Assessing the Role of Age, Education, Gender and Income on the Digital Divide: Evidence for the European Union

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Assessing the role of age, education, gender and income on the digital divide: Evidence for the European Union

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Assessing the European Digital Divide

ABSTRACT

This paper assesses the digital divide between and within the 28 member-states of the European Union. The analysis comprised four socio-demographic contexts: age, education, gender, and income. Because of the digital divide's complexity, a multivariate approach was applied - factor analysis with oblique rotation, which resulted in two distinct dimensions: e-Services and Social Networks. To test the significant differences of European Union positioning and European Union disparities, Multivariate Analysis of Variance and Squared Rank Test were computed. Findings show that e-Services adoption is influenced primarily by the education level of individuals, while Social Networks adoption is more affected by individuals' age.

KEYWORDS: digital divide; age; education; gender; income

1. INTRODUCTION

Since the dawn of humanity, communication has been a regular activity for passing information, triggering a continuous evolution from the drawings on the walls to the zettabytes of today that circulate around the world. This huge amount of data and the ability to transmit it in real time, is due to Information and Communication Technologies (ICT). The World Bank (2011) has recognized the importance of ICT for promoting economic, human, and social progress, sustaining that technological advance is the second force after economic progress, given that since 1990 it has lifted more than 10 percent of the world population out of poverty. Likewise, the United Nations (2014) highlighted that ICT are the right podiums for knowledge sharing, skills improvement, and some electronic services such as e-government, that can bring welfare in areas like employability, health, and education. The European Commission (EC) wants to ensure, until 2020, the growth of an information society across the members of the European Union (EU) by sponsoring innovation and knowledge sharing among member states, making the most of ICT, encouraging innovation and smart solutions, and creating the right structure to deal with the social challenges of the European and global society (European Commission 2010a). The EC recognized that Europe is behind her economic partners in matters of growth rate, due in part to the lack of use of ICT, although the ICT sector in 2010 was responsible for more than 5 percent of European GDP and even more of the productivity growth (European Commission 2010b).

The novelty of ICT at the beginning (when only developed countries had the opportunity to implement them, mainly due to their high costs) along with the fast evolution of ICT in recent years, has led to discrepancies between and within countries, resulting in a technological divide. Research has been conducted to analyze the European digital divide, among or inside countries,

but rarely both at the same time (Cruz-Jesus et al. 2016); though *"the digital divide within countries can be as high as that between countries"* (World Bank 2016, p. 7). The goals of this study are to appraise the European domestic digital divide for its 28 members, and to analyze Europeans' demographic characteristics, scrutinizing:

(1) the main dimensions of digital divide of the 28 members of EU;

(2) the main socio-demographic characteristics that most impact the digital divide in the EU;

(3) the main socio-demographic characteristics that potentially contribute most to the digital divide, and those that lead to greater asymmetries in the use of ICT, for each country of EU.

In addressing these issues, this paper is structured in seven sections. The next one - section two - presents a literature review about digitalization, from the digital revolution to the current digital society with reference to the challenging digital divide. The third section is dedicated to the domestic digital divide and describes four socio-demographic drivers that influence ICT adoption. The fourth one defines the methodology, describing the data and the applied multivariate data technique, as well the outcomes of the data analysis. Section five presents the discussion of findings as well as the limitations of the study. Section six presents the theoretical and managerial implications. In the last section a synopsis of findings is presented.

2. LITERATURE REVIEW

2.1 DIGITAL REVOLUTION

With the emergence of the information society, a turning point came in the living standards of individuals, with ground-breaking technologies restructuring the traditional society (Webster 2013). The first computers, and later the Internet, enabled boundless information besides data, giving a new meaning to manipulation and exchange of these resources, creating a service society and increasing productivity and standards (Cruz-Jesus et al. 2016; Webster 2013). The personal computer and the presence of the Internet are recognized in the literature as the key ingredients of the digital revolution, since they not only brought material condition and services that otherwise would be unreachable, but also redesigned both cultural and human nature. Directly or indirectly, this technological revolution influenced society's fundamental elements such as: world population, life expectancy, governance, entertainment, human relationships and others (Bostrom 2007; Last 2017). The ability to use ICT and surf the Internet became requirements to live in contemporaneous society, also known as the Information Age (Selwyn 2004; Zhang 2013).

There are no doubts that in the past IT were already considered *"the lynchpin of our modern society"* (Cooper 2006, p. 320) being this revolution acknowledged as one of the most remarkable accomplishments of humanity (Bostrom 2007). ICT is one of the most important General-Purpose Technologies (GPT), on a par with electrification. For instance, when comparing the U.S. labor productivity in the electrification era and the ICT era, remarkably similar patterns of productivity growth are visible, even though in different time periods (Jovanovic and Rousseau 2005; World Bank 2016). Still, in the year 2000 the IT revolution was just emerging, with mobile phones and Internet usage growing by more than sevenfold between 2000 and 2015 globally (World Bank 2016).

2.2 DIGITAL DIVIDE

As ICT became better known within societies and the Internet technologies became popular, given the *"placeless connectivity"* with the "*anywhere, anytime"* approach, intensifing their adoption (Webster 2013). Notwithstanding the high level of adoption, Internet access still evaded some individuals, retaining some doubts about how this access gap will affect them in the coming years. Over the years, these gaps widened and led to the isolation and marginalization of individuals and communities, given the uneven access to ICT. The most common term to describe these ICT disparities is "digital divide", and although fairly old, the following definition provided by the Organization for Economic Co-operation and Development (OECD) is still one of the most suitable to clarify this phenommena, defining it as "the *gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities"* (OECD 2001).

