Economic crisis and digital divide in Europe

Apostolos Mitrou

A dissertation submitted in partial fulfillment of the requirements for the degree of Master of Science in Applied Economics & Data Analysis

School of Business Administration

Department of Economics

Master of Science in

"Applied Economics and Data Analysis"

September 2017

University of Patras, Department of Economics
Apostolos Mitrou

Three-member Dissertation Committee

Research Supervisor:	Nicholas Giannakopoulos	Associate Professor
Dissertation Committee Member:	Ioannis Venetis	Associate Professor
Dissertation Committee Member:	Manolis Tzagkarakis	Assistant Professor

The present dissertation entitled

«Economic crisis and digital divide in Europe »

was submitted by **Apostolos Mitrou, Sid 1016317**, in partial fulfillment of the requirements for the degree of Master of Science in *«Applied Economics & Data Analysis»* at the University of Patras and was approved by the Dissertation Committee Members.

I would like to dedicate my dissertation to my beloved parents and brother, who supported me during my postgraduate studies with every means possible.

Acknowledgments

I would like to thank my research supervisor, Associate Professor Nicholas Giannakopoulos for his patience, guidance and continuous support during the writing of this dissertation. I would also like to thank him for providing me through his lextures with knowledge and perspective that will certainly help me over the cource of my professional career.

I could not but also thank the rest MsC professors for providing me with the essential tools in order to complete my studies with success and become a better economist.

Great thanks also to all my colleagues during this postgraduate year for managing to become a pleasant and united company, especially to those who became my friends and helped me go through my postgraduate studies with optimism and joy.

Last but not least, I would like to thank my non-colleague friends who missed me from their daily life this year but where always by my side to support me when I needed it.

Summary

In this dissertation, using Eurobarometer micro data we investigate the structure of digital divide in EU member-states for the period 2006-2016. For estimation purposes, we apply linear probability models adopting five indicators of Internet diffusion: Internet connection at home, Internet access at home, Internet use at home, Internet access at work and Internet use at work. The analysis focuses on the role of demographics (age, gender, marital status and nationality), human capital (education), income related outcomes (employment status and durables) and location characteristics (region of residence) which may correlate with Internet diffusion. According to our results, a significant digital divide appears to all dimensions of Internet diffusion both between and within countries. However, the economic crisis of 2007-2008 does not seem to affect Internet diffusion.

Keywords: Digital divide, Internet diffusion, Information and communication technologies (ICT), European Union, Economic crisis

Περίληψη

Στην παρούσα διπλωματική εργασία, χρησιμοποιώντας μικρο-δεδομένα από το Ευρωβαρόμετρο, ερευνούμε τη δομή του ψηφιακού χάσματος σε κράτη μέλη της Ευρωπαϊκής Ένωσης για την περίοδο 2006-2016. Για τους υπολογισμούς της ανάλυσης εφαρμόζουμε γραμμικά μοντέλα πιθανότητας, υιοθετώντας πέντε δείκτες για την εξάπλωση του Ίντερνετ: σύνδεση Ίντερνετ στο σπίτι, πρόσβαση Ίντερνετ στο σπίτι, χρήση του Ίντερνετ στο σπίτι, πρόσβαση Ίντερνετ στη δουλειά και χρήση του Ίντερνετ στη δουλειά. Η ανάλυση επικεντρώνεται στο ρόλο των δημογραφικών στοιχείων (ηλικία, φύλο, οικογενειακή κατάσταση και εθνικότητα), του ανθρώπινου κεφαλαίου (εκπαίδευση), σχετικών με το εισόδημα παραγόντων (επαγγελματική κατάσταση και διαρκή αγαθά) και χαρακτηριστικών τοποθεσίας (περιοχή διαμονής) τα οποία μπορεί να συσχετίζονται με την εξάπλωση του Ίντερνετ. Σύμφωνα με τα αποτελέσματα, σημαντικό ψηφιακό χάσμα εμφανίζεται σε όλες τις διαστάσεις της εξάπλωσης του Ίντερνετ, τόσο μεταξύ χωρών όσο και μέσα σε αυτές. Ωστόσο, η οικονομική κρίση του 2007-2008 δεν φαίνεται να επηρεάζει την εξάπλωση του Ίντερνετ.

Λέξεις κλειδιά: Ψηφιακό χάσμα, Εξάπλωση του Ίντερνετ, Τεχνολογίες πληροφορίας και επικοινωνίας (ΤΠΕ), Ευρωπαϊκή Ένωση, Οικονομική κρίση

Contents

List of Figures

List of Tables

Chapter 1

Introduction

During the last years, European countries are facing one of the worst financial and economic crises with various and major social effects. At the same time, there has been a worldwide increase in the adoption of Information and Communications Technologies (ICT), which have been revealed as key possible factors for economic growth and social development (ITU and UNCTAD, 2007; Pohjola, 2003). However, the evolution of the information society is irregular (Vicente and López, 2006a) and differences in ICT adoption have the potential to enlarge existing socioeconomic disparities (Demoussis and Giannakopoulos, 2006). These facts may lead to a digital divide between differing countries or regions of the world which is referred to as the global digital divide. There is also a divide within countries which may refer to inequalities between individuals, households, businesses, or geographic areas, usually at different socioeconomic levels or other demographic categories. A widely accepted and repeated definition of digital divide is the one provided by the Organization for Economic Co-operation and Development (OECD, 2001): "The term digital divide refers to the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access ICT and to their use of the Internet for a wide variety of activities".

Literature suggests that the digital divide has been considerably reduced during the last years in Europe, but the gap has not yet closed (Negreiro, 2015; Lera-López et al., 2011) and although the digital gap may be closing, the impact of digital divide is getting bigger in time, as the benefits of ICT are continuously growing. According to Lera-López et al. (2011), another level of the digital divide, based on dissimilar digital usage may also unfold. By 2020, it is believed 90% of jobs will require at least some digital skills (Negreiro, 2015). So, it is not only important for everyone to be able to access and use the Internet but also use it effectively.

Several existing studies focus on the determinants of Internet adoption (Chaudhuri et al., 2005; Flamm and Chaudhuri, 2007), which mainly refers to the existence of an Internet connection at the unit of analysis (household, firm or institutions). Other studies focus on the individual use of the Internet, mostly at household level (Mills and Whitacre, 2003; Rice and Katz, 2003). There are also several studies that concentrate on the extent of use as measured by frequency and variety of use (Bucy, 2000; Demoussis and Giannakopoulos, 2006; OECD, 2007).

This desertation analyzes the impact of a variety of socioeconomic, demographic and regional factors to explain Internet diffusion in the terms of access and use both at home and work. We use data from Eurobarometer for EU-15[1], during years 2006 - 2016, to model five indicators which account for Internet/ICT diffusion. Linear probability models will be applied and we expect to find significant correlation between the determinants used (demographics, income related outcomes and location characteristics) and Internet diffusion. There is also a possibility that the economic crisis has negatively affected Internet use and access.

In comparison with prior research, the present study manages to extend results for the digital divide in Europe and make several contributions. To begin with, the units of our analysis will be both households and firms. Most studies in the past, focused on the individual's Internet access or use (usually not both) regardless the location, while others focused either on household or firm level. In

[1]The term EU-15 refers to the 15 Member States of the European Union as of December 31, 2003, before the new Member States joined the EU. The 15 Member States are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

this desertation, we will examine Internet access and use, both at home and work. In addition, we will look into the evolution of Internet diffusion and digital divide during a wide time range (2006-2016), using a significantly large sample consisted of almost 600,000 individuals. Last, we are able to explore the structure of digital divide not only within a specific country but also among 15 EU member states. We find that a digital divide do exist not only among EU countries, indicating a south/north divide, but also among individuals with different demographic and socioeconomic characteristics. The probability of Internet access and use is primarily influenced by age, education, durables, household size, occupational status and area of residence. We find mixed results for gender and marital status.

The structure of the present dissertation is the following. Chapter 2 shows an overview of the existing relative literature. Chapter 3, firstly explores the global and european evolution of Internet diffusion. Next, it evaluates data from Eurobarometer comparing them with data from Eurostat and finally it performs an aggregate analysis on Internet diffusion. Chapter 4 describes data and variables, presents summary statistics and deploys the heterogeneous profile of Internet diffusion in EU-15, giving a fisrt view of possible relations between the determinants and the five indicators of Internet diffusion. Chapters 5 and 6 deploy the empirical framework for our study and discuss the empirical results. Finally, chapter 7 presents the major conclusions of our results, discusses some policy implications and suggests areas for further research.

Chapter 2

Literature review

In the earlier years of ICT and Internet diffusion, most of the economic literature studied disparities in Internet adoption between individuals and households at various socio-economic and demographic levels (e.g. Hoffman and Novak, 2000; Fairlie, 2004; Chaudhuri et al. 2005, among others). Grazzi and Vergara (2014) also argues that inequality in Internet adoption probably reflects preceding socioeconomic inequities. As Internet penetration rates rapidly grew, researchers recently extended their interest to online usage. Goldfarb and Prince (2008) and Campos et al. (2017), under the common sense that access does not necessarily imply usage, they model the adoption/usage decision as a two-stage process. In the first decision, individuals decide whether or not to access Internet, while in the second they decide whether or not to use the Internet and how much time to spend online. Demoussis and Giannakopoulos (2006) also suggest that the decision on Internet use is conditional on Internet access, whereas the extent of Internet usage is conditional on the Internet use decision. However, the intention to use the Internet is not always a required condition for Internet access. Other authors have emphasized on analyzing variations on online activities. For example, Goldfarb and Prince (2008) find that low-income people in USA have higher probability to use the Internet for chat, health information and online games, in comparison with purchasing activities. Orviska and Hudson (2009) find similar results for the

European Union. Grazzi and Vergara (2014) find evidence that people with high education in Latin America are more likely to use the most sophisticated applications, such as banking, purchasing and government and that strengthens the belief that some technological skills are necessary to fully exploit Internet potentials.

Considering the factors that might be correlated with Internet or ICT diffusion, some literature highlights macroeconomic factors related with Internet diffusion across countries. Hargittai (1999) in a study of telecommunications policy reaches a conclusion that among OECD countries, economic wealth is one of the most significant factors in determining Internet connectivity. Vicente and López (2006a) included Internet costs as an aggregate variable (among others) to take into account the differences in adoption levels across EU-15 countries. Kiiski and Pohjola (2002) also consider Internet diffusion across countries and find GDP per capita and Internet cost are significant in explaining Internet growth. They show that a 50% decrease in Internet access costs would increase the number of computer hosts per capita by 25% in 23 OECD countries, over a period of five years. In addition, Goldfarb and Prince (2008) suggest that Internet cost is an important obstacle to connect to the Internet for low-income individuals and Demoussis and Giannakopoulos (2006) also find that access costs negatively affect the desicion to use the Internet. Vicente and López (2006b) emphasize the importance of R&D activities to justify differences in Internet adoption across countries.

According to the existing literature, there are also key demographic and socio-economic determinants for Internet access or use and its extent. Empirical evidence shows that income and education are the strongest predictors of Internet access and use. The higher the education and income levels, the higher the probability of Internet access (see Fairlie, 2004; Chaudhuri et al., 2005; Goldfarb and Prince, 2008, among others) or use (see Rice and Katz, 2003; Demoussis and Giannakopoulos, 2006; Goldfarb and Prince, 2008, among others). According to OECD (2007) the perceived benefits and utility from Internet use vary according to economic status and education level and Mills and Whitacre (2003) also suggest that individuals with higher income report higher benefits than those with lower income. Moreover, Goldfarb and Prince (2008) finds that income and education negatively correlate with hours spent online while Demoussis and Giannakopoulos (2006) suggest the opposite according to their results.

Age in many studies found to be negatively associated with Internet use (Rice and Katz, 2003; Mills and Whitacre, 2003; Demoussis and Giannakopoulos, 2006; Goldfarb and Prince, 2008). The negative effect of age could be attributed to several factors, such as the lack of skills for older people and the perception of the benefits associated with Internet use, which is higher for younger people (Hargittai, 2003; OECD, 2007). Chaudhuri et al. (2005) also suggests that younger people would be more prone to access the Internet because of the novelty of the new technology and its relation with the computer.

Literature with respect to gender presents various results and conclusions. For example, several studies show that the likelihood of Internet use is lower for women (Bimber, 2000; Demoussis and Giannakopoulos, 2006) while others find no significant differences between men and women. Chaudhuri et al. (2005) finds being a male seems weakly associated with a lower probability of having access. In addition, according to OECD (2007), it looks like gender is becoming a less important factor as Internet use rises.

