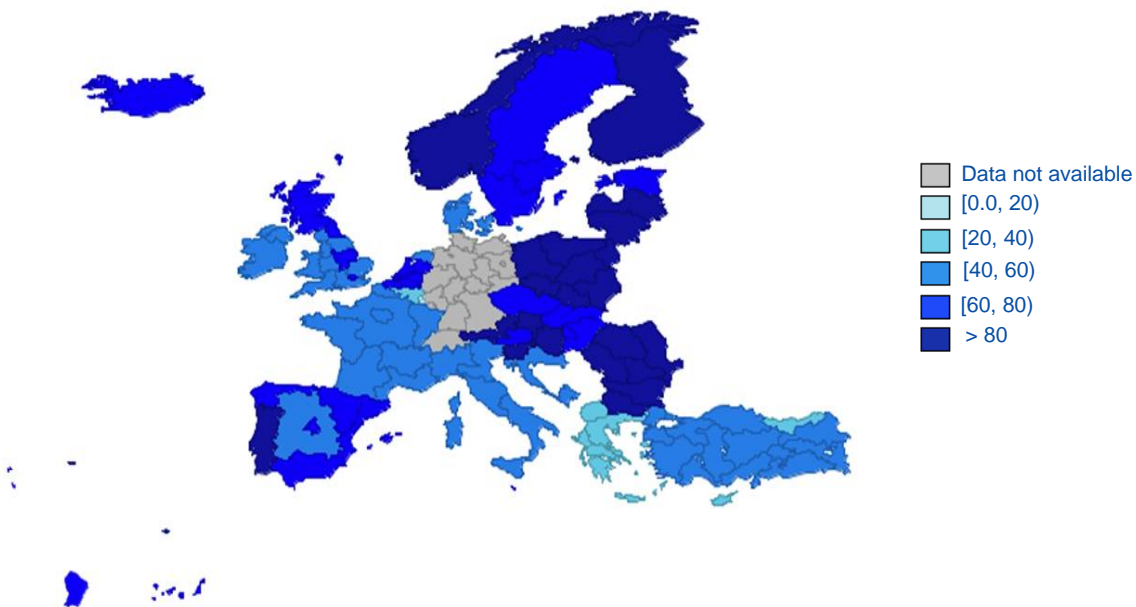
Use of broadband (% of households with Internet access) by NUTS 1 in 2013



Source: BBVA Research and Eurostat

Map 3

Use of second generation broadband (% of households with Internet access) by NUTS 1 in 2013