ICT handling has evolved at an unprecedented speed, generating uneven spread of these technologies, depending on whether countries are industrialized or developing, widening digital disparities and attracting the stakeholder's attention (Campbell 2001; Zhang 2013). The United Nations (2014) states that individuals were falling behind due to the lack of access to technologies, missing opportunities and personal added value that the online world entails, so it has raised the bar for digitalization, trying to make ICT *"universal"* and *"affordable*" (United Nations 2016, p. 78).

The definition and classification of the digital divide is volatile although this is not related to capriciousness or an inability to be precise. It is not a unique concept and it has varied because technology itself has changed considerably (Gunkel 2003). The continuous evolution of ICT has given rise to different digital divides. Digital inequalities are gaining new forms, shifting from a matter of access to a matter of intensity, frequency, and aim of Internet use (Araque et al. 2013).

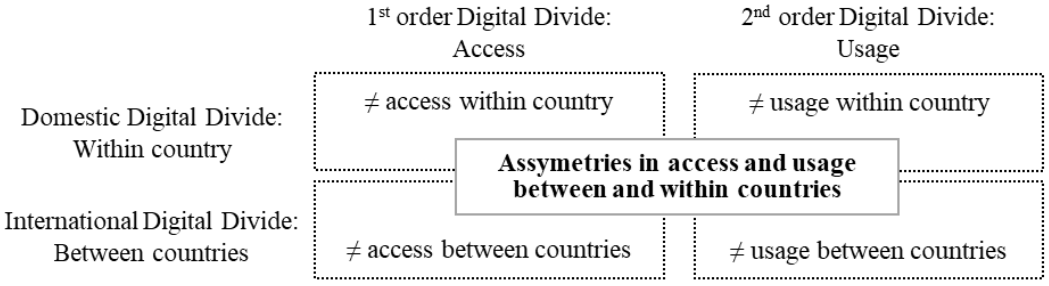
The first-order digital divide, which represents the lack of adoption, the binary divide of "have" or "have not" access to ICT, has become outdated, patronized, and imprecise (Dewan and Frederick 2005; Warschauer 2003). The second-order digital divide, representing the ICT usage and the proficiency of ICT usage, has become relevant as a measure of digitalization, allowing the inter-country assessment (Campbell 2001; Dewan and Frederick 2005). Van Dijk (2006) analyzed the technological differences and affirmed that in most developed countries the physical access divide is narrowing, leaving behind the digital divide confined to access metrics, alleging also that digital skills vary according to innovation speed of new technologies. In 2012, the same author remarked that there is a shift from the first-order digital divide that represents unequal access to ICT, to a second-order digital divide embracing inequalities of skills and usage.

It is known that ICT access is on track, but not all of the problems are yet solved. On the contrary, the problems grow deeper (Ernest-Jones 2008; van Dijk 2012). The second-order digital divide reveals itself to be one that is even more important - and more difficult to bridge - than the first-order digital divide; separating those who are able to make good use of all of these technologies entailing opportunities and improving their standards of living, from those who are not (Ritzhaupt et al. 2013). The emergent second-order digital divide is about capabilities and abilities, recognized as a knowledge divide, linked to fundamental skills that allow exploring all the benefits of the access. This raises a new challenge, a second form of inequality, that should be fully appreciated (Brotcorne et al. 2010; Robinson et al. 2015). People and organizations that use computers and Internet have a relative advantage, compared with others that do not (Ballano et al. 2014; Castaño 2008; United Nations 2014). This digital competence of handling ICT is relevant inasmuch as it gives responses to other citizens satisfying their societal needs, strengthening socially, economically, culturally, and politically, and opening space for innovative content (Selwyn 2010; United Nations 2012).

Digital inequalities of first and second-order can be used as a measure for digitalization. These digital gaps can be analyzed, whether between nations (international digital divide) or within nations (domestic digital divide) (Çilan 2013; Çilan et al. 2009; Hilbert 2010; Vicente Cuervo and Lopez Menéndez 2006). According to Çilan (2013) and Sadowski (Sadowski 2017), the level of ICT access and usage – first-order and second-order digital divides – vary among individuals within countries and digital discrepancies inside nations can justify the differences among them. Ritzhaupt (2013) considers the digital divide as a many-sided phenomenon crossing different digital extents such as access, usage, and skills as does Lindblom and Räsänen (2017, p. 147) stating that *"the digital divide at the individual level springs from many different sources"* which emphasizes that individuals act differently in terms of digitalization. For instance, the most disadvantage individuals such as the elderly, less educated, women, and individuals with lower

income widen the domestic digital disparities given their disadvantage in society (Cruz-Jesus et al. 2012).

FIG. I – The scope of the study, crossing different technological divides (Source: authors)



3. DIGITAL DIVIDE'S DRIVERS

Technology on its own, without any other catalyst, may drive deep divides within societies, rather than narrow socio-economic problems. It negatively impacts the sustainability of a society, hindering the competitiveness and the economic growth in the long term (S. R. Park et al. 2015), and is vital to comprehend vulnerable groups' behavior, guiding them to the best opportunities toward digitalization, fostering economic and social progress. Van Deursen et al. (2015) mention that socio-demographic characteristics affect online behaviors, as does Yu (2011), who explains the variability of ICT access through socio-economic conditions. To understand domestic susceptibilities and their implications in the contemporaneous society, four demographic segments were chosen: age, education, gender, and income.