Some empirical studies include employment as one of the socio-economic factors affecting online access and/or usage in individuals. Campos et al. (2017) find that when controlling for income, employment status still has a remarkable impact on both access and usage, which means that dissimilarities in access and usage among the employed and the unemployed are not merely driven by differences in income. They also find that employed individuals are about 9% more probable to be frequent Internet users than the unemployed. Goldfarb and Prince (2008), Orviska and Hudson (2009) and Vicente and López (2011) also reach a conclusion that the likelihood of Internet access is significantly higher for workers. Fairlie (2004) also finds that occupation is an important determinant of computer ownership and Internet access. On the other hand, Chaudhuri et al. (2005) finds having a job is not associated in a significant way with having Internet access.

Other socioeconomic factors have also contributed in understanding the structure of digital divide. Family structure influences Internet access and use as well. The number of children in a household has proved to exert either positive (Mills and Whitacre, 2003; OECD, 2007) or no significant effects (Bucy, 2000) on Internet diffusion. Larger households are more likely to have access according to Grazzi and Vergara (2014) but Demoussis and Giannakopoulos (2006) find they are associated with low levels of Internet use perhaps because they deal with limited free time and income issues. Concerning marital status, empirical studies have also shown that it can be correlated with Internet access and/or use. Chaudhuri et al. (2005) and Goldfarb and Prince (2008) find that people who are married are more likely to have Internet access. However, this could be attributed to the fact that being married adds at least one adult in the household (Farlie, 2004). In addition, the probability of access is found to be higher for those who live in urban areas (Campos et al., 2017) and similarly Internet usage by rural residents is usually less frequent than that of the urban population (e.g. Mills and Whitacre, 2003; Demoussis and Giannakopoulos, 2006). Vicente and López (2006b) suggests that there is a lower probability of computer or Internet use in jobs in rural areas.

Finally, several empirical studies and reports confirm the well-known North-South European divide. Vicente and López (2006a) suggests that this divide reflects to some extent social and economic disparities across countries. Demoussis and Giannakopoulos (2006) finds that there are major structural differences between northern and southern Europe related to undetected factors and this unobserved disparity is an important justification of the observed digital divide in Europe. Moreover, Beñat Bilbao, in an article on world economic forum in April 2014, claims that the Nordic countries are ideal on how to increase digitization and merge it with an enabling environment for innovation.

Chapter 3

Stylized facts

3.1 The global and european evolution of Internet diffusion

Digital divide is a fact. It is often discussed in an international context, indicating certain countries are far more capable than other developing countries to utilize the benefits from the rapidly expanding Internet. The global digital divide, as measured by cross-national differences in Internet use, is the result of the economic, regulatory and sociopolitical attributes of countries and their development over time (Guillen and Suarez, 2005). On 31 March 2017, North America's penetration rate (Internet users % of the region's population) is estimated to be 88.1%, the highest of all world regions. Europe follows with 77.4% while Asia and Africa are at the bottom of that list with 45.2% and 28.3% respectively (www.internetworldstats.com).

Moving at a country level and looking through over the last decade worldwide, some countries have seen significant evolution of Internet access, while others have managed to sustain or even increase their already high ratios. According to OECD data for Internet access per household, Australia reached 83% in 2012 from 60% in 2005, while Canada also improved access at home increasing this ratio from 64.3% in 2005 to 83.9% in 2013. Mexico presented an almost 400% access growth between 2005 - 2014, raising from 9% to 34.4%. Finally, South Korea although having reached an astonishing 92.7% in 2005, it managed to improve more by reaching 98.5% in 2014.

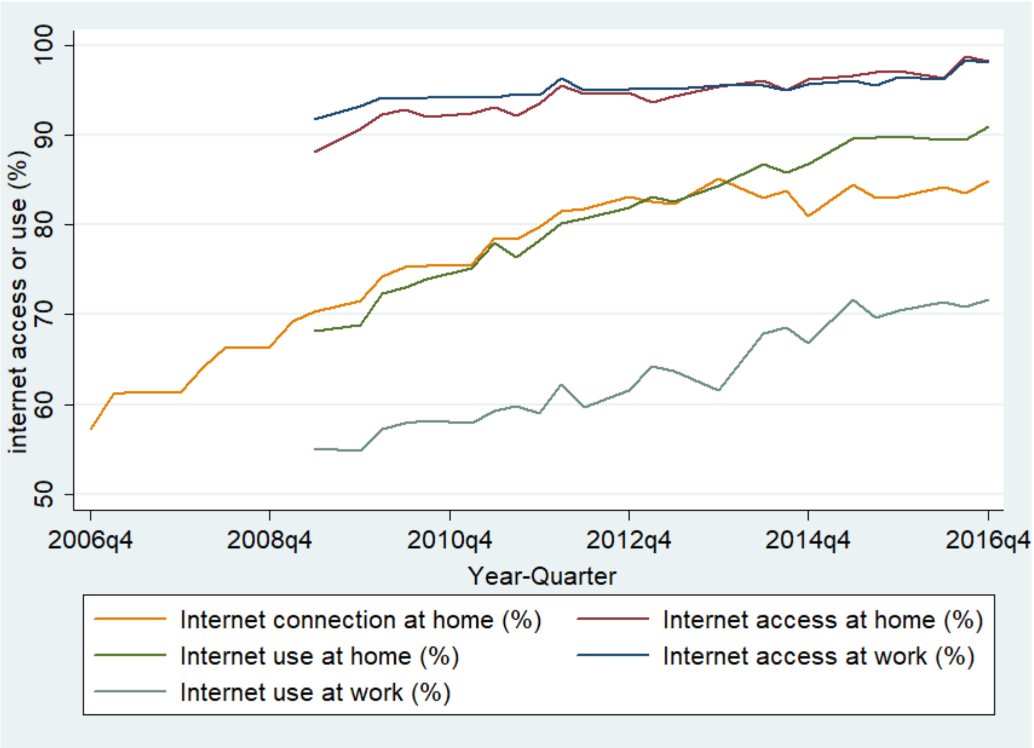
In Europe, countries such as Czech Republic (19.1% in 2005 - 79% in 2015), Greece (21.7% in 2005 - 68.1% in 2015), Turkey (7.7% in 2005 - 69.5% in 2015) and Lithuania (15.8% in 2005 - 68.3% in 2015) have achieved a huge growth in Internet access per household (OECD and Eurostat complying data). Europe has identified new engines to boost growth and jobs, through Europe 2020 initiative that consists of a ten-year jobs and growth strategy for the EU, under the idea that the digital divide can and should be made smaller. So, the digital divide has been significantly reduced over the last decade in Europe (Lera-López et al., 2011), but the gap remains far from closed. According to the 2015 European Commission's Digital Agenda Scoreboard, two related targets have already been met (all EU households can access basic broadband and 75% of all Europeans are regular Internet users). Furthermore, important challenges on Internet use remain, as about half of the less-educated and the elderly in the population do not use it regularly, and about 58 million EU citizens (aged 16-74 years old) have never used it at all. The digital divide also varies across Member States. (Negreiro, 2015)

In our analysis, we are going to focus on EU-15 and five indicators of Internet adoption and diffusion. So, we are going to investigate the structure of digital divide in EU-15 by observing Internet connection at home, Internet access at home, Internet use at home, Internet access at work and Internet use at work, indicators constructed using Eurobarometer data.

To begin with, we are going to present each country's evolution on those indicators for the period 2006 - 2016[1]. In figure 3.1, we can see our five indicators' cource through time. It is obvious that there is an increasing trend on all indicators. Internet access at home or work, having already reached about 90% in 2009, has a small but quite steady increase, reaching about 98% in 2016. Use at home

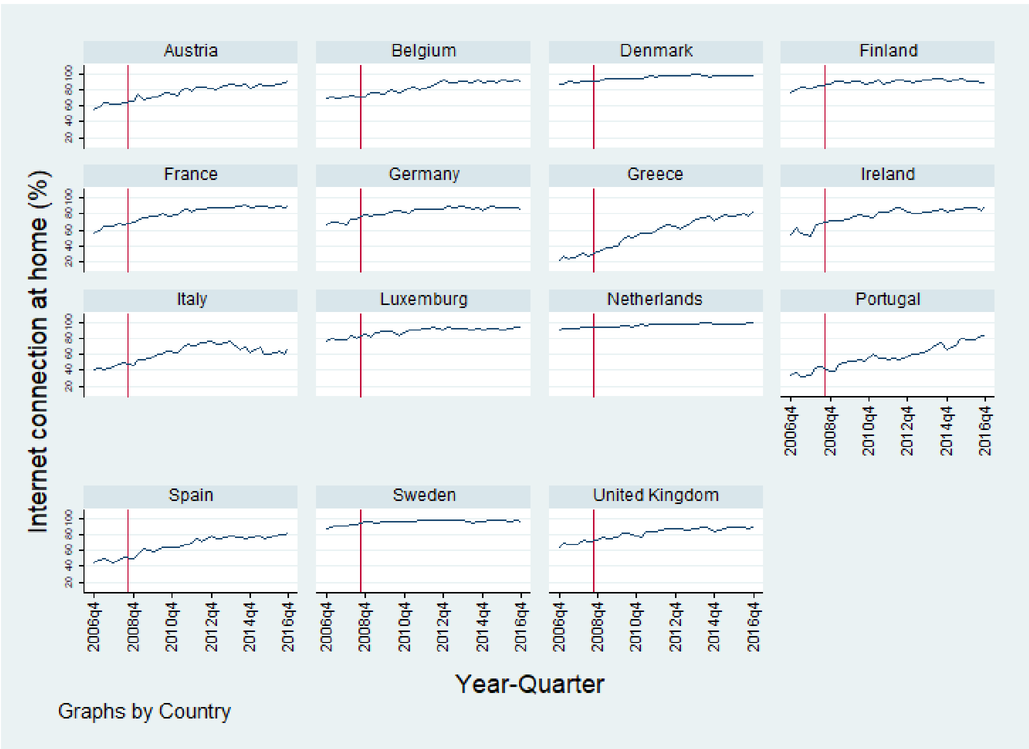
[1]Author's work by data retrieved from Eurobarometer

Figure 3.1: Time series plot of Internet indicators' means for EU-15



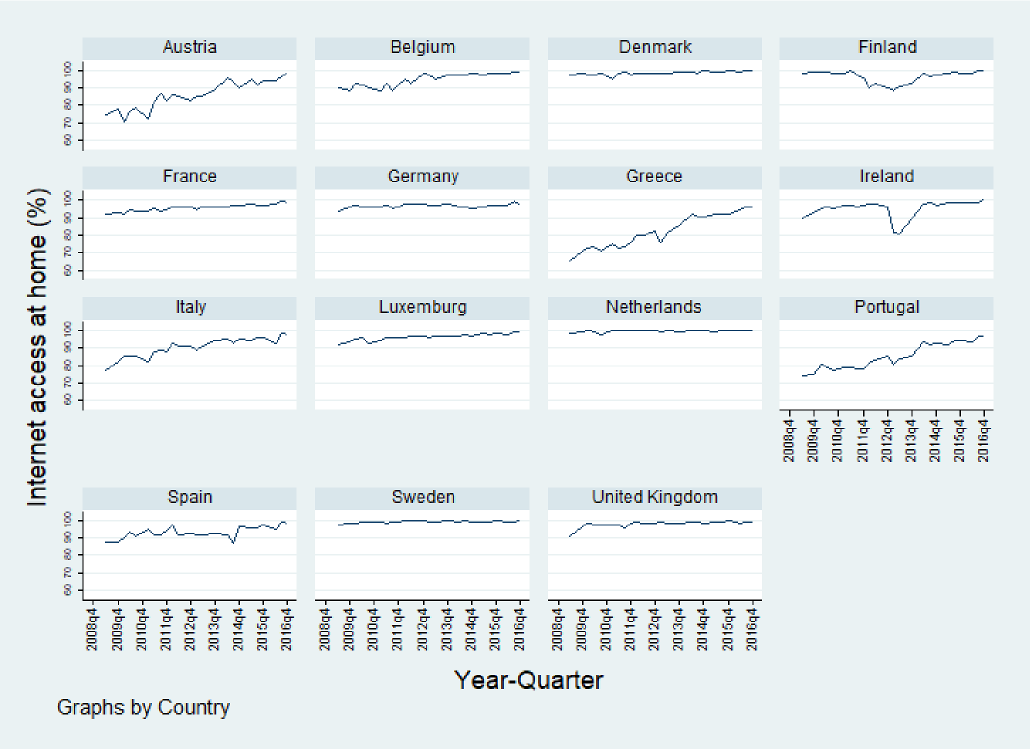
Source: Standard & Special Eurobarometer Series, years 2006 - 2016, Author's calculations.