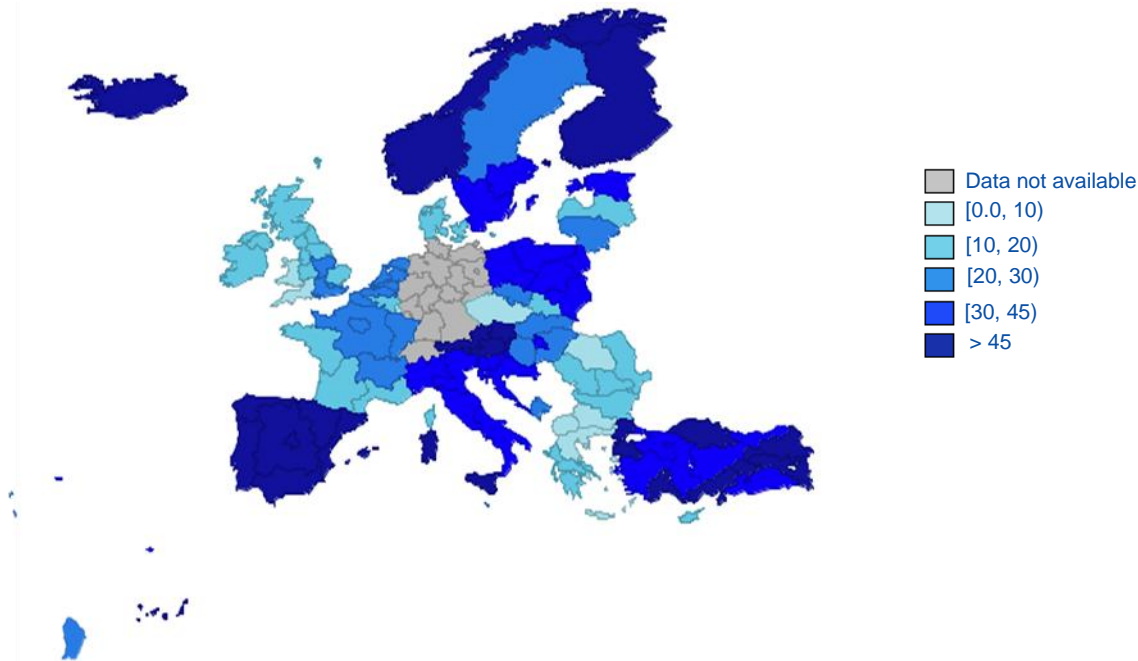


Source: BBVA Research and Eurostat

The distribution of the use of 3G mobile networks (Map 4) is another aspect which it is important to highlight, since it seems to be fairly uniform within countries, at regional level, but highly disparate among them. Spain, Austria, Italy, Turkey and the Nordic countries stand out above the rest, with more than 30% usage, which is uniformly distributed among all their regions. Thus the greatest differences in the use of 3G mobile networks are not those among regions, but among countries, a fact that can demonstrate the effective difficulty of mobile operators to offer this technology to cross national borders.

Map 4

## Use of 3G mobile networks (% of households with Internet access) by NUTS 1 in 2013



Source: BBVA Research and Eurostat

## 5. Conclusions

According to the EC, the Digital Single Market Strategy set out in May 2015 and which includes a roadmap with 16 actions which it aims to implement before 2017, is based on three pillars: taking maximum advantage of the European digital economy's growth potential, improving consumers' and businesses' access to on-line goods and services throughout Europe, and creating the conditions for digital networks and services to flourish.

This document aims to stress the reality represented by the last two pillars from the point of view of consumers. Computer ownership and Internet access in European households is evolving positively, albeit slowly. Average access to a computer stood at 77% and Internet access at around 76% in 2013. The European country with the greatest proportion of households with access to a computer and the Internet is Iceland, with 97% for both. Bulgaria and Turkey have the lowest percentages of households with access to a computer and to the Internet (55% and 54% respectively).

In general terms, the main impediment on individuals having access to the Internet in the home is self-imposed, with 42% asserting that they do not need Internet access in the period 2008-2013. In second place comes lack of skills (34%). The costs of access and the equipment needed to access the Internet are also factors largely impeding access to the Internet, although we would point out that the introduction of mobile technology has helped lower income households to gain access to high bandwidth Internet. The least determinant barrier is the lack of privacy or security (6%), together with the Internet access elsewhere different to the home (around 14%).

Because of the high degree of disparity in Internet use among European countries, the results for barriers on entry to use Internet require further and more in-depth analysis, especially bearing in mind that the group of households without Internet decreases in a non-random way and at very different speeds depending on the country being considered. For example, households in countries with a high rate of Internet access seem to



cite the lack of need for the Internet and the availability of the Internet other than at home as the main barriers; in countries with moderate rates of access, the costs associated with equipment and network access are seen as more important barriers. Conversely, in countries with low rates of access, the lack of skill arises as the main barrier to setting up an Internet connection at home. This movement requires governments to adapt their digital agenda to consumers' circumstances if they aim to continue expanding the use of ICT throughout Europe.

The majority of European households have broadband connections, although there are big differences between first generation (DSL) and second generation broadband (cable, fibre optic and high-speed mobile networks). Bulgaria stands out as the country with the highest percentage of households accessing the Internet by means of second generation broadband, although Iceland, Finland and Austria stand out above the rest as regards 3G mobile connections. Access to mobile networks increased considerably between 2010 and 2013, although few households select this method of connection as their first choice.