TABLE I– Studies that support the chosen socio-demographic segments as drivers of digital divide

Drivers	Authors
Age	(Prensky 2001; Mitzner et al. 2010; van Dijk 2012; United Nations 2012; Ballano, Uribe, and Munté-Ramos 2014; Vroman, Arthanat, and Lysack 2015; United Nations 2016; Friemel 2016; Lüders and Gjevjon 2017))
Education	(Rogers 1995; Vicente Cuervo and López Menéndez 2006b; Castaño 2008; United Nations 2012; van Deursen, Van Dijk, and Ten Klooster 2015; Pick and Nishida 2015; World Bank 2016; Nishijima, Ivanauskas, and Sarti 2017)
Gender	(Kennedy, Wellman, and Klement 2003; Cooper 2006; Hilbert 2011; Dixon et al. 2014; Correa 2016; Liu 2016; Mumporeze and Prieler 2017)
Income	(Vicente Cuervo and López Menéndez 2006b; United Nations 2012; Zhang 2013; van Deursen, Van Dijk, and Ten Klooster 2015; Robinson and Williams 2015; Wong et al. 2015; World Bank 2016; Richmond and Triplett 2017; Cruz-Jesus et al. 2017)

3.1 AGE

Age is one of the most popular drivers when it comes to ICT adoption, with the United Nations (2012) stating that the digital divide is also an age matter. The generational rift is particularly important to understand the day-to-day appropriation of ICT by the younger and by the elders -

the first group labeled as digital natives that were born and grew up already surrounded by ICT and the second group as digital immigrants that were not, and therefore had to adapt themselves to ICT (Ballano et al. 2014; Prensky 2001). There are some previous evidences that this second group can present computer anxiety and technophobia given their age-specific characteristics and their non-intuitive ICT skills and usage, exhibiting social conditions such as: disabilities/chronic health problems, living alone, single or widowed, presenting *"lower level of education than ICT users"* (van Dijk 2012; Vroman et al. 2015, p. 165). There are evidences that the online communication among the older group, people over 65 years, is significantly lower when comparing to the youngsters (Lüders and Gjevjon 2017). It is also evident that *"for seniors older than 70 years, the relation between age and Internet use seems not to be linear but rather exponential"*, likewise *"with every additional year of age, the likelihood of Internet usage decreases by 8% in five-year differences when considering a range of 65–90 years or more"* (Friemel 2016, p. 12,16). Senior citizens are usually stereotyped as unable or reluctant. However, they simultaneously perceive that technology could enhance their self-sufficiency (Mitzner et al. 2010). By increasing ICT adoption and usage by this group, there would be less isolation via the social networks, strengthening relationships and more medical assistance via telemedicine, increasing social and health care (United Nations 2016).

3.2 EDUCATION

Educational digital divides persist in contemporaneous society (United Nations 2014) affecting digital development, justified by the complexity of ICT, which is considered as *"a major obstacle for adoption*" (Cruz-Jesus et al. 2016, p. 74). Van Deursen et al. (2015, p. 262) agree that *"education is an important predictor for the types of activities that people engage in online activities*", which is in tune with Nishijima et al. (2017, p. 15) who consider that the educational attainment affects access to ICT as it is *"positively related to ICT usage in both developed and developing countries"* explaining most of the disparities in personal skills for ICT utilization. For Kathuria and Oh (2018, p. 177) is necessary a threshold level for education and skills to diffuse faster the ICT. For instance, the United Nations (2012) mentions that most websites are in English. For people with low education level, who are uncomfortable with the English language, it is a hindrance for e-inclusion. Rogers (1995, p. 239) assumes that *"the complexity of an innovation (…) is negatively related to its rate of adoption"*. Hence, education can be the turning point for the digital divide, overcoming the ICT complexity, making the difference when individuals are faced with ICT, providing the opportunities to achieve digital dividends, prospects for future employment, making it a competition between traditional qualifications and technologies (Pick and Nishida 2015; United Nations 2012; World Bank 2016).

3.3 GENDER

The gender-related digital divide reflects gender related inequalities, in which *"digital inequalities mirror structural social inequalities"* (Correa 2016, p. 1103; Hilbert 2011). The main digital disparities are more visible in developing nations, where *"the gender gap in accessibility and use of ICTs increases the existing gender inequalities*" (Mumporeze and Prieler 2017, p. 1287). This driver plays a role in drawing ICT asymmetries as some authors argue: *"the phenomenon of technology itself cannot be fully understood without reference to gender"* (Dixon et al. 2014, p. 993; Liu 2016). Families, institutions, and religions shape gender roles and stereotypes, giving the idea that *"computers are toys for boys not for girls"*, determining and framing conducts (Cooper 2006, p. 331; Kennedy et al. 2003).

3.4 INCOME

The income level is considered by international organizations as a key component of digital disparities (United Nations 2012; World Bank 2016) and is an important driver on the digital development of countries (Cruz-Jesus et al. 2017). This in turn influences the Internet access (van Deursen et al. 2015) and the "*intensity of computer usage, as well as online activity footprints"* (Robinson and Williams 2015, p. 575). Zhang (2013, p. 526) states that *"income budget is the fundamental factor influencing the Internet consumption behavior"*. This driver was crucial in the early days of technology diffusion: those with higher income could afford to buy technologies, purchasing them in advance and using it more frequently, compared with individuals with lower middle income level that can be considered unprivileged given the lack of opportunities to acquire digital devices (Lindblom and Räsänen 2017; Vicente Cuervo and López Menéndez 2006b; Wong et al. 2015). Using just the GDP and the GDP-squared (for a non-linear relationship), in a set of 110 developed and developing countries, Cruz-Jesus et al. (2017) were able to explain 82.7 of the digital development's variation, i.e., the digital divide. The authors highlighted the overwhelming importance of income as a global digital divide driver, but also the fact that this is especially important in developing countries, as the ability to acquire ICT is often not yet met. Regarding the income dimension, the low-income groups *"lack adequate access to ICT tools, including the Internet"* (United Nations 2012, p. 95), experiencing instability in the form of temporarily disconnected service or limited public internet access. However, recent findings show that the narrowing of income inequality can create positive externalities, increasing internet usage and mobile phones subscriptions, reinforcing that the income digital divide exists. By reducing income inequalities, the narrowing of the digital divide is expected (Richmond and Triplett 2017).