Figure 3.2: Time series plots of Internet connection at home for EU-15



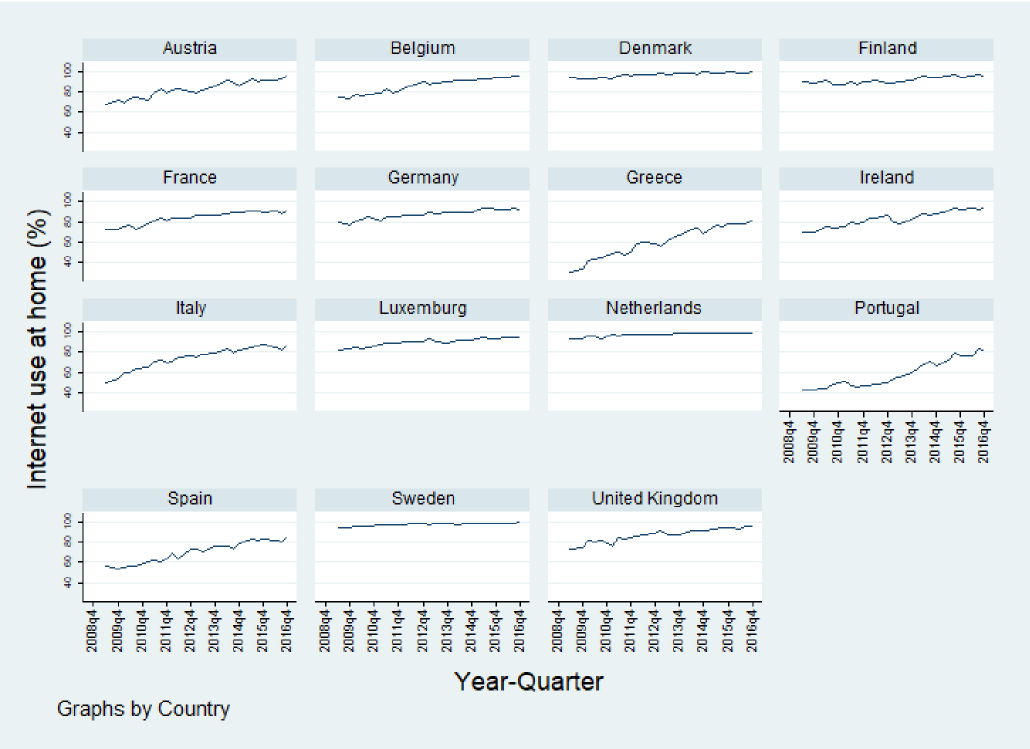
Source: Standard & Special Eurobarometer Series, years 2006 - 2016, Author's calculations.

Figure 3.3: Time series plots of Internet access at home for EU-15



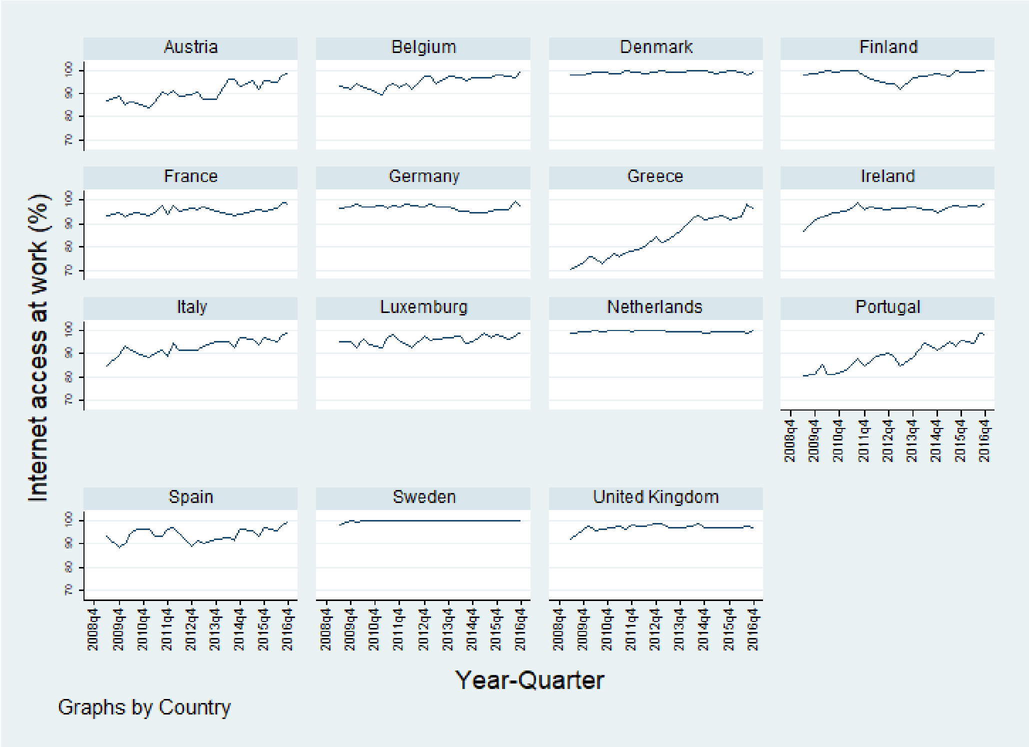
Source: Standard & Special Eurobarometer Series, years 2009 - 2016, Author's calculations.

Figure 3.4: Time series plots of Internet use at home for EU-15



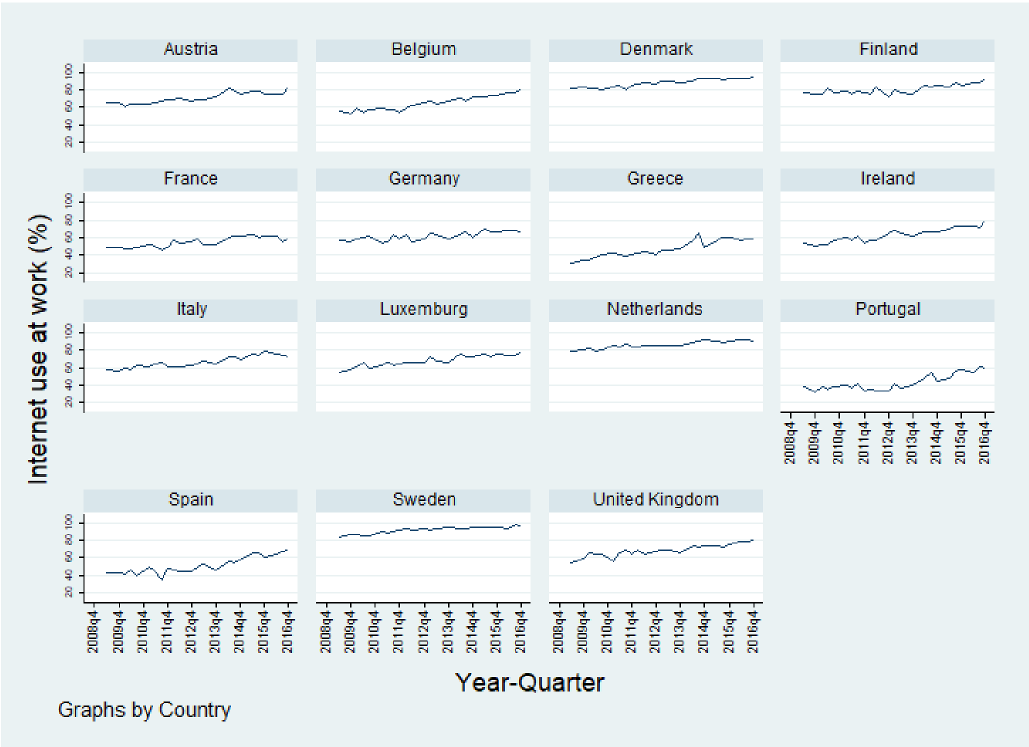
Source: Standard & Special Eurobarometer Series, years 2009 - 2016, Author's calculations.

Figure 3.5: Time series plots of Internet access at work for EU-15



Source: Standard & Special Eurobarometer Series, years 2009 - 2016, Author's calculations.

Figure 3.6: Time series plots of Internet use at work for EU-15



Source: Standard & Special Eurobarometer Series, years 2009 - 2016, Author's calculations.

and work may have a 15-20% gap through these years, but they both grow in similar pace. Growth in Internet users is slowing down (Turk et al., 2008) and the ceiling of internet users in the population could have been reached since 2015.

A major increase is also the case for Internet connection at home, at least until 2013 where its seems to remain stable at about 85%. The economic crisis seems to have no effect on ICT diffusion in EU-15, at least to the part that Internet connection at home explains ICT diffusion. The trend that comes from 2006 seems to be strong enough to remain until 2013 when Internet connection at home probably reached its peak. Campos et al. (2017) suggest that in the years after the economic crisis, Information and Communication Technologies are still recognized as powerful drivers of growth and job creation across many sectors.

Next, graphs for each indicator and each country are presented. In figures 3.2 to 3.6, we can see that, in general, most countries more or less increased the probability of Internet connection, access or use during the period 2006-2016. We can see that in almost all indicators the countries with the smallest probabilities are Greece, Portugal, Spain and Italy. Ireland and Austria follow, while northen countries such as Sweden, Netherlands and Denmark are leading in most indicators. This is a strong reason to believe that a digital divide among southern and northern european nations do exist (Demoussis and Giannakopoulos, 2006; Vicente and López, 2006a). On the other hand, growth of Internet diffusion displays quite opposite results. Southern countries seem to enjoy higher growth rates as the gap from the rest EU-15 countries looks like shrinking over the years for most indicators. For example, Denmark, Sweden and Netherlands couldn't possibly increase a lot their probabilities of Internet access, connection or use, as they reach numbers above 80-90% in most indicators, even 100% in some cases. So, lagged behind countries had their opportunity of closing this digital gap and they seem to have achieved it in a major degree.

3.2 Eurobarometer vs Eurostat data

Having used Eurobarometer data for exploring the evolution of Internet diffusion in Europe, in order to evaluate the credibility of these data, we compare them with data from Eurostat. Fisrtly, we downloaded yearly data from Eurostat for Internet access at home[2] and we compared them with our internet access at home as well as Internet connection at home. Then, we also compared access and use at work with equivalent data from Eurostat. The way Eurostat measures use at home is quite different from that of Eurobarometer, so we couldn't relate this indicator to any data from Eurostat. In figure 3.7 we can see the corresponding scatterplots for the four comparisons. We notice that in all cases there is a strong positive correlation between data from Eurostat and Eurobarometer. The results on table 3.1 support this statement as we can see that the correlations, regarding the scatterplots in figure 3.7, vary between 0.573 and 0.924.

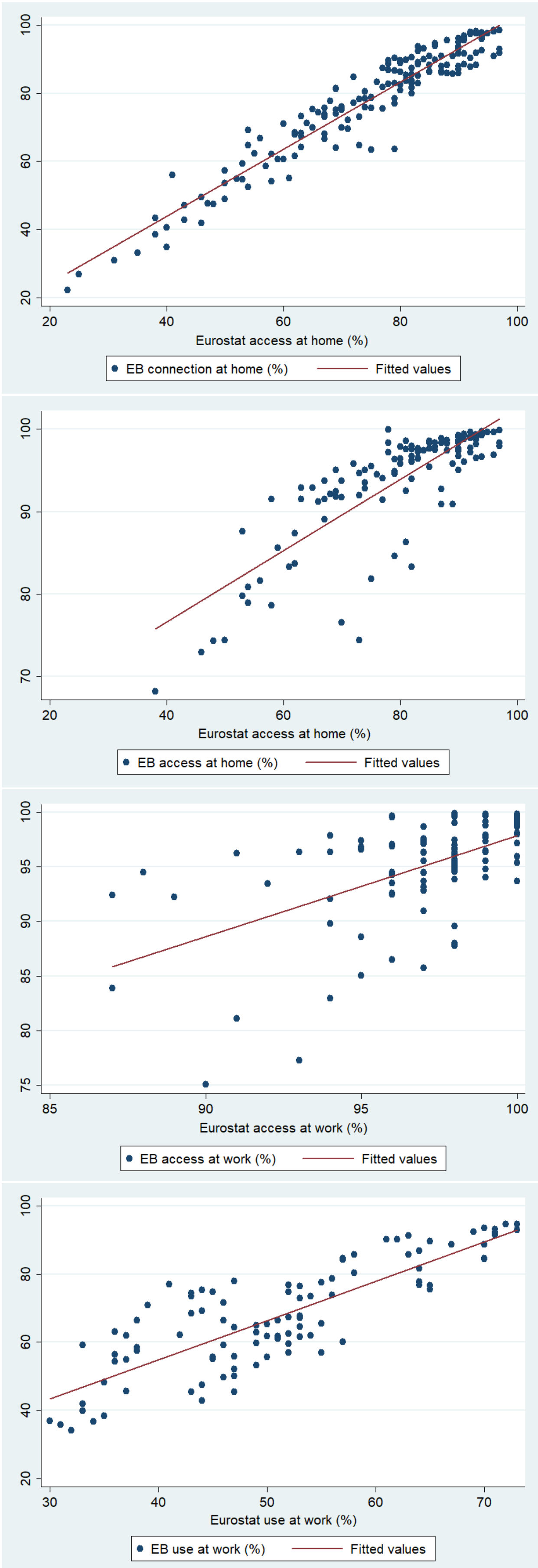
Table 3.1. Correlation matrix of Eurobarometer and Eurostat data

	Eurobarometer Internet connection at home	Eurobarometer Internet access at home	Eurobarometer Internet access at work	Eurobarometer Internet use at work
Eurostat Internet access at home	0.924	0.791	0.831	0.818
Eurostat Internet access at work	0.558	0.493	0.573	0.563
Eurostat Internet use at work	0.835	0.660	0.719	0.830

Source: Standard & Special Eurobarometer Series and Eurostat's database, yearly data from 2006 to 2016, author's calculations.

