Regional patterns and drivers of the EU digital economy

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Abstract: This paper examines the progress made by the EU regions on the path of digitalisation and growth of digital economy, by analysing the dynamics and drivers of a selected number of specific indicators, based on Eurostat data running from 2001 to 2016. The study is conducted at regional level, and finally aims to identify policy measures that could enhance the growth of digital economy in the EU area. Moreover, the paper investigates whether a common set of economic and social policy measures is effective in improving several indicators of digital economy, in the New Member States (NMS) as well as in the Old Member States (OMS), given that they still exhibit different patterns of digital transformation at regional level. The increase in tertiary education attainments together with the increase in the number of issued patents are found to be policy measures that generate positive effects for several indicators of digital economy, as well as for the NMS and OMS.

JEL: O11, O30, R58.

Introduction

The digital technologies have been transforming the national economies all over the world. They continuously evolve and expand into more and more parts of the economy and society, opening the doors toward a new economy - the smart, data-driven and learning economy (Hanna, 2016). The policy makers' ability and motivation to harness the digital revolution for economic development vary from one country to another, so that the technological advance and digitalization differently impact regional and national economies (Hanna, 2016).

Although the empirical evidence suggests that the digital sector is less than 10% of most economies when being measured by value added, income or employment (IMF, 2018), the modern economy is in a broad sense a "digital economy" since digitalization is part of almost all economic activities. All EU countries are embarked on the road of digital economy, but important gaps still exist between them. The digital transformation is at the core of this new economy whose biggest challenge is to largely and equitably ensure developmental payoffs. But this digital transformation goes much beyond developing advanced digital technologies. It equally requests investing in institutions and effective economic policies because otherwise, despite the widespread use of the

Internet, the benefits from digitalization will be rather isolated. A number of strategic frameworks have been recently advanced to facilitate the construction of the digital transformation ecosystems (Hanna and Knight, 2012; Hanna, 2016). Common interdependent components of the ecosystems discussed in the literature are: policies and institutions; human capital; ICT services sector; ICT infrastructure; and digital transformation applications.

The Digital Agenda for Europe was launched in 2010 with the primary aim to boost Europe's economy by delivering sustainable economic and social benefits from a digital single market. Since then, a number of initiatives were taken by the European Commission and other European institutions, as well as by regional and local authorities, to support the development of the Digital Single Market and to finally help Europe's citizens and businesses to get the most out of digital technologies (EU, 2014). For instance, in 2015 the European Commission launched the Digital Economy and Society Index for the EU Member Countries, as an online tool to measure the progress toward a digital economy and society as well as the digital divide across the EU on an annual basis.

Even though most European initiatives in the area of digitalization aims at developing the Digital Single Market by addressing priorities at national level, the digital strategies undertaken at *local and regional level* are equally important for the citizens' well-being and economic growth. However, there is a number of challenges still to be overcome at regional level, including the lack of personnel with ICT skills, poor broadband connectivity, and regional gaps in the use of new technologies (Margaras, 2018). At both the regional and national level, the digital divide still exists across the EU with regard to connectivity, human capital, use of internet, integration of digital technologies by businesses, and digital public services (Răileanu Szeles, 2018; Margaras, 2018).

This paper comparatively examine the effects of a number of governmental policy measures on a set of digital economy indicators, in order to find out whether their effects are positive and consistent across indicators, as well as across the New Member States (NMS) and Old Member States (OMS). The policy measures analyzed in the paper are selected as to be in line with the digital transformation ecosystem proposed by Hanna (2016), while the indicators of digital economy are chosen upon the digital economy metrics introduced by Kotarba (2018). Although the concept of "regional digital economy" has been identified by several national and international organization and occasionally referred to as in reports and strategies (e.g. The River Valley Regional Commission, Digital Economy Strategy for Melbourne's North, SAMENA Telecommunications Council, Association of South-east Asian Nations etc.