4. METHODOLOGY

4.1 DATA

To measure the digital divide between and within the 28 members of the EU, 14 variables were chosen from Eurostat's Digital Agenda Scoreboard Key Indicators for the year of 2016 having into account their relevance in the digital divide matter. The support and rationale behind each one is provided in Table 2. Each variable is disaggregated per each of the four drivers mentioned in the previous section, resulting in 11 sub-levels. These sub-levels are three for age: Generation Y (16-34 years), Generation X (35-54 years) and Baby Boomers (55-74 years); three for education: Low/No formal degree (ISCED 0-2), Secondary degree (ISCED 3-4), Tertiary degree (ISCED 5-8); two for gender: Female and Male; as for income three sub-segments were defined: 1st quartile, 50% around the median and 4th quartile. For Ireland, Italy, Malta, and United Kingdom, data compiled at income classes is not available.

The three levels of education were defined using eight basic ISCED levels, as they allow the control of differences in education levels across countries, and are consistent with Eurostat which states that "at this level (the three aggregated we used) of aggregation data are considered as comparable over time for all available countries". As for income, using intranational quartiles, allows for the control of specific national differences like exchange rates, purchase power, ICT and other products and services costs, etc. Moreover, we have one group representing the ICT disadvantaged, one of the advantaged groups, and another which is hypothesized to be in the middle. This is consistent with age and education also, in which "Generation Baby Boomers" and the "Low/No formal degree" represent the ICT disadvantaged, whereas "Generation Y" and "Tertiary degree" represent the ICT advantaged. In this way, we can assess which socio-demographic characteristic (age, education, income, or gender) is more relevant in drawing digital inequalities.

TABLE II – Studies that support the variables as representative of digital divide

Variable	Description	Support
noUse	Never used the internet	(European Commission 2010b; Robinson and Williams 2015; World Bank 2016)
Mobile	Use of mobile phones to access the Internet	(Kathuria and Oh 2018; OECD 2001; Pivec 2003; United Nations 2012; World Bank 2012; Yousafzai et al. 2016)
FreqUser	Frequent internet users	(Zillien and Hargittai 2009)
eBank	Online banking	(Antonio and Tuffley 2014; Cruz-Jesus et al. 2012)
eGov	Submitting filled forms to eGov services, last 12 months	(European Commission 2010b; Taipale 2013; United Nations 2012, 2016; van Dijk 2009; World Bank 2016)
eLearning	Doing an online course	(Campbell 2001; Ernest-Jones 2008; Fakhoury and Aubert 2017; OECD 2015; World Bank 2016)
eHealth	Appointment with a practitioner via a website	(European Commission 2010b; Lin et al. 2015; United Nations 2014; World Bank 2016)
Streaming	Watching video on demand from commercial services	(European Commission 2014; Kyriakidou et al. 2011; Pil Han et al. 2016; World Bank 2016)
SocialNet	Participating in social networks	(Berry, 2011; Friemel, 2016; Haight, Quan-Haase, & Corbett, 2014; Igarashi, 2016; United Nations, 2012; Yu, Ellison, McCammon, & Langa, 2016)
UGC	Uploading self-created content	(Lee and Ma 2012; Leung 2009; Tang et al. 2014)
VoIP	Telephoning or video calls	(Jun et al. 2017; Pivec 2003; World Bank 2012, 2016)
Privacy	Awareness about cookies	(European Commission 2010b)
eBuy	Ordering goods or services online	(OECD 2001; E.-Y. Park and Nam 2014; Pivec 2003; World Bank 2016)
eSell	Selling online (e.g. via auctions)	(Dewan and Frederick 2005; European Commission 2014; World Bank 2016)

To effectively measure the digital divide, variables such as the usage of ICT and the channel to access it must be acknowledged. Considerable lack of ICT usage continues to exist, given that *"the lives of the majority of the world's people remain largely untouched by the digital revolution"* (World Bank 2016, p. 6). In developing countries mobile phones are the main form to access the Internet (Kabbiri et al. 2017) and according to Kathuria and Oh (2018, p. 177) *"mobiles have diffused the fastest among all ICT"*. Hence, the percentage of individuals that never used the Internet (noUse) and the percentage using mobile phones to access the Internet (Mobile) were included. The frequency of usage (FreqUser) is also appropriate for the study, affecting the ICT knowledge. Zillien and Hargittai (2009, p. 282) consider that *"those without frequent availability have little chance to develop the skills that they need through trial and error and practice"*, lagging behind in terms of ICT proficiency. This digital expertise is increasingly necessary, given that mundane services such as banking, health assistance, education programs, civic engagement, and other services, is more frequently carried out virtually by more users, everyday (Antonio and Tuffley 2014; European Commission 2010b; Miguel et al. 2011; United Nations 2014; World Bank 2016). Electronic services such as online banking, online submission of filled forms to government, online health appointment, and doing an online course should be studied given their importance to several international organizations. For instance, the European Commission (2010b, p. 16) considers e-banking and e-health as "some of the *most innovative and advanced online services"*. In the health sector, ICT is promising, since it empowers *"remote consultations*

and healthcare service delivery and better dissemination of vital health information to patients" (United Nations 2014, p. 143), surpassing physical barriers. Also, governments are becoming more digital*: "by 2014, all 193 member states of the United Nations (UN) had national websites"* making available to citizens online features that allow them to deal with daily bureaucracies (World Bank 2016, p. 6). Hence, the use of these coined by the EC as *"advanced services"* (eBank, eGov, eLearning and eHealth) were included in the analysis.

Participating in social networks, uploading self-created content, telephoning or making video calls, and watching video on demand, are new forms of interaction among societies. User Generated Content (UGC) *"has exploded in recent years"* (Leung 2009, p. 1328), boosting online sales (Tang et al. 2014). From the digital linkage also came the VoIP, such as Skype and Viber, which *"substitute paid voice calls with calls made "free of charge" over the internet"* (World Bank 2016, p. 205), relieving telephony costs and shaping communication between individuals. Likewise, with the evolution of ICT, the individual's rights - privacy and security concerns - came to surface over time, affecting digital aptitudes (European Commission 2010b). Hence, the use of Streaming, Social Networks, UGC, and VoIP were considered in our framework.