[2]Eurostat doesn't have data for Internet connection at home, so we compare our indicator of Internet connection at home with that of Eurostat's Internet access at home, considering that access and connection are both similar ways of measuring access

Figure 3.7: Scatterplots for comparing Eurostat and Eurobarometer data



Source: Standard & Special Eurobarometer Series and Eurostat's database, yearly data from 2006 to 2016, author's calculations.

3.3 Aggregate analysis of Internet diffusion

So far, we have taken a look at the evolution of global and european Internet diffusion and we have also evaluated our data comparing them with Eurostat data. Before we proceed with the microeconomic analysis, considering previous literature (see Kiiskia and Pohjola, 2002; Guillen and Suarez, 2005; Demoussis and Giannakopoulos, 2006b; Vicente and López, 2006b), we test if two macroeconomic factors are associated with Internet diffusion among EU-15. These are GDP and Internet access costs.

As an indicator of the cost of Internet access, we use the median offer (without line rental) for all baskets of Mbps and states of ISP (Internet Service Provider) during 2014-2015, extracting annual[3] data from European Commission and specifically the "Study on retail broadband access prices". Moreover, obtaining quarterly data from Eurostat, we use GDP (constant 2010 prices, euros per capita) as a measure of economic development and purchasing power (Guillen and Suarez, 2005).

On table 3.2 we can see the results of the aggregate estimation using OLS method. They confirm previous evidence on the positive impact of GDP on Internet access (e.g. Kiiskia and Pohjola, 2002) and use (e.g. Guillen and Suarez, 2005), while access costs seem to be a barrier for Internet access (e.g. Kiiskia and Pohjola, 2002) and use (e.g. Guillen and Suarez, 2005).

To begin with, all results presented on table 3.2 are statistically significant at a 1% level. Moreover, we can see that both GDP and access cost have a deeper impact on Internet connection at home and use (at home or work) than Internet access (at home or work). For example, if quarterly GDP per capita increases by 1%, then there is a 0.208% greater probability of using the Internet at home while only a 0.048% better chance of accessing it at home. Similar intensity we can see

[3]Using quarterly GDP data, we transform annual into quarterly data for access cost using the same annual value for each quarter, considering access costs have little or no variation over the same year

about cost. A raise of 1% at the access cost reduce the probability of a using the Internet at home by 0.152% and that of having access at home by 0.026%. Moreover, we couldn't but notice that Internet use at work is the indicator affected most by GDP and Internet access cost. This could probably mean that Internet use at work is correlated with GDP and cost in an indirect and not apparent way.

To sum up with aggregate analysis, GDP seems to be positevely correlated to all our indicators while access cost causes a negative effect, results also confirmed by previous literature and findings (e.g. Kiiskia and Pohjola, 2002; Guillen and Suarez, 2005; Demoussis and Giannakopoulos, 2006; Vicente and López, 2006b). Nevertheless, there is not enough evidence to support causal inference between access costs and digital divide or between GDP and digital divide. Internet access costs and GDP don't necessarily create digital divide. We can only observe a strong association between them.

Table 3.2. The macroeconomic indicators of Internet diffusion in Europe

Variables	Internet connection at home	Internet access at home	Internet use at home	Internet access at work	Internet use at work
GDP (ln)	0.212***	0.048***	0.208***	0.040***	0.315***
	(0.021)	(0.006)	(0.020)	(0.006)	(0.034)
Cost (ln)	-0.143***	-0.026***	-0.152***	-0.026***	-0.285***
	(0.033)	(0.009)	(0.027)	(0.009)	(0.059)
Constant	3.037***	4.233***	3.139***	4.302***	2.424***
	(0.203)	(0.069)	(0.226)	(0.064)	(0.390)
Observations	90	90	90	90	90
R-squared	0.504	0.407	0.712	0.390	0.522

Source: Standard & Special Eurobarometer Series, Eurostat and European Commission quarterly data for EU-15, years 2014 - 2015, author's calculations.
Notes: Linear regressions were applied. GDP refers to the natural logarithm of the GDP per capita (2010=100). Cost refers to the natural logarithm of the median price offer (without line rental) for all baskets of Mbps and states of Internet Service Provider (ISP).
Robust standard errors in parentheses.
***Statistical significance at 1%.

Chapter 4

Data analysis

4.1 Data sources

In order to investigate the structure of digital divide in EU members-states, we use Eurobarometer micro data from 58 surveys conducted in European countries during 2006 - 2016. Our dataset is a pool of cross-sections between October 2006 and November 2016, constructed by data for 15 Member States[1] from Standard & special Eurobarometer[2].

As mentioned before, we are going to investigate the structure of digital divide in EU-15 by observing Internet connection at home, Internet access at home, Internet use at home, Internet access at work and Internet use at work during the period 2006-2016, focusing on the role of demographics (age, gender, marital status and nationality), human capital (schooling), income related outcomes (current occupation, and durables) and location characteristics (type of community).

[1] Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

[2] (Editions: 66.2, 66.3, 67.1, 67.2, 67.3, 68.1, 68.2, 69.1, 69.2, 70.1, 71.1, 71.2, 71.3, 72.2, 72.3, 72.5, 73.1, 73.2, 73.3, 73.5, 74.1, 75.1, 75.2, 75.3, 75.4, 76.1, 76.2, 76.3, 76.4, 77.1, 77.2, 77.3, 77.4, 78.1, 78.2, 79.1, 79.2, 79.3, 79.4, 79.5, 80.1, 80.2, 81.4, 81.5, 82.1, 82.2, 82.3, 83.3, 83.4, 84.1, 84.2, 84.3, 84.4, 85.1, 85.2, 85.3, 86.1, 86.2).

4.2 Summary statistics

To achieve our research goal, we focus on individuals from EU-15, aged 15-64. We assume that the starting age of schooling is 6 years old, considering that for the overwhelming majority of EU citizens education begins at the age of 6 (European Commission, 2014-2016). On table 4.1 we can see summary statistics of the variables used in our analysis. The dataset contains 591,747 observations, splited about in half for males and females. The corresponding period is October 2006 - November 2016. Due to data limitation, the variables Internet access at home, Internet use at home, Internet access at work and Internet use at work refer to period May 2009 - November 2016 with the last two including only employed individuals. A weight variable[3] has also been used.

On table 4.2 we present frequencies of the five indicators used in order to investigate digital divide in relation with gender, age, schooling, marital status, occupational status, area of residence, durables, year and country of residence. The total means are highest for Internet access at home and work at 0.945 and 0.952 respectively, followed by Internet use at home at 0.815. This means that 13% of people who have access at home, choose not to use the Internet. Internet adoption may not necessarily imply usage, as individuals should have a certain degree of digital skills to use Internet services (DiMaggio et al., 2004) or may derive different benefits from the Internet (Goldfarb and Prince, 2008). So people need to be trained how to use the Internet efficiently and effectively (Hargittai, 2007). Lower frequencies are observed at Internet connection at home at 0.772 and Internet use at work at 0.633. About home related indicators, it is logical that Internet access exceeds both use and connection at home as connection is one way of access and use requires access. The same thing applies for access and use at work.

---

[3]A weight variable that extrapolates the actual universe (population aged 15 or more) for each country (sample), i.e. this weight variable integrates all other available weights, but does not reproduce the number of cases in the data set.

Table 4.1. Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Internet connection at home	591,747	0.772	0.420	0	1
Internet access at home	477,801	0.945	0.228	0	1
Internet use at home	477,801	0.815	0.388	0	1
Internet access at work	330,944	0.952	0.215	0	1
Internet use at work	330,944	0.633	0.482	0	1
Female	591,747	0.503	0.500	0	1
Age 15-25 years old	591,747	0.100	0.301	0	1
Age 26-35 years old	591,747	0,212	0.409	0	1
Age 36-45 years old	591,747	0.257	0.437	0	1
Age 46-55 years old	591,747	0.245	0.430	0	1
Age 56-64 years old	591,747	0.185	0.388	0	1
Schooling 0-6 years	591,747	0.249	0.156	0	1
Schooling 7-12 years	591,747	0.532	0.499	0	1
Schooling 13-16 years	591,747	0.259	0.438	0	1
Schooling 17+ years	591,747	0.184	0.387	0	1
Single	591,747	0.342	0.474	0	1
Married	591,747	0.552	0.497	0	1
Divorced etc.	591,747	0.106	0.308	0	1
Household size 1 person	591,747	0.156	0.363	0	1
Household size 2 persons	591,747	0.296	0.457	0	1
Household size 3 persons	591,747	0.224	0.417	0	1
Household size 4 persons	591,747	0.218	0.413	0	1
Household size 5 persons	591,747	0.068	0.253	0	1
Household size 6+ persons	591,747	0.037	0.188	0	1
Self-employed	591,747	0.105	0.306	0	1
Employed professionals or managers	591,747	0.152	0.359	0	1
Other white collars	591,747	0.156	0.363	0	1
Manual workers	591,747	0.289	0.454	0	1
Unemployed or house persons	591,747	0.204	0.403	0	1
Retired or unable to work	591,747	0.094	0.291	0	1

Table 4.1 Continued

Variable	Obs	Mean	Std. Dev.	Min	Max
Rural area or village	591,747	0.317	0.465	0	1
Small or middle sized town	591,747	0.442	0.497	0	1
Large town	591,747	0.241	0.427	0	1
Television	591,747	0.977	0.150	0	1
DVD player	591,747	0.810	0.392	0	1
CD player	591,747	0.719	0.450	0	1
Personal computer	591,747	0.725	0.446	0	1
Car ownership	591,747	0.834	0.372	0	1
Paid apartment/house	591,747	0.297	0.457	0	1
Still paying apartment/house	591,747	0.370	0.483	0	1
No durables	591,747	0.002	0.049	0	1
Year 2006	591,747	0.034	0.182	0	1
Year 2007	591,747	0.074	0.262	0	1
Year 2008	591,747	0.052	0.222	0	1
Year 2009	591,747	0.096	0.294	0	1
Year 2010	591,747	0.088	0.284	0	1
Year 2011	591,747	0.134	0.340	0	1
Year 2012	591,747	0.107	0.309	0	1
Year 2013	591,747	0.126	0.331	0	1
Year 2014	591,747	0.091	0.288	0	1
Year 2015	591,747	0.108	0.311	0	1
Year 2016	591,747	0.090	0.286	0	1
Austria	591,747	0.022	0.148	0	1
Belgium	591,747	0.028	0.164	0	1
Denmark	591,747	0.013	0.114	0	1
Finland	591,747	0.013	0.114	0	1
France	591,747	0.154	0.361	0	1
Germany	591,747	0.200	0.400	0	1

Table 4.1 Continued

Variable	Obs	Mean	Std. Dev.	Min	Max
Greece	591,747	0.027	0.163	0	1
Ireland	591,747	0.012	0.107	0	1
Italy	591,747	0.150	0.357	0	1
Luxemburg	591,747	0.001	0.036	0	1
Netherlands	591,747	0.042	0.201	0	1
Portugal	591,747	0.025	0.157	0	1
Spain	591,747	0.124	0.329	0	1
Sweden	591,747	0.023	0.150	0	1
United Kingdom	591,747	0.165	0.372	0	1

Source: Standard & Special Eurobarometer Series, years 2006 - 2016, Author's calculations. Notes: As the variables are defined as dummy variables, the mean values represent the percentage of individuals for which the variable takes the value 1. A weight variable has been used which extrapolates the actual universe (population aged 15 or more) for each country (sample). Dataset refers to EU-15 for period October 2006 - November 2016. Internet access at home, Internet use at home, Internet access at work and Internet use at work refer to period May 2009 - November 2016 with the last two including only employed individuals. Other white collars refers to employed position, working mainly at a desk, or not (salesmen, driver, etc.). Divorced etc. refers to divorced, seperated, widow/er or other.