We observe a high degree of simultaneous overlap as regards the number of households' connections. Norway, Iceland and Finland have the highest percentages of households with two or more types of connection. The results suggest that the countries that are last to adopt ICT are also more likely to adopt the latest technology directly. The other countries introduce it more gradually, replacing older technology with it or running both in parallel for a certain time. The speed at which countries replace old technology and adopt new technology or implement it on an auxiliary (complementary) basis depends on the previous technological stock and the propensity to replace older technology.

The economic level and location of households, depending on the degree of urbanisation, are decisive factors for access to both Internet and technology available on the market. High-income households located in densely populated areas are more likely to have a high-speed Internet connection. Conversely, households with a low socio-economic level and located in thinly populated areas are more likely to access the Internet exclusively through 3G mobile networks.

In the past few years the differences in Internet access and available technology among European countries have diminished, although not in the same way among them. Europe still has a long way to go before it can stand out as a whole among the international powers in the field of access to ICT. The path to follow on the supply side starts with the creation and full development of a digital single market that contributes to the free circulation of technology and increased competition among telecommunications companies that can be translated into an increase in ICT innovation in Europe. It is also necessary to increase investment in infrastructure and networks so as to be able to provide service and deliver the latest technology to all regions of Europe.

On the demand side, one very important aspect is education. Education plays a fundamental role in enabling individuals to develop sufficient skills to be able to interact and prosper in an ever more digital world. It should be remembered that many European households do not have Internet access because they lack training in the use of ICT. Consequently, it is necessary to put in place effective education programmes in order to avoid the co-existence in Europe of "digital natives" and the "digitally displaced", and to make possible a real digital integration regardless of economic level, age or country of residence.

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## Appendix

Table A.1

## List of countries and number of households by year of study

Code	Country	2008	2009	2010	2011	2012	2013
AT	Austria	5,260	4,945	5,104	3,709	3,597	3,537
BE	Belgium	9,992	6,431	6,160	5,989	6,065	6,350
BG	Bulgaria	3,929	4,030	4,122	5,381	3,897	4,161
CY	Cyprus	1,599	1,549	1,522	1,588	1,805	1,661
CZ	Czech Republic	-	3,931	3,892	4,190	4,248	4,163
DK	Denmark	4,347	4,301	4,201	4,144	4,180	4,222
EE	Estonia	1,964	1,720	1,841	1,984	2,297	2,311
EL	Greece	5,045	5,095	4,610	4,803	4,108	4,209
ES	Spain	18,415	17,585	17,248	16,649	14,109	13,892
FI	Finland	2,883	2,774	2,761	2,815	2,704	2,582
FR	France	5,030	3,939	5,568	7,681	9,970	8,938
HR	Croatia	-	-	-	3,026	2,609	2,554
HU	Hungary	7,237	6,958	6,762	7,039	6,975	6,768
IE	Ireland	8,508	7,671	7,242	5,532	9,287	9,741
IS	Iceland	1,618	1,640	1,629	1,614	1,638	1,632
IT	Italy	17,219	16,837	17,306	17,121	16,708	16,498
LT	Lithuania	-	5,663	5,692	5,521	5,092	4,885
LU	Luxembourg	1,501	1,500	1,505	1,519	1,504	1,538
LV	Latvia	3,737	-	3,628	3,877	3,319	3,416
ME	Montenegro	-	-	-	-	1,172	1,153
MK	Republic of Macedonia	-	-	-	-	1,725	-
MT	Malta	1,137	1,089	1,128	1,430	1,127	1,315
NL	Netherlands	4,139	4,105	4,076	4,140	4,255	4,136
NO	Norway	1,094	1,126	982	1,087	960	1,057
PL	Poland	-	5,010	5,149	5,166	5,030	4,431
PT	Portugal	4,249	7,868	7,205	7,175	6,650	7,057
RO	Romania	-	8,232	8,136	7,917	7,594	7,615
SE	Sweden	3,837	4,427	3,787	2,735	1,314	1,401
SI	Slovenia	1,701	1,754	1,727	1,818	1,731	1,843
SK	Slovakia	4,116	4,500	4,122	4,171	4,500	4,500
TR	Turkey	-	-	-	-	-	11,620
UK	United Kingdom	-	-	-	2,948	2,611	2,770