The United Nations (2016, p. 2) mentions that *"efforts are being made to ensure privacy and security of personal data"*, pointing out that privacy is a contemporaneous and growing concern. Thus, a measure of privacy awareness (Privacy) was also included. Finally, despite all these technological progresses, one of OECD's first concerns related to ICT was how to foster the access and adoption of e-commerce among citizens (OECD 2001). The single digital market taunted a shift from the traditional decentralized consumerism to a flexible, universal market in which trading – goods, services or online content – is one click away, prevailing popular in the current society, converging to the single global market. For these reasons, two measures of electronic commerce were included, one regarding individuals who buy online (eBuy) and another for individuals who sell (eSell).

4.2 DIGITAL DIVIDE DIMENSIONS

Given the multidimensionality of the subject that mirrors the EU countries disaggregated by 11 sub-segments for 14 variables (307 observations), a multivariate approach - factor analysis - is appropriate to find the underlying patterns and to deal with the complexity of this matter (Cruz-Jesus et al. 2012; Vicente Cuervo and Lopez Menéndez 2006). As the successful use of this technique is grounded on the correlation between the variables, these were the first to be analyzed, concluding that a strong correlation structure appears to exist. This finding is supported by the Kaiser-Mayer-Olkin (KMO) measure of sample adequacy - 0.9 - which is, according to Sharma (1996), "marvellous". The next step is to decide the "best" number of factors, taking into

consideration the Kaiser's, Pearson's, and Scree Plot criteria. This choice resulted in a two-factor solution. As is recommended, to increase the interpretability of the factors, different rotations were used, starting with the two most popular and widely used in this context - Varimax and Quartimax. However, although most studies in this and other contexts use these orthogonal rotations, implying that factors will be completely uncorrelated, from a theoretical standpoint it does seem plausible to hypothesize that the different dimensions of the digital divide may be, at least to some extent, correlated. From the authors' understanding, countries performing very well on a specific dimension, should *a priori*, also perform well in others, and *vice-versa*. Orthogonal rotations do not allow this to happen, affecting "artificially" countries' performance, especially those that score very well in one dimension and, to keep the zero correlations between the factors, are prevented from performing well also in the other. This was, by the way, noticeable in the results using orthogonal rotations, especially in the Northern countries, which scored very well in one dimension and below-average in the other without a valid reason, meaning that they were poorly represented in the new axes.

Hence, an oblique rotation, Promax was employed. If the hypothesis of the analysis is true, the results should lead to factors that have a significantly different from zero correlation, and since *"oblique rotation allows for correlated factors whereas orthogonal rotation does not, it would appear that oblique rotation would be preferred to orthogonal rotation on this basis"*, notwithstanding, "*orthogonal rotation is a subset of oblique rotations"* (Rummel 1970). Factors represent the extent to which variables are correlated and an oblique rotation could allow seeing "*the extent to which the factors themselves are intercorrelated"* (Iacobucci 2001). According with Iacobucci (2001), the correlation between the two factors was calculated, yielding a value of 0.63 ($p<0.001$), meaning that the data are adequate for this rotation, as it is neither below an absolute value of 0.3, which could mean that orthogonal rotation could be enough; nor above 0.7, which could indicate that many factors had been retained. The two dimensions are interpreted: one related to ICT applications and services, labeled as e-Services; and the other representing the social networks and the communication channels labeled as Social Networks, thereby responding to the first research question of this study (see Table 3).

TABLE III – Factor Analysis results

	Varimax		Promax					
	Rotated Factor Pattern		Rotated Factor Pattern (Regression Coefficients)		Reference Structure (Semi partial Correlations)		Factor Structure (Correlations)	
	e-Services	Social Networks	e-Services	Social Networks	e-Services	Social Networks	e-Services	Social Networks
eHealth	**0.83**	0.13	**0.95**	-0.19	**0.73**	-0.15	**0.82**	0.40
eBank	**0.87**	0.32	**0.92**	0.02	**0.71**	0.02	**0.93**	0.60
eGov	**0.82**	0.28	**0.87**	-0.01	**0.68**	-0.01	**0.87**	0.54
eSell	**0.78**	0.22	**0.85**	-0.06	**0.66**	-0.05	**0.81**	0.47
Streaming	**0.76**	0.36	**0.77**	0.11	**0.60**	0.08	**0.84**	0.59
eBuy	**0.80**	0.48	**0.76**	0.24	**0.59**	0.18	**0.91**	0.72
eLearning	**0.72**	0.40	**0.70**	0.18	**0.55**	0.14	**0.81**	0.62
Privacy	**0.76**	0.51	**0.70**	0.29	**0.54**	0.23	**0.89**	0.74
VoIP	0.19	**0.88**	-0.15	**0.99**	-0.12	**0.77**	0.47	**0.89**
UGC	0.22	**0.87**	-0.11	**0.97**	-0.08	**0.75**	0.5	**0.90**
SocialNet	0.38	**0.86**	0.09	**0.89**	0.07	**0.69**	0.65	**0.94**
FreqUser	0.64	0.74	0.45	0.62	0.35	0.48	0.84	0.91
Mobile	0.67	0.63	0.54	0.47	0.42	0.37	0.84	0.82
noUse	-0.63	-0.68	-0.47	-0.55	-0.36	-0.43	-0.82	-0.85
Cronbach's α	0.95	0.92						
Variance	47%	34%						
Total Var.	47%	80%						

Note: Correlation between the two factors is 0.63 and statistically significant ($p<0.001$)