Looking deeper at each category, many interesting observations can be made from the results. To begin with, we observe that frequencies for Female are about the same for all indicators, unlike some literature suggests. Nevertheless, Rice and Katz (2003) and Goldfarb and Prince (2006) find no significant difference in adoption rates by gender. The only notable difference is that men are 2.6% more likely to use the Internet at home (e.g. Demoussis and Giannakopoulos, 2006; Campos et al., 2017; Bimber, 2000). In any case, it seems that gender is becoming a less important factor as Internet use grows (OECD, 2007).

In general, age seems to play a positive role at younger people. After middle age, the frequencies of all indicators are slowly declining. Specifically, the probability of having an Internet connection at home for ages 15-25 is about 77% and remains quite stable at around 80% until the age of 55. After that, the probability drops significantly at almost 67%. Access at home is about 0.96 for the first 3 groups, 0.946 at ages 46-55 and drops at 0.898 at the oldest group. Access at work is similar, except that it starts at a lower 0.944 for the youngest group and finishes at 0.935 for the oldest. Probably, no significant differences there. Internet use at home is decreasing after the group 26-35 with quite large differences between older groups. Similar fluctuations happen for use at work but with a larger difference between the two first qroups and smaller between the last ones. Among others, Chaudhuri et al. (2005), Vicente and López (2006b), Campos et al. (2017) and Goldfarb and Prince (2006) find that the probability of access is higher for younger individuals. Generally, the impact of age may be credited to multiple factors, including the lack of Internet abilities as well as dissimilarities in attitude among age groups and the perceptions of the benefits related to its use, which are lower for older people (Hargittai, 2003; OECD, 2007). Orviska and Hudson (2009) also find a complex non-linear relationship with age.

Years of completed education seem to largely affect our indicators. Wider gaps exist at first stages and the effect wears of, but still remains, at higher levels of schooling. One of the possible justifications is that Internet cost is an important barrier for the decision to connect to the Internet for low-income people (Goldfarb and Prince, 2008) and also that well educated individuals tend to reach higher professional and economic status, being also more keen on adopting innovations such as the Internet. In addition, the perceived profits and utility from Internet use depend on economic status and education level (OECD, 2007). Thus, people with higher income levels report higher benefits than people with lower income levels (Mills and Whitacre, 2003).

In relation to single persons, married ones have 5% higher probability of having a connection at home but marriage probably makes little or no difference for the other indicators. Divorced, seperated or widows/ers have the smallest frequencies among the three categories of marital status.

Size of household seems to play a positive role on all indicators until households consisting of 5 persons (4 persons for Internet use at work). After that size, the frequencies of our indicators drop. Demoussis and Giannakopoulos (2006) find that larger households are associated with reduced levels of Internet use and suggest that an explanation for this could be that they face more income difficulties and time limitations.

Moreover, Internet access and use vary according to employment status and type of occupation. This is a good reflection of people's income status, as our data lack a direct income variable. Retired or unable to work have the smallest probabilities of using the Internet at home or even having a connection or access at home. This may be a reflection of retired people's age, as retired people tend to be old and old people tend to access or use the Internet less (Vicente and López, 2006b; Campos et al., 2017; Goldfarb and Prince, 2006). In addition, individuals who are unemployed have also significantly smaller chances of accessing or using the Internet (Campos et al., 2017; Orviska and Hudson, 2009; Vicente and López, 2011; NTIA, 2013, among others). Kim (2011) argues that companies promote and subsidize Internet access and usage to increase productivity. Firms also invest in human capital either by demanding high skilled-workers (Bresnahan et al., 2002) or upgrading the skills of their current workers (Hempell, 2003). This could explain the result that workers are more likely to have accessed the Internet. Among different types of occupations, we can observe differences in access and use, noticing that employed professionals or managers are leading in each indicator with frequencies of at least 0.899.

Examining results for the area of residence, the size of the area/town seems to play a positive role on every indicator. The most significant differences are observed at Internet use at work. This could be explained by the different types of occupation one can come across in villages, small and large towns. Campos et al. (2017) also find that the probability of Internet access is higher for individuals that live in urban areas. Demoussis and Giannakopoulos (2006) suggest that living

Table 4.2. The heterogeneous profile of Internet diffusion

	Internet connection at home	Internet access at home	Internet use at home	Internet access at work	Internet use at work
Male	0.778	0.946	0.828	0.950	0.636
Female	0.766	0.943	0.802	0.954	0.631
Age 15-25 years old	0.768	0.958	0.879	0.944	0.550
Age 26-35 years old	0.800	0.961	0.890	0.957	0.668
Age 36-45 years old	0.811	0.960	0.866	0.958	0.665
Age 46-55 years old	0.788	0.946	0.795	0.951	0.626
Age 55-64 years old	0.668	0.898	0.655	0.935	0.571
Schooling 0-6 years	0.313	0.747	0.243	0.800	0.182
Schooling 7-12 years	0.710	0.926	0.746	0.928	0.471
Schooling 13-16 years	0.845	0.971	0.905	0.968	0.725
Schooling 17+ years	0.912	0.986	0.953	0.988	0.880
Single	0.755	0.947	0.837	0.952	0.633
Married	0.806	0.952	0.822	0.955	0.644
Divorced etc.	0.649	0.899	0.704	0.929	0.564
Household size 1 person	0.619	0.898	0.712	0.939	0.625
Household size 2 persons	0.742	0.933	0.790	0.951	0.634
Household size 3 persons	0.811	0.959	0.840	0.954	0.622
Household size 4 persons	0.851	0.968	0.873	0.956	0.655
Household size 5 persons	0.853	0.969	0.876	0.958	0.626
Household size 6+ persons	0.809	0.964	0.854	0.955	0.599
Self-employed	0.816	0.958	0.858	0.944	0.704
Employed professionals or managers	0.929	0.990	0.965	0.991	0.899
Other white collars	0.839	0.974	0.910	0.976	0.791
Manual workers	0.763	0.947	0.814	0.920	0.380
Unemployed or house persons	0.662	0.908	0.699	-	-
Retired or unable to work	0.625	0.882	0.626	-	-
Rural area or village	0.764	0.936	0.788	0.944	0.582
Small or middle sized town	0.765	0.945	0.819	0.953	0.636
Large town	0.795	0.9657	0.844	0.959	0.694

Table 4.2 Continued

	Internet connection at home	Internet access at home	Internet use at home	Internet access at work	Internet use at work
Television no	0.643	0.953	0.838	0.966	0.732
Television yes	0.775	0.945	0.815	0.951	0.631
DVD player no	0.579	0.896	0.697	0.924	0.566
DVD player yes	0.817	0.957	0.845	0.957	0.647
CD player no	0.617	0.906	0.715	0.928	0.554
CD player yes	0.833	0.961	0.858	0.960	0.663
Personal computer no	0.397	0.839	0.556	0.902	0.533
Personal computer yes	0.914	0.986	0.915	0.967	0.665
Car ownership no	0.545	0.893	0.666	0.923	0.523
Car ownership yes	0.817	0.955	0.845	0.955	0.648
Paid apartment/house no	0.784	0.953	0.842	0.955	0.636
Paid apartment/house yes	0.743	0.925	0.751	0.942	0.625
Still paying apartment/house no	0.721	0.931	0.772	0.941	0.580
Still paying apartment/house yes	0.860	0.968	0.889	0.966	0.706
No durables no	0.774	0.945	0.816	0.952	0.633
No durables yes	0.029	0.603	0.815	0.922	0.599
Year 2006	0.572	-	-	-	-
Year 2007	0.612	-	-	-	-
Year 2008	0.655	-	-	-	-
Year 2009	0.707	0.896	0.685	0.926	0.549
Year 2010	0.749	0.925	0.729	0.942	0.577
Year 2011	0.789	0.932	0.779	0.944	0.591
Year 2012	0.822	0.950	0.810	0.955	0.612
Year 2013	0.832	0.946	0.832	0.953	0.632
Year 2014	0.824	0.959	0.866	0.955	0.676
Year 2015	0.836	0.970	0.898	0.962	0.708
Year 2016	0.843	0.972	0.898	0.971	0.714

Table 4.2 Continued

	Internet connection at home	Internet access at home	Internet use at home	Internet access at work	Internet use at work
Austria	0.774	0.858	0.821	0.905	0.703
Belgium	0.830	0.947	0.859	0.949	0.642
Denmark	0.954	0.983	0.964	0.990	0.876
Finland	0.892	0.960	0.913	0.975	0.797
France	0.815	0.957	0.840	0.954	0.545
Germany	0.831	0.967	0.869	0.967	0.614
Greece	0.580	0.821	0.600	0.834	0.459
Ireland	0.792	0.948	0.827	0.957	0.624
Italy	0.625	0.903	0.737	0.929	0.662
Luxemburg	0.892	0.964	0.900	0.962	0.680
Netherlands	0.962	0.996	0.972	0.995	0.858
Portugal	0.576	0.849	0.573	0.888	0.428
Spain	0.675	0.929	0.697	0.936	0.511
Sweden	0.953	0.991	0.971	0.997	0.913
United Kingdom	0.818	0.979	0.869	0.969	0.684
Total	0.772	0.945	0.815	0.952	0.633

Source: Standard & Special Eurobarometer Series, years 2006 - 2016, Author's calculations. Notes: All frequencies are means for EU-15 from period May 2009 - November 2016 apart from Internet connection at home which refers to period October 2006 - November 2016. Internet access at work and Internet use at work include only employed individuals. A weight variable has been used which extrapolates the actual universe (population aged 15 or more) for each country (sample). Other white collars refers to employed position, working mainly at a desk, or not (salesmen, driver, etc.). Divorced etc. refers to divorced, seperated, widow/er or other.

in rural areas appears to display reduced levels of Internet usage.

Lacking income data for the respondents, apart from occupation, we also include durables to see income related outcomes. Continuing on table 4.2, we see that respondents who own a dvd player, a cd player, a computer or a car, they all are more likely to have an Internet connection at home, access or use the Internet (at home and work). The influence of these durables is stronger on Internet connection at home, use at home and use at work. For example, having a pc or not seems to play a very important role on those indicator's frequencies. Individuals who own a pc have a 91.4% probability to have a connection at home, 91.5% to use the Internet at home and 66.5% to use it at work. On the other hand, probabilities for people who don't have a pc to have a connection at home, use the Internet at home and work are about 40%, 56% and 53% respectivily. Differeneces also exist among Internet access but are less intense, as although some individuals may not own any of these durables, they have frequencies mostly above 89%. Having a television causes mixed effects on our indicators. Minor differences can be seen on access at home or work. Respondents who own a television are more likely to have an Internet connection at home, but less likely to use the Internet at home or work than those who don't have a pc. Television and Internet use are subtitutes in many ways, such as the fact that they both provide information, news, movies etc. Advancing to the other variables for durables, respondents who have an appartment for which they have finished paying for, seem to have opposite results from those who are still paying for one. This makes sense, as paying for an appartment can be a considerable expense for a person and his/her family and cost of Internet can become more easily a barrier for them. Finally, having no durables at all is certainly a mirror to one's economic situation, so people with no durables are by far less likely to have a connection, access or use the Internet at home than those who have at least one durable. The differences in access and use at work are minor, probably because those indicators are including only people who are employed and thus they have income. Apart form that, respondents with no durables are only the 0.16% of the total sample size, so conclusions could be misleading.

Continuing on table 4.2, we can see how the frequencies of the five indicators vary year after year. Consistent with figure 3.1, we can see that there is a major increase in all indicators' frequencies during 2006-2016. Specifically, Internet connection at home begings at a quite low frequency of 0.572 in 2006, to reach its highest value (0.843) in 2016. There is a positive trend on Internet connection at home, until 2013, where the growth rate is slowing down. For Internet access at home and work starting at numbers above 89% in 2009, there was no room for large growth, but they managed to reach 97.2% in 2016. Individuals who used the Internet at home back in 2009 were the 68.5% of the total sample. With a non-stop upturn, the percentage reached 89.8% in 2015 and remained the same during 2016. Finally, only 54.9% of the respondents used the Internet at work in 2009 while 71.4% did so in 2016.