Source: BBVA Research and Eurostat

Table A.2

**Definition of the variables of interest**

Variables	Question	Definition
COMP	Do you, or does anyone in the household have access to a computer at home?	Binary: 1 Yes and 0 No
IACC	Do you, or does anyone in the household have access to the Internet at home?	Binary: 1 Yes and 0 No
<b>Barriers on Internet access</b>		
XNEED	No need	
XSKL	Lack of skills	
XEQU	High cost of equipment	
XACC	High cost of access	Binary: 1 Yes and 0 No
XELSE	Access elsewhere	
XSEC	Security or privacy	
XOTH	Other reasons	
<b>Type of Internet connection in the household</b>		
DIAL-UP + MPHNR	Modem (dial-up access over normal telephone line) or ISDN	Binary: 1 Yes and 0 No
MPHNR	Mobile phone over narrowband (GPRS, etc.)	Binary: 1 Yes and 0 No
DSL + Other broadband	DSL-type connection (ADSL, SHDSL, etc.)	Binary: 1 Yes and 0 No
<b>Type of connection: other broadband in the years 2008 and 2009</b>		
BBOTH	Other broadband connections (cable, UMTS, etc.)	Binary: 1 Yes and 0 No
<b>Type of connection: other broadband in the years 2010 and 2011</b>		
BBWFX	Wired fixed (cable, fibre, Ethernet, PLC, etc.)	Binary: 1 Yes and 0 No
BBFWL	Fixed wireless (satellite, public Wi-Fi or WiMax)	Binary: 1 Yes and 0 No
BBMOB	Mobile connection (at least 3G, UMTS)	Binary: 1 Yes and 0 No
<b>Type of connection: other broadband in the years 2012 and 2013</b>		
BBWFX	Wired fixed (cable, fibre, Ethernet, PLC, etc.)	Binary: 1 Yes and 0 No
BBFWL	Fixed wireless (satellite, public Wi-Fi or WiMax)	Binary: 1 Yes and 0 No
BBMOBH	Mobile telephone network (at least 3G, UMTS) via telephonic apparatus	Binary: 1 Yes and 0 No
BBMOBM	Mobile telephone network (at least 3G, UMTS) via card or USB port	Binary: 1 Yes and 0 No
<b>Type of connection: Narrow band</b>		
DIAL-UP + MPHNR	Narrow band Internet connection	Binary: 1 Yes and 0 No
<b>Type of connection: Broadband</b>		
DSL + Other broadband	Broadband Internet connection	Binary: 1 Yes and 0 No

Source: BBVA Research and Eurostat

Table A.3

**Definition of the socio-demographic variables taken into account**

<b>Variables</b>	<b>Characteristics of the household</b>	<b>Definition</b>
<b>Type of location, 2008 to 2012 (GEO_DENS)</b>	Population density for the period 2008-2012	1 Densely populated area, 2 Intermediate area, 3 Sparsely populated area
<b>Type of location, 2013 (DEG_URBA)</b>	Population density for the year 2013	1 Densely populated area, 2 Intermediate area, 3 Sparsely populated area
<b>Household's income quartile (HH_IQ)</b>	Households' income quartile	1 Lower quartile, 2 Second quartile, 3 Third quartile, 4 Upper quartile
<b>Household size (HH_POP)</b>	Number of members residing in the households	1 Only one member, 2 Two members, 3 Three members, 4 Four members, 5 Five members or more
<b>Number of children (HH_CHILD)</b>	Number of children residing in the households	Quantitative: 0 No children, 1 One child, 2 Two children, 3 Three children, 4 Four children or more

Source: BBVA Research and Eurostat

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