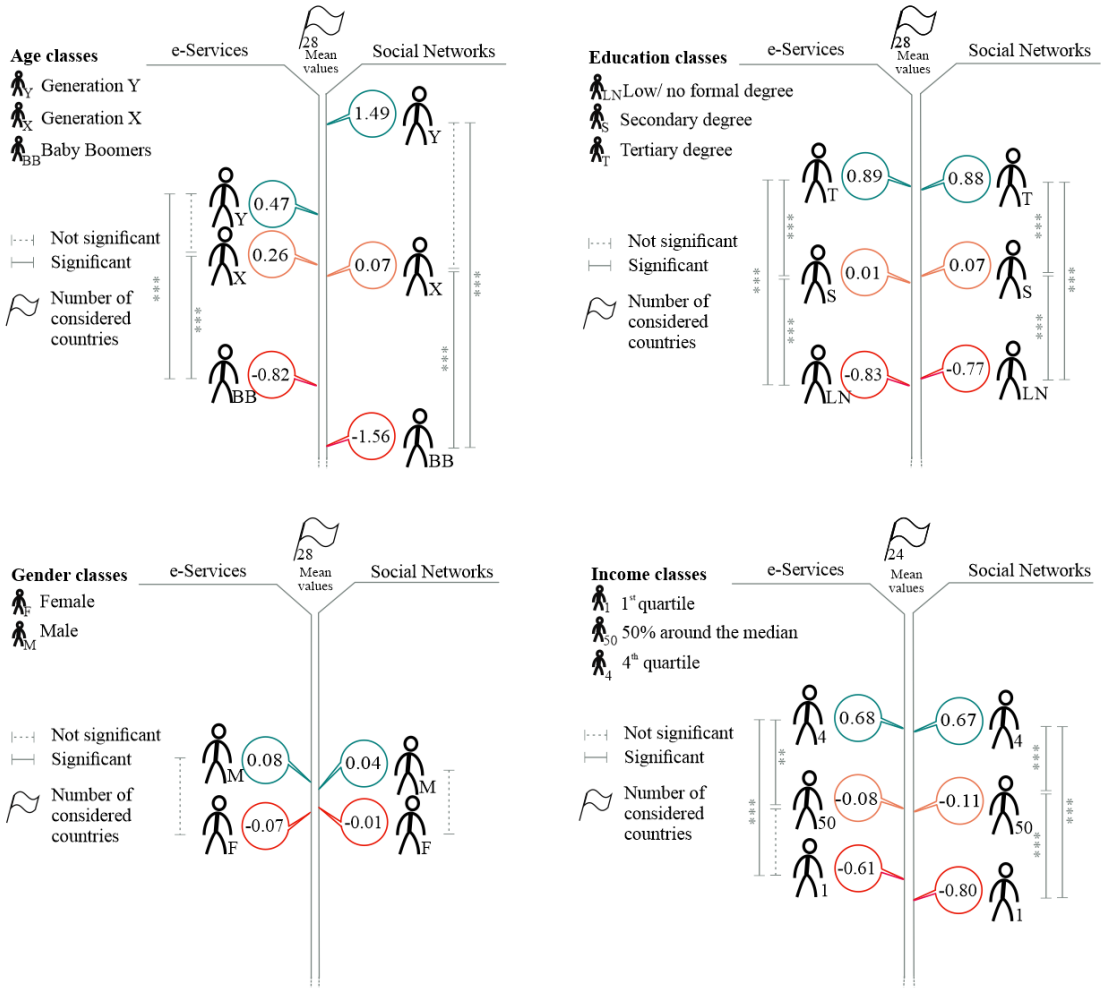
In the solution provided by Varimax, the two dimensions found explain 80% of the variance contained in the original 14 variables. The factor structure is similar between the orthogonal and oblique rotations. Note that the reference structure, i.e., the correlations between each factor and variable after the common variance with the other factor has been isolated, provided a clear differentiation between the variables highly correlated with the e-Services, from those with Social Networks. It is noticeable that, given the correlation of 0.63 and looking at the overall correlations, although the structure is still clear, some indicators are relatively well correlated with both dimensions.

The factor scores of this analysis, i.e., the values that each country/segment has on each dimension, are examined below from different perspectives, to answer the second and third research questions of this study.

4.3 ASSESSING THE IMPACT OF SOCIO-DEMOGRAPHIC CHARACTERISTICS

Multivariate Analysis of Variance (MANOVA) was chosen to assess the existence of different digital adoption levels among the 28 EU member states, when looking at different socio-demographic sub-segments. This analysis aims to compute the distances between the centroids of the subgroups, detecting if the distance between them is statistically significant (Sharma 1996). In MANOVA the null hypothesis assumes that all means are the same, testing the differences in two or more vectors of means (Çilan et al. 2009). MANOVA tests for each socio-demographic segment (age, education, gender, and income), if the sub-segments share the same mean toward e-Services and Social Networks. Also, a post-hoc test was conducted (Tukey's HSD - honest significant difference) to find which groups, specifically, have significant differences (see Figure II).

FIG. II – Multiple comparisons of the means of the socio-demographic sub-groups (Tukey HSD)



Notes: *** The mean difference is statistically significant (p<0.01); ** The mean difference is statistically significant (p<0.05); * The mean difference is statistically significant (p<0.10)