Observing the indicators at a country level, we can clearly see that there are significant differences - variations among EU-15. Connection at home varies from country to country, with Netherlands leading at 96.2% while only about the 58% of the respondents at Portugal and Greece have a connection at home. Major variations also exist at Internet use, whether it is at home or work. Again Portugal and Greece have poor "performances". Only 57.3% of portuguese people and 60% of the greeks claim to use the Internet at home. The percentages for use at work are 42.8% and 45.9% respectively. On the other hand, in countries such as Netherlands, Sweden and Denmark, about 97% use the Internet at home and about 86-91% at work. Differences on access at home and work are less intensive, with households at most countries seeming to have found the way of accessing Internet and enterprises providing Internet to their employees. It is obvious from these results, that there is a digital gap among southern and northern nations. Not only Portugal and Greece, but also Italy and Spain have small frequencies at almost every indicator relatively to the rest EU-15, especially the northen ones (e.g. Denmark, Netherlands, Sweden, Finland). As mentioned before in this study, Demoussis and Giannakopoulos (2006) find that there is indeed a digital divide and significant structural differences between northern and southern Europe. Vicente and López (2006a) also find that people of the northen countries present higher probability of using the Internet than those who live in the south. They suggest that the results of their analysis reinforce the fact that digital disparities reflect social and economic imbalances across countries.

Chapter 5

Empirical framework

In previous literature (see Rappoport et al., 2002; Orviska and Hudson, 2009; Demoussis and Giannakopoulos, 2006; Campos et al., 2017 etc.), it is argued that the decision on Internet use is conditional on Internet access. However, the intention to use the Internet is not always a required condition for Internet access. Individuals can use the Internet at home or work by exploiting a network which has been setup for reasons unrelated to their Internet use intensions. So, they model the adoption/usage decision as a two-stage process of a Heckman-type procedure (Heckman, 1979) probit model with sample selection. Factor analysis has also revealed as a useful tool to capture the overall dimension of the digital divide as shown by Al-Mutawkkil et al. (2009), Corrocher and Ordanini (2002), Soupizet (2004), Turk et al. (2008), and Vicente and López (2006a, 2011), among others.

In order to model ICT diffusion, we are going to model the five indicators mentioned previously: Internet connection at home, Internet access at home, Internet use at home, Internet access at work and Internet use at work. Our determinants will be variables for demographics (age, gender, marital status and nationality), human capital (schooling), income related outcomes (occupational status and durables), location characteristics (type of community) and we will aslo control for the year of the survey, since we expect that it exerts a significant and positive effect on all indicators (see table 4.2). For our analysis, we are going to use ordinary least squares (OLS) method in order to estimate the unknown parameters in the following linear regression model:

$$Y_{it} = \alpha + \beta X_{it} + u_{it}$$

where Y_{it} stands for Internet diffusion indicators and can be equal to one of five possible dependent dummy variables (Internet connection at home, Internet access at home, Internet use at home, Internet access at work and Internet use at work.) for individual i at time t. X_{it} is a vector of explanatory variables for individual i at time t where we incorporate a dummy variable for gender (female), five dummies for age (15-25, 26-35, 36-45, 46-55, 56-64 years old), four dummies for schooling (0-6, 7-12, 13-16, 17+ years), three dummies for marital status (Single, Married, Divorced etc.), six dummies for household size (1, 2, 3, 4, 5, 6+ persons), six dummies for the current occupational status (Self-employed, Employed professionals or managers, Other white collars, Manual workers, Unemployed or house persons, Retired or unable to work), three dummies for the type of community (Rural area or village, Small or middle sized town, Large town), seven dummies for durables (Television, DVD player, CD player, Personal Computer, Car ownership, Paid apartment/house, Still paying apartment/house, No durables), eleven dummies for the year of the survey (2006-2016) and fifteen dummies for country of EU-15 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.). β is the associated vector of coefficients, α is the constant term and u_{it} is the error term. All dependent and explanatory variables that we use in the estimations are described in section 4.2, on table 4.1.

Taking table 4.2 into consideration, we expect to find from the estimated results that explanatory variables will have stronger effects on Internet connection at home and use at home or work, rather than Internet access. In spesific, we expect that gender has weak and mixed effects on our indicators. For age, we expect to have a non linear relationship on most indicators. Probably, we will see a positive correlation at younger ages and negative at older ones. Schooling, consistent also with literature, we believe it will play a major and positive role on Internet connection, access and use. Married people will probably be more likely to have an Internet connection at home while divorced etc. will use the Internet less at home. Next, we believe that size of household could have a positive impact on Internet connection and maybe on some other indicators. Results for occupation are expected to be multidimensional. Unemployed, retired and manual workers will probably be less likely to have connection, access or use the Internet at home. The last ones, considering the nature of their job, will also be less likely to use the Internet or access it at work, comparing to other employed individuals. Large towns are expected to host individuals more probable to have a connection, access or use the Internet. Owning durables will probably increase the probability of having a connection, accessing or using the Internet. However, television may have negative correlation with Internet access. Year of the survey will have a strong positive impact on the probabilities of connection, access or use. Finally, great variations are expected among countries, especially on Internet connection and Internet use at home or work.

Chapter 6

Empirical results

The estimated results on table 6.1 indicate that Internet connection, access and use by EU citizens are influenced by a wide range of factors. This is an indication that the observed digital divide in Europe is indeed a multidimensional and complex phenomenon (van Dijk and Hacker, 2003).

To begin with, results for gender are mixed. Interestingly, Internet connection and access at home favour women (Chaudhuri et al., 2005) while Internet use at home and work show that men have higher probability of use. Campos et al. (2017) and Bimber (2000) also report a gender gap in use against women. Bimber (2000) attributes this to a combination of socio-economic and gender effects (stereotypes, differences in technology skills, etc.). However, unlike our findings, they suggest the existance of this gap also in access. Although most of our results for gender (it seems to have no effect on Internet access at work) are statistically significant at a 1% level of significance, the values of the coefficients are low. For example, women have only a 0.46% better chance than men of accessing the Internet at home. Gender's most considerable effect is reflected on Internet use at work, where women are 1.9% less likely than man to use it. This could possibly mean that women take jobs that they do not need to use the Internet. This is consistent with other papers (e.g. Goldfarb and Prince, 2008; Orviska and Hudson, 2009; Pérez-Hernández and Sánchez-Mangas, 2011; Campos et al., 2017) where

Internet users[1] among the labor force tend to be male.

For models (1)-(3), age exerts negative and statistically significant (at a 1% level of significance) effects (see Campos et al., 2017; Goldfarb and Prince, 2006; Demoussis and Giannakopoulos, 2006, among others). First, as people grow older they should become more knowledgeable. However, in an era of continuous technological change, people's ability to use new technologies may get worse with time since they finished formal education (Orviska and Hudson, 2009). Probably, the second effect overcomes the first one. Reference category for age is the group 15-25 years old. Major differences can be seen between this group and the oldest one on the first three models. Specifically, individuals aged 56-64 years old have 18.6% lower probability of using the Internet at home than those who are between 15 and 25 years old. For Internet access and use at work, negative and statistically significant results between the youngest group and the others can be seen only for groups 46-55 and 56-64 years old (and 36-45 years old at model (5)). Both groups are less likely to have Internet access and use the Internet at work than the 15-25 years old group.

Results on table 6.1 also indicate that Internet connection, access or use pertain to educated individuals (Campos et al., 2017; Goldfarb and Prince, 2006; Demoussis and Giannakopoulos, 2006, etc.). As mentioned previously, the perceived benefits and utility from Internet use vary according to economic status and education level and more educated individuals tend to achieve higher professional and economic status. Moreover, schooling provides an initial intellectual advantage that enables the well educated to process new information more effectively. All coefficients are positive and statistically significant at 1% level. Internet connection and use coefficients are higher than those of access. Specifically, the largest impact of schooling can be seen on models (3) and (5), where individuals who have 17 or more years of completed education are 31.3% more likely to use the Internet at home and 35.5% to use it at work than those who have 0-6 years

[1] Using Internet in general, not necessarily at work

of schooling. However, significant disparities exist also between other groups. For example, at model (5), the difference on the coefficients between group 7-12 years and 13-16 years is about 0.15. Major differences in the likelihood of having a connection, access or use the Internet also seem to exist even among those who have 0-6 years of schooling and those of 7-12 years, with higher percentages for the second group from 6.7% to 22.6% in all models.

Regarding marital status, married individuals are more likely to have a connection or access the Internet at home in relation to persons who are single. Goldfarb and Prince (2008) also find that Internet adoption is higher for married people which Chaudhuri et al. (2005) attribute to the "we never go out any more since we've been married" effect. There is no statistically significant difference between them in using the Internet at home and accessing or using it at work. Divorced, seperated or widowed people, statistically have the same probabilities of having a connection at home or using the Internet, as singles. They are also less likely to access the Internet at home or work.

As mentioned on section 4.2, size of household excibits mixed effects as a determinant on our models. Looking at model (1), individuals who live alone are less likely to have an Internet connection at home than households with more than one person. The effect rises until households with 4 persons. After that, the positive effect of the number of persons remains but wears off. Quite similar is the case for model (2) where like model (1) all coefficients are statistically significant at a 1% level. Single-person households also use the Internet at home less. So, for the first 3 models, the effect of household size is non-linear, where size increases the probability of connection, access or use at home only to the point of 3-4 persons. Household size seems to have no effect on access at work, apart from 4 persons households which is less likely for the respondent to access the Internet at work than one who lives alone. Last, employed individuals who live alone have a higher probability to use the Internet at work. An explanation for this and consistent with Freeman (2002) is that computerization and use of the Internet are associated

Table 6.1. Linear regression results for the five indicators of Internet diffusion

Variables	(1) Internet connection at home	(2) Internet access at home	(3) Internet use at home	(4) Internet access at work	(5) Internet use at work
Female	0.0094***	0.0046***	-0.0056***	0.0015	-0.0190***
	(0.0012)	(0.0008)	(0.0013)	(0.0010)	(0.0021)
Age 26-35 years old	-0.0099***	-0.0078***	-0.0313***	-0.0004	-0.0016
	(0.0027)	(0.0016)	(0.0025)	(0.0023)	(0.0048)
Age 36-45 years old	-0.0242***	-0.0128***	-0.0666***	-0.0004	-0.0171***
	(0.0027)	(0.0016)	(0.0026)	(0.0023)	(0.0048)
Age 46-55 years old	-0.0344***	-0.0215***	-0.1240***	-0.0061***	-0.0397***
	(0.0027)	(0.0017)	(0.0028)	(0.0024)	(0.0049)
Age 56-64 years old	-0.0593***	-0.0361***	-0.1860***	-0.0175***	-0.1020***
	(0.0031)	(0.0021)	(0.0032)	(0.0027)	(0.0055)
Schooling 7-12 years	0.1010***	0.0744***	0.2260***	0.0672***	0.1360***
	(0.0037)	(0.0046)	(0.0047)	(0.0065)	(0.0074)
Schooling 13-16 years	0.1420***	0.0933***	0.2980***	0.0916***	0.2840***
	(0.0039)	(0.0046)	(0.0049)	(0.0066)	(0.0077)
Schooling 17+ years	0.1600***	0.0952***	0.3130***	0.0980***	0.3550***
	(0.0040)	(0.0046)	(0.0049)	(0.0065)	(0.0077)
Married	0.0048***	0.0028**	-0.0002	-0.0014	-0.0016
	(0.0017)	(0.0011)	(0.0017)	(0.0014)	(0.0028)
Divorced etc.	-0.0004	-0.0074***	0.0035	-0.0098***	-0.0018
	(0.0023)	(0.0018)	(0.0025)	(0.0022)	(0.0040)
Household size 2 persons	0.0416***	0.0129***	0.0345***	-0.0003	-0.0134***
	(0.0022)	(0.0016)	(0.0023)	(0.0018)	(0.0034)
Household size 3 persons	0.0722***	0.0237***	0.0365***	0.0001	-0.0322***
	(0.0024)	(0.0017)	(0.0025)	(0.0019)	(0.0038)
Household size 4 persons	0.0774***	0.0220***	0.0357***	-0.0053***	-0.0334***
	(0.0025)	(0.0017)	(0.0026)	(0.0020)	(0.0040)
Household size 5 persons	0.0765***	0.0212***	0.0373***	-0.0041	-0.0487***
	(0.0031)	(0.0020)	(0.0033)	(0.0026)	(0.0054)
Household size 6+ persons	0.0639***	0.0221***	0.0335***	-0.0024	-0.0537***
	(0.0041)	(0.0025)	(0.0042)	(0.0035)	(0.00742)
Employed professionals or managers	0.0058***	-0.0029**	0.0126***	0.0189***	0.113***
	(0.0022)	(0.0012)	(0.0022)	(0.0014)	(0.0033)
Other white collars	0.0058**	0.0068***	0.0196***	0.0243***	0.0735***
	(0.0023)	(0.0013)	(0.0024)	(0.0016)	(0.0035)
Manual workers	-0.0223***	-0.0082***	-0.0291***	-0.0207***	-0.2670***
	(0.0022)	(0.0014)	(0.0023)	(0.0017)	(0.0035)

Table 6.1 Continued

Variables	(1) Internet connection at home	(2) Internet access at home	(3) Internet use at home	(4) Internet access at work	(5) Internet use at work
Unemployed or house persons	-0.0557***	-0.0284***	-0.0796***		
	(0.0024)	(0.0016)	(0.0026)		
Retired or unable to work	-0.0440***	-0.0261***	-0.0605***		
	(0.0028)	(0.0022)	(0.0033)		
Rural area or village	-0.0475***	-0.0188***	-0.0372***	-0.0091***	-0.0390***
	(0.0016)	(0.0011)	(0.0017)	(0.0014)	(0.0029)
Small or middle sized town	-0.0294***	-0.0113***	-0.0192***	-0.0038***	-0.0234***
	(0.0015)	(0.0010)	(0.0016)	(0.0012)	(0.00262)
Television	0.0120**	-0.0239***	-0.0383***	-0.0188***	-0.0560***
	(0.0053)	(0.0027)	(0.0047)	(0.0031)	(0.0070)
DVD player	0.0470***	0.0134***	0.0252***	0.0118***	0.0205***
	(0.0020)	(0.0014)	(0.0020)	(0.0017)	(0.0032)
CD player	0.0421***	0.0070***	0.0193***	0.0084***	0.0376***
	(0.0017)	(0.0011)	(0.0017)	(0.0014)	(0.0027)
Personal computer	0.4840***	0.1490***	0.3620***	0.0624***	0.1010***
	(0.0018)	(0.0015)	(0.0019)	(0.0018)	(0.0029)
Car ownership	0.1070***	0.0211***	0.0725***	0.0151***	0.0547***
	(0.0021)	(0.0015)	(0.0022)	(0.0020)	(0.0035)
Paid apartment/house	0.0270***	-0.00187	-0.0006	0.0048***	0.0366***
	(0.0012)	(0.0012)	(0.0019)	(0.0016)	(0.0031)
Still paying apartment/house	0.0310***	-0.0007	0.0157***	0.0091***	0.0579***
	(0.0016)	(0.0010)	(0.0016)	(0.0013)	(0.0028)
No durables	-0.2240***	0.0163	0.0675***	0.0250*	0.0467*
	(0.0092)	(0.0136)	(0.0200)	(0.0138)	(0.0268)
Year 2007	0.0314***				
	(0.0041)				
Year 2008	0.0617***				
	(0.0044)				
Year 2009	0.1000***				
	(0.0039)				
Year 2010	0.1290***	0.0249***	0.0351***	0.0121***	0.0142***
	(0.0039)	(0.0022)	(0.0030)	(0.0025)	(0.0045)

Table 6.1 Continued

Variables	(1) Internet connection at home	(2) Internet access at home	(3) Internet use at home	(4) Internet access at work	(5) Internet use at work
Year 2011	0.1601***	0.0289***	0.0763***	0.0136***	0.0235***
	(0.0038)	(0.0020)	(0.0027)	(0.0022)	(0.0041)
Year 2012	0.1810***	0.0428***	0.0987***	0.0232***	0.0423***
	(0.0038)	(0.0020)	(0.0028)	(0.0023)	(0.0043)
Year 2013	0.1920***	0.0382***	0.1200***	0.0202***	0.0575***
	(0.0038)	(0.0019)	(0.0027)	(0.0022)	(0.0042)
Year 2014	0.3310***	0.0965***	0.2610***	0.0427***	0.1340***
	(0.0042)	(0.0021)	(0.0030)	(0.0026)	(0.0047)
Year 2015	0.3850***	0.1190***	0.3220***	0.0567***	0.1790***
	(0.0041)	(0.0021)	(0.0029)	(0.0025)	(0.0045)
Year 2016	0.4110***	0.1270***	0.3350***	0.0677***	0.1900***
	(0.0042)	(0.0021)	(0.0031)	(0.0024)	(0.0047)
Austria	-0.0244***	-0.0950***	-0.0279***	-0.0602***	0.0848***
	(0.0021)	(0.0019)	(0.0023)	(0.00223)	(0.0040)
Belgium	0.0110***	-0.0140***	-0.0045**	-0.0219***	0.0034
	(0.0021)	(0.0015)	(0.00226)	(0.0019)	(0.0041)
Denmark	0.0644***	0.0031**	0.0393***	0.0039***	0.1370***
	(0.0020)	(0.0012)	(0.0021)	(0.0015)	(0.0038)
Finland	0.0323***	-0.0099***	0.0174***	-0.00367**	0.0958***
	(0.0020)	(0.0014)	(0.0022)	(0.0017)	(0.0041)
France	-0.0056***	-0.0052***	-0.0286***	-0.0144***	-0.0708***
	(0.0021)	(0.0014)	(0.0023)	(0.0019)	(0.0041)
Greece	-0.1360***	-0.1080***	-0.1710***	-0.1190***	-0.1710***
	(0.0025)	(0.0022)	(0.0028)	(0.0028)	(0.0044)
Ireland	-0.0022	-0.0021	-0.0090***	-0.0089***	-0.0061
	(0.0022)	(0.0015)	(0.0024)	(0.0019)	(0.0042)
Italy	-0.1500***	-0.0464***	-0.0902***	-0.0359***	0.0164***
	(0.0025)	(0.0018)	(0.0026)	(0.0021)	(0.0040)
Luxemburg	0.0094***	-0.0129***	-0.0101***	-0.0176***	-0.0064
	(0.0025)	(0.0017)	(0.0028)	(0.0022)	(0.0049)
Netherlands	0.0570***	0.0103***	0.0399***	0.0071***	0.1190***
	(0.0018)	(0.0010)	(0.0019)	(0.0013)	(0.0037)

Table 6.1 Continued

Variables	(1) Internet connection at home	(2) Internet access at home	(3) Internet use at home	(4) Internet access at work	(5) Internet use at work
Portugal	-0.0610***	-0.0437***	-0.1010***	-0.0403***	-0.0588***
	(0.0026)	(0.0023)	(0.0029)	(0.0027)	(0.0043)
Spain	-0.0887***	-0.0111***	-0.1060***	-0.0196***	-0.0493***
	(0.0023)	(0.0016)	(0.0026)	(0.0022)	(0.0044)
Sweden	0.0541***	0.0068***	0.0342***	0.0078***	0.1460***
	(0.0021)	(0.0012)	(0.0021)	(0.0013)	(0.0038)
United Kingdom	0.0179***	0.0241***	0.0232***	0.0025	0.0629***
	(0.0021)	(0.0012)	(0.0022)	(0.0017)	(0.0041)
Constant	-0.0396***	0.7170***	0.2200***	0.8030***	0.3250***
	(0.0080)	(0.0059)	(0.0077)	(0.0080)	(0.0121)
Observations	591,747	477,801	477,801	330,944	330,944
R-squared	0.464	0.160	0.386	0.065	0.307

Source: Standard & Special Eurobarometer Series, years 2006 - 2016, Author's calculations.
Notes: Dataset refers to EU-15 for period October 2006 - November 2016. Internet access at home, Internet use at home, Internet access at work and Internet use at work refer to period May 2009 - November 2016 with the last two including only employed individuals. A weight variable has been used which extrapolates the actual universe (population aged 15 or more) for each country (sample). Other white collars refers to employed position, working mainly at a desk, or not (salesmen, driver, etc.). Divorced etc. refers to divorced, seperated, widow/er or other. Reference categories are: Age 15-25 years old, Schooling 0-6 years, Single, Householdsize 1 person, Self-employed, Large town, Year 2006 for model (1), Year 2009 for models (2)-(5), Germany.
Robust standard errors in parentheses.
*Statistical significance at 10%.
**Statistical significance at 5%.
***Statistical significance at 1%.

with more hours at work, so large households probably face time constraints.

Next, on table 6.1 we also observe results for occupational status. The coefficients are in comparison with self-employed individuals. Regarding models (1)-(3), unemployed are less likely than all occupational categories to have connection, access or use the Internet at home. Demoussis and Giannakopoulos (2006), Lera-López et al. (2011) and Grazzi and Vergara (2014) among others, also suggest unemployed individuals have a smaller chance to access or use the Internet. Retired or unable to work have the lower probabilities of both employed and unemployed persons, which probably includes the effect of both age and employment status. Internet access and usage is lower for elderly and higher for employed individuals (Goldfarb and Prince, 2008; Orviska and Hudson, 2009; Campos et al., 2017, among others). Among employed individuals, manual workers are less likely to access or use the Internet, especially at work (26.7% lower probability than self-employed). This probably comes from the nature of their work but could also be a consequence of lower professional and economic status among employed persons. Employed professionals or managers and other white collars seem to overcome self-employed at all indicators. Actually, a quite high and statistically significant at 1% level difference (11.3%) in the probability of using the Internet at work is observed between self-employed and employed professionals or managers.

Next determinant of our models is the type of community in which the respondent lives. Reference category is Large town. So, consistent with other papers (e.g. Demoussis and Giannakopoulos, 2006; Campos et al., 2017), we find with statistical significance at 1% that people who live in smaller towns or villages are less likely to access or use the Internet in general than those who live in large towns. The existence of a digital divide between rural and urban areas is once again verified. One way to look at this, is that the access to ICT technologies is easier and cheaper in cities (than in rural areas) because they have better telecommunications infrastructure, and the costs of the deployment of new infrastructure are lower. Besides, cities tend to concentrate high-skilled labor and knowledge resources (Cruz-Jesus et al., 2012).

Next, we have durables as determinants for all 5 models. Television, DVD player, CD player, Personal computer and Car ownership, all are statistically significant (at a 1% level) determinants of Internet connection, access or use. Apart from television which is a subtitute for Internet, owning any of the other four durables has a positive effect on the likelihood of accessing or using the

Internet. One way to explain this, is that having these durables may reflect a better economic status of the respondent. For instance, not surpisingly, having a pc rises the probability of having a Internet connection at home by 48.4% and using the Internet at home by 36.2%. Having an apartment/house paid or still paying for it, are not statistically significant on model (2) but on models (1), (4) and (5) they have a positive direction with varying intensity. Still paying for an apartment/house also has a statistically significant and positive correlation with Internet use at home. Finally, having no durables has different impact depending on the model.

Continuing with the year of the survey, reference category for model (1) is 2006 while for models (2)-(5) is 2009, as there are no data before this year for those indicators. All coefficients have a positive sign and are statistically significant at a 1% level. As discussed on section 4.2, it is obvious now that more and more EU-15 citizens have a connection, access or use the Internet each year since 2009 (2006 for connection at home). The only small drawback happened in access at home and work from 2012 to 2013. The difference in connection and use at home are major over the years. The probability of having a connection at home, continuously increasing, reaches an astonishing difference of 41.1% between 2006 and 2016. Thus, the economic crisis seems to have no obvious impact on Internet diffusion in EU-15 (to the extent at which having a connection at home account for Internet diffusion), since the probability of having a connection at home had a 2-4% increase per year from 2006 to 2012. Similarly, in 2016, a EU-15 citizen is 33.5% more likely to use the Internet than one back at 2009 with the same characteristics. However, it looks like this upturn is fading the last two years, probably meaning that Internet access and use may have reached a (temporary) ceiling. It also seems that there is room for increase at people who use the Internet at work in EU-15. The same probably doesn't apply for access at home or work, beacause as presented on section 4.2, both indicators had already reached 90% back in 2009.

Finally, the last determinant presented on table 6.1 is country with Germany being the reference category, a country which for all indicators displays frequencies quite close to the mean of EU-15 (see table 4.2). Based on these results, we can be positive that a digital divide in the EU-15 does exist. In models (2) and (4) we can see that differences in the values of the coefficients are not that high as in models (3) and (5), suggesting that the digital gap is wider for Internet use than access, as expected (see figures 3.2 - 3.6). Coefficients' signs and values vary a lot among countries. Consistent with other papers (e.g. Demoussis and Giannakopoulos, 2006; Vicente and López, 2006a), we can observe a digital divide among southern and northern EU countries. For example, people in Netherlands, Sweden and Denmark seem to be a lot more likely to have a connection, access or use the Internet than individuals who live in Portugal, Greece, Spain or Italy. To be more specific, for example, a citizen in Greece has 17.1% lower probability to use the Internet at home than one in Germany while Netherlands overcomes Germany by 4%. The same applies for use at work where greeks are below germans by 17.1% while in Sweden and Netherlands likelihood for Internet use at work exceeds that in Germany by 14.6% and 11.9% respectively. As mentioned above, noticable differences in the coefficients can be seen at all models and between most countries but the most apparent inequalities seem to exist on Internet use (at home or work) rather than access. This means that the Internet access gap is probably closing but Internet use gap is far from being extinguished. Mar Negreiro, in the European Parliament briefing in December 2015 (Negreiro, 2015), also expresses the opinion that the digital divide has been substantially reduced over the last decade in Europe, but the gap remains far from closed. Demoussis and Giannakopoulos (2006) after exploring further the causes of the observed differences in Internet use between southern and northern European states, conclude that there are major structural differences between them, related with unseen factors while Vicente and López (2006a) suggest digital disparities mirror social and economic inequalities across countries.

Chapter 7

Conclusions

Concluding, the objective of this study was to investigate the structure of digital divide in EU-15 members-states, using cross-sectional data from Eurobarometer for the period 2006 - 2016. Linear probability models were applied, where five indicators of Internet diffusion (Internet connection at home, Internet access at home, Internet use at home, Internet access at work and Internet use at work) were used as dependent variables. The obtained empirical results show that indeed the observed digital divide in Europe is a complicated and multidimensional phenomenon (van Dijk and Hacker, 2003; Demoussis and Giannakopoulos, 2006, among others).

After performing a quick aggregate analysis on section 3.3, we found evidence that GDP (positive impact) and Internet access costs (negative impact) both associate with Internet access and use in the macro enviroment (Kiiskia and Pohjola, 2002; Guillen and Suarez, 2005). Proceeding with micro analysis, most effects are found to be deeper and more intense on Internet use rather than access, which in combination with results from figures 3.1 - 3.6 suggests that the digital gap, although far from closed, is shrinking, especially in Internet access. Bimber (2000) provides an explanation for this, as he claims that as the Internet grows and access becomes less expensive and less skill intensive, socioeconomic status is becoming less correlated with Internet access. Nevertheless, the impact of digital divide could be getting bigger in time, as the benefits of ICT are continuously growing.

Specifically, the results suggest the existence of a digital divide both in access and use against less educated, older people and those who do not live in large towns. Similarly, female are less likely than male to use the Internet at work which may suggest a digital divide against women in labor force. However, results on other indicators are mixed and less intense, with women even overcome men at probabilities for having Internet connection or access at home. Marital status also seems to have mostly no significant effect on Internet diffusion. In addition, most durables exert positive effects on individuals likelihood of access or use (expept television which has mainly negative effects), probably reflecting people's economic status. Internet use and access aslo differ by occupational status. Unemployed individuals have a smaller chance to access or use the Internet than employed. Retired or unable to work have the lower probabilities of both employed and unemployed persons, which probably includes the effect of both age and employment status. Among employed individuals, manual workers are less likely to have a connection at home and access or use the Internet (at home or work). Household size exerts a non-linear effect on all home related indicators while the more persons exist in a household, the lower is the probability for an individual to use the Internet at work. In addition, individuals in EU-15 are each year more and more likely to access or use the Internet since 2009 (since 2006 for Internet connection at home, finding no evidence of any effect of the economic crisis on Internet and ICT diffusion relating to Internet connection). Finally, there are many disparities among EU-15 member states in access and use. In fact, a north–south divide appears to exist, which implies that people in the south of Europe exhibit lower probabilities of Internet use or access than those living in the north.

From a policy perspective, the results of this study suggest that a uniform policy across the EU will not be effective in narrowing the observed digital divide. So, first of all, different policy instruments should be applied in southern and northen countries, as same policies would probably have different impacts, considering the south/north divide. In addition, policy makers should take into account region, socio-demographic and income related characteristics in order to build strategies and take effective measures. We believe that such an orientation by policy makers would be helpful, given the structural character of the observed digital divide in EU. For example, according to the European Commission, in the coming years, up to 100,000 digital jobs are likely to come up in the market every year. So, Internet access for starters and then basic skills in computing and using the Internet should be given to those who really need it (e.g. older, less educated and poor people), so they could be able not only to use the Internet but also learn how to use it effectively. In this way, subsides focused on ICT skills would result in those people's deriving a greater level of utility and choosing to adapt the Internet.

Finally, although the analysis has confirmed and uncovered a few important factors explaining the digital divide in European Union, further research is needed to better understand the causes of disparities in access and use among nations but also between people with different demographic and socio-economic characteristics. The main limitation of this study is the lack of data. At the individual level, information about variables such as income, Internet skills or Internet costs would enrich the analysis. At the country and national levels, it would be very useful to have information on regional variables, such as R&D intensity. Another limitation is that we do not observe either the frequency of use or its extent (what online activities are mostly used).

Bibliography

[1] Al-mutawkkil, A., A. Heshmati, and J. Hwang. 2009. “Development of telecommunication and broadcasting infrastructure indices at the global level.” Telecommunications Policy, Volume 33, Issue 3, Pages 176-199.

[2] Bimber, B. 2000. “Measuring the Gender Gap on the Internet.” Social Science Quarterly 81 (3): 868–876.

[3] Bresnahan, T. F., E. Brynjolfsson, and L. M. Hitt. 2002. “Information Technology, Workplace Organization and the Demand for Skilled Labor: Firm-Level Evidence.” The Quarterly Journal of Economics 117 (1): 339–376.

[4] Bucy, E. P. 2000. “Social access to the Internet.” Harvard International Journal of Press and Politics 5: 50–61.

[5] Campos, R., M. Arrazola, and J. D. Hevia. 2017. “Economic crisis and benefits of the Internet: differentiated Internet usage by employment status.” Economics of Innovation and New Technology, 26:3, 269-294.

[6] Chaudhuri, A., K. S. Flamm, and J. Horrigan. 2005. “An Analysis of the Determinants of Internet Access.” Telecommunications Policy 29 (9): 731–755.

[7] Corrocher, N., and A. Ordanini. “Measuring the digital divide: a framework for the analysis of cross-country differences.” 2002. Journal of Information Technology 17, pp. 9-19.

[8] Cruz-Jesus F., T. Oliveira, and F. Bacao. 2012. “Digital Divide across the European Union.” Information and Management. 49. 278-291.

[9] Demoussis, M., and N. Giannakopoulos. 2006. "Facets of the Digital Divide in Europe: Determination and Extent of Internet use." Economics of Innovation and New Technology 15 (3): 235–246.

[10] van Dijk, J. A. G. M., and K. Hacker. 2003. "The digital divide as a complex and dynamic phenomenon." 19(4), 315-326.

[11] DiMaggio, P., E. Hargittai, C. Celeste, and S. Shafer. 2004. "Digital Inequality: From Unequal Access to Differentiated Usage." In Social Inequality, edited by Kathryn Neckerman, 355–400. New York: Russell Sage Foundation.

[12] European Commission/EACEA/Eurydice. 2014. Compulsory education in Europe – 2014/15. Eurydice Facts and Figures. Luxembourg: Publications Office of the European Union.

[13] European Commission/EACEA/Eurydice. 2015. Compulsory education in Europe – 2015/16. Eurydice Facts and Figures. Luxembourg: Publications Office of the European Union.

[14] European Commission/EACEA/Eurydice, 2016. Compulsory Education in Europe – 2016/17. Eurydice Facts and Figures. Luxembourg: Publications Office of the European Union.

[15] Fairlie, R. 2004. "Race and the digital divide: Contributions to Economic Analysis and Policy." 3 (1), 15.

[16] Flamm, K., and A. Chaudhuri. 2007. "An analysis of the determinants of broadband access." Telecommunications Policy 31: 312–26.

[17] Freeman, R. B. 2002. "The Labour Market in the New Information Economy." Oxford Review of Economic Policy, Oxford University Press, vol. 18(3), pages 288-305.

[18] Goldfarb, A., and J. Prince. 2008. "Internet Adoption and Usage Patterns are Different: Implications for the Digital Divide." Information Economics and Policy 20 (1): 2–15.

[19] Grazzi, M., and S. Vergara. 2014. "Internet in Latin America: Who Uses it?. . . and for What?" Economics of Innovation and New Technology 23 (4): 327–352.

[20] Guillen M. F., and S. L. Suarez. 2005. "Explaining the Global Digital Divide: Economic, Political and Sociological Drivers of Cross-National Internet Use." Soc Forces 84 (2): 681-708.

[21] Hargittai, E. 2003. "The digital divide and what to do about it." In New economy handbook, ed. Jones, D.C. pp. San Diego, CA: Academic Press.

[22] Hempell, T. 2003. "Do Computers Call for Training? Firm-level Evidence on Complementarities between ICT and Human Capital Investments." ZEW Discussion Paper No. 03-20. Mannheim.

[23] Hoffman, D. L., and T. P. Novak. 2000. "The growing digital divide: implications for an open research Agenda." In: Brynjolfsson, E., Kahin, B. (Eds.), Understanding the Digital Economy: Data, Tools, Research. The MIT Press, Cambridge, MA, pp. 245–260.

[24] Internet World Stats. World Internet usage and population statistics June 30, 2017 - Update. Miniwatts Marketing Group. http://www.internetworldstats.com/stats.htm

[25] ITU and UNCTAD. 2007. World information society report 2007: Beyond WSIS. Geneva: ITU.

[26] Kiiski, S., and M. Pohjola. 2002. "Cross-country diffusion of the Internet." Information Economics and Policy, 14, 297–310.

[27] Kim, S. 2011. "The Diffusion of the Internet: Trend and Causes." Social Science Research 40 (2): 602–613.

[28] Lera-López, F., M. Billón, and M. Gil. 2011. "Determinants of Internet Use in Spain." Economics of Innovation and New Technology 20 (2): 127–152.

[29] Mills, B. F., and B. E. Whitacre. 2003. "Understanding the non-metropolitan –metropolitan digital divide." Growth and Change, 24, 219–243.

[30] Negreiro, M. 2015. "Bridging the digital divide in the EU." European Parliament briefing, December 2015. EPRS – European Parliamentary Research Service.

[31] NTIA. 2013. "Exploring the Digital Nation: America's Emerging Online Experience." National Telecommunications and Information Administration (NTIA) and Economics and Statistics Administration (ESA). US Department of Commerce, June 2013.

[32] OECD. 2001. "Understanding the Digital Divide." OECD Digital Economy Papers, No. 49, OECD Publishing, Paris.

[33] OECD. 2007. "Working Party on the Information Society. Broadband and ICT access and use by households and individuals." DSTI/ICCP/IE(2007)4/ FINAL.

[34] Orviska, M., and J. Hudson. 2009. "Dividing or Uniting Europe? Internet Usage in the EU." Information Economics and Policy 21 (4): 279–290.

[35] Pérez-Hernández, J., and R. Sánchez-Mangas. 2011. "To Have or Not to Have Internet at Home: Implications for Online Shopping." Information Economics and Policy 23 (3): 213–226.

[36] Pohjola, M. 2003. "The adoption and diffusion of ICT across countries: Patterns and determinants." In D. C. Jones (Ed.), The New Economy Handbook (pp. 77–100). San Diego: Academic Press.

[37] Rappoport, P. N., D. J. Kridel, and L. D. Taylor. 2002. “The Demand for Broadband: Access, Content and the Value of Time.” In Robert, C. and James, A. (eds.) Broadband: Should We Regulate High-Speed Internet Access? Washington, D.C.: AEI-Brookings Joint Center for Regulatory Studies.

[38] Rice, R. E., and J. E. Katz. 2003. “Comparing Internet and mobile phone usage: Digital divides of usage, adoption, and dropouts.” Telecommunications Policy 27: 597–623.

[39] Soupizet, J. F. 2004. “The north–south digital divide.” Paper presented at the digital divides international conference, November 18–19, Universite´ Paris Sud, Paris.

[40] Turk, T., B. Jerman-Blazic, and P. Trkman. 2008. “Factors and sustainable strategies fostering the adoption of broadband communications in an enlarged European Union.” Technological Forecasting and Social Change, 75(7), 933-951.

[41] Vicente, M. R., and A. J. López. 2006a. “A multivariate framework for the analysis of the digital divide: Evidence for the European Union-15.” Information and Management, 43: 756–66.

[42] Vicente, M. R., and A. J. López. 2006b. “Patterns of ICT Diffusion Across the European Union.” Economic Letters 93 (1): 45–51.

[43] Vicente, M. R., and A. J. López. 2011. “Assessing the regional digital divide across the European Union-27.” Telecommunications Policy 35(3): 220–37.

[44] World Economic Forum. 2014. “The winners and losers in Europe’s digital divide.” Written by Beñat Bilbao-Osorio, Regional Director for Latin America and The Caribbean, The Economist Intelligence Unit (The EIU)