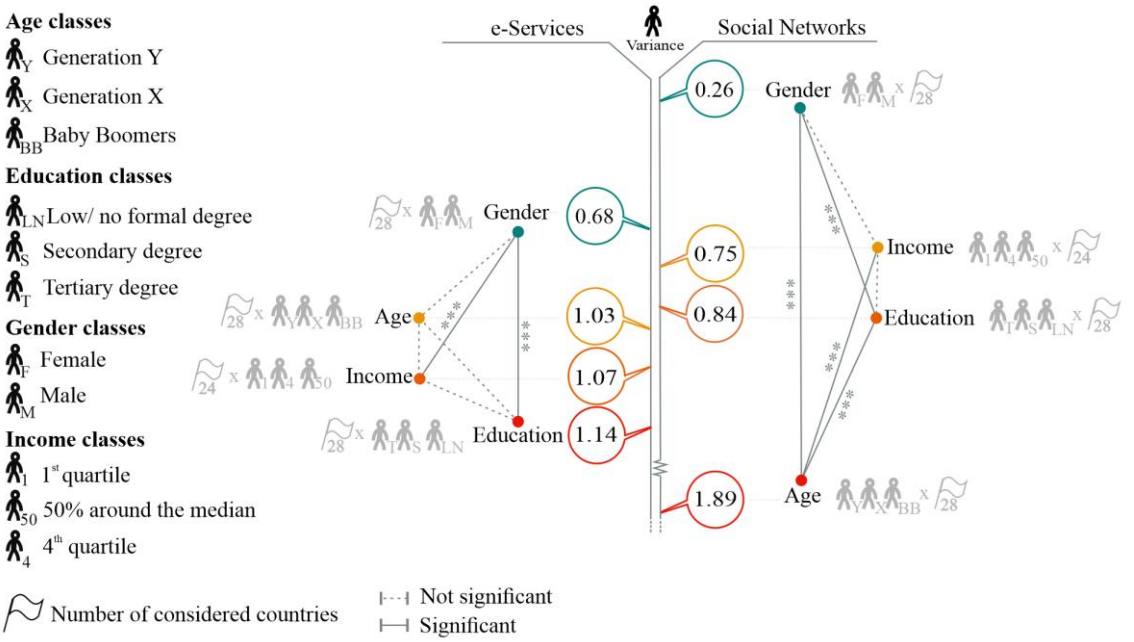
According to Figure II, within the age segment there is statistical evidence that the Baby Boomers present different levels of adoption for both e-Services and Social Networks when compared to

the two younger generations (X and Y). As for education, all three sub-segments present different levels of adoption for both dimensions, as well as for income, except for the first quartile of income group and the 50 percent around the median group, who do not present statistically significant differences in the level of adoption of e-Services. Among the 28 EU countries, in a developed society such as Europe, gender does not present statistical evidence of different levels of adoption between men and women.

MANOVA tests the differences of the means/levels of digital development, without testing if the digital disparities across the sub-segments of the same "driver" are similar. In other words, MANOVA cannot test which driver(s), if any, present higher digital divide, which is clearly of interest to know given the statement of Conover (1999) that "*the variance of the population may be the quantity of interest"*. As for this study, the asymmetries of the four socio-demographic indicators will be assessed, identifying which of them engender bigger/smaller digital disparities in the EU, by using the abovementioned sub-segments (Figure II). So, given the assumptions of the data, not following a normal distribution according to the Kolmogorov-Smirnov test, a non-parametric significance test was computed. Conover's Squared Rank Test for Variances (Conover 1999) was applied to evaluate if the digital asymmetries, i.e., the variance within the socio-demographic segments is different and, if so, identify in which of these segments there are significantly different disparities (see Figure III).

In Figure III, to calculate the variances within each socio-demographic indicator, the respective sub-segments were considered reiterated for the 28 EU countries, except for income, which presents three income subgroups among 24 countries. According to the Figure IV, for e-Services, education presents the biggest disparities; for Social Networks, age is the socio-demographic indicator with the largest asymmetries between the three generations for the 28 EU states; for the e-Services dimension, the socio-demographic asymmetries are statistically significant only when comparing gender with income and gender with education with a confidence level of 99%. As for Social Networks, most variances are statistically significantly different, at confidence level of 99%. However, when comparing the discrepancies for gender with income and for income with education, there is no statistical evidence that their variances are different. This analysis thereby responds to the second research question of this study.

FIG. III – Pair comparisons of socio-demographic segments' variance (Squared Rank Test)



Notes: *** The variance difference is statistically significant (p<0.01); ** The variance difference is statistically significant (p<0.05); * The variance difference is statistically significant (p<0.10)

To respond the third and last question of the study (see Figure IV), the standard deviation among the subgroups was calculated for each of the socio-demographic indicators for each of the EU countries. For each country and dimension the socio-demographic indicator with the largest standard deviation was identified. In the case of e-Services adoption, education is the socio-demographic indicator that most affects the digital disparities (23 countries), except for other EU members (5 countries) with age as the main indicator responsible for digital divide for e-Service. Regarding Social Networks, age is unanimously (28 countries) the socio-demographic indicator that generates the biggest disparities among the subgroups (i.e. generations) when compared to the dispersion of other subgroups, such as for education, gender, and income.

FIG. IV – The main socio-demographic indicators affecting domestic digital divide per EU country – measured by the standard deviation

5. DISCUSSION

5.1 DISCUSSION OF FINDINGS

The EU member states have different backgrounds with diverse levels of expansion and standards of living (European Commission 2010a) influencing unequally the socio-demographic groups, and thereby disrupting the equal usage and adoption of ICT.

When analyzing the four socio-demographic segments, starting by the age groups, the Baby Boomers are far below the arithmetic average adoption point (0; 0) for e-Services and Social Networks, presenting statistically significant differences against the youngest two generations at a confidence level of 99% (see Figure II). This matches with Quan-Haase's (2016) statement, affirming that Baby Boomers are still behind in terms of Internet access, digital know-how, and enthusiasm. Regarding education, the differences between the subgroups' average, for both dimensions, are statistically significant among themselves. Gender in EU28, in opposition to developing countries (Mumporeze and Prieler 2017) does not present significant differences in

terms of digital adoption toward the two dimensions of the study. For income, on the other hand, individuals with higher income present significant differences against the other two groups of income, on e-Services. As for Social Networks, there is statistical evidence at a confidence level of 99% that all income categories have different levels of adoption. These differences in developing countries would be even more noticeable, as most European individuals, regardless their income sub-segment, have sufficiently high yields that allow ICT acquisition, which is in line with earlier research (Cruz-Jesus et al. 2017).

Is noticeable that for the most proficient groups – generation Y, those with tertiary degrees, or in the 4th quartile of income – the mean differences toward the less proficient groups are statistically significant on both dimensions. High education and income levels are recognized as an "entrance ticket" to access and ICT usage, enabling individuals with solid know-how in technology (OECD 2001).

To identify which of the segments – age, education, gender, or income – present significant asymmetries – according to the Conover's variance test there is at least one socio-demographic segment with asymmetries significantly different from the other three segments. For instance, on the e-Services dimension, among the four socio-demographic segment there is at least one pair of them that present unequal asymmetries, statistically significant with a probability of 90% to be true. On Social Networks, the corroboration of significant asymmetries achieves 99% of probability, revealing stronger evidence of disparities regarding Social Networks. For both dimensions (see Figure III), there are no statistically significant differences in digital asymmetries between each pair of segments, except for education and gender (where education is higher); and income and gender (where income is higher). For Social Networks, age presents statistically significant differences toward all of the other three segments, displaying the largest disparities.

Looking at the two dimensions found (see Figure IV), education levels draw the most noticeable asymmetries for e-Services adoption, given that the most educated individuals deal better with ICT complexity, taking advantage of online services in their regular day to day activities compared to less educated individuals (Cruz-Jesus et al. 2016; van Deursen et al. 2015). For countries such as Denmark, Estonia, Finland, Germany, and Latvia e-Services adoption is more unequal among generations. Spain and Lithuania present more inequalities on both income and education. For Social Networks, it is unanimous among the 28 EU countries that age is the indicator that generates the greatest inequalities when compared to education, gender, and income, largely justified by the detachment between the youngest and the oldest. Coelho et al. (2016) enumerate several reasons that can lead to this gap between the elders and the Social Network Services (SNS), such as the apathy to ICT, prejudgment of sharing online their privacy, in

opposition to the young adults that esteem the online network and the communication associated with it (van Deursen et al. 2015).

5.2 LIMITATIONS

The study analyzes the domestic digital divide for a specific point of time, considering data from 2016. Some changes might therefore have occurred and findings must be considered as a proxy to the present reality. Another limitation of this study is that are there are only 14 variables, which can be considered as too few, given the multidimensionality of the digital divide and the constant innovations in ICT. The income segment had missing data relative to income for four countries: Italy, Ireland, Malta, and United Kingdom, and for that reason this segment must be seen with caution. Nevertheless, the main goal of the study is to identify the main socio-demographic characteristics that cause greater disparities, despite the implicit level of adoption. There might exist low levels of dispersion between the subgroups of a socio-demographic indicator, which is positive. However, their digital level of adoption could be very low or very high, which is not considered.

6. IMPLICATIONS

6.1 THEORETICAL IMPLICATIONS

OECD (2001, p. 4) mentioned that *"the digital divide among households appears to depend primarily on two variables, income and education"*, and was a matter of access that only the wealthier, therefore also more educated, could afford. Scrutinizing the divides of the 28 EU countries in 2016, namely: age, education, gender, and income, there are still some digital disparities that need to be closed. This study specifies the neediest groups with lack of adoption. For instance, e-Services adoption is more related to the education level of individuals, while Social Networks adoption is more determined by age. Income is no longer the main trigger for digital divide for the 28 EU countries when analyzing developed societies, such as those that belong to the EU. Digital divide results should be analyzed with caution, since it is a multidimensional phenomenon and different backgrounds ask for different measures, if the goal is to narrow digital discrepancies in an effective way. Regarding the multivariate technique that was applied, findings show that an oblique rotation when analyzing the digital divide through factor analysis better represents, the reality: e-Services dimension is correlated with Social Networks, sharing 36% of variance within each factor.

6.2 MANAGERIAL IMPLICATIONS

Europe is suffering from a growing professional ICT skills shortage and a digital literacy deficit. These failings are excluding many citizens from the digital society and economy and are holding back the large multiplier effect of ICT take-up to productivity growth. This requires a coordinated reaction with member states and other stakeholders at its center (European Commission 2010b). It is necessary to flip the spotlights - EU strategies and efforts - according to the two dimensions, e-Service and Social Networks, ensuring different focuses consonant with the socio-demographic sub-segments. As ICT became a commodity, the effort to narrow within and between digital divides was through the implementation of initiatives that could bridge the generational gap in case of Social Networks and that could harmonize the educational level within countries, raising awareness of the benefits of the electronic services. Public authorities, private organizations, and individuals should make a personalized effort to narrow digital differences. If each EU country would analyze the within country digital divide by socio-demographic segments and act according to its necessities, the EU would benefit more as a whole, narrowing at the same time the international and domestic digital divide, improving digital literacy of Europe.

7. CONCLUSIONS

The European strategies and recommendations intend to narrow digital disparities, achieving similar conduct between and within countries, but there is still work to be done. This study analyzes the domestic digital divide for a specific point of time, considering data from 2016 relative to age, education, gender, and income, disaggregated by 11 sub-segments: three for age, education, and income; and two for gender. On the 14 variables of the study, two dimensions were identified to represent the digital divide, e-Services and Social Networks. There is statistical evidence that the level of adoption of the two ICT dimensions varies according to the socio-demographic sub-segments, within each socio-demographic segment, presenting a confidence level of 99% when computing multiple comparison. For e-Services, education presents the biggest disparities, and for Social Networks, age classes are clearly the most unequal. Nevertheless, there is statistical evidence that the segments present disparities between them, with a confidence level of 90% for e-Services and 99% for Social Networks, revealing greater evidence of inequalities in this dimension. When analyzing the countries' asymmetries, the main drivers for digital divide in e-Services are mainly education and age. As for Social Networks, age is unanimous as being the driver that affects this digital divide, for all countries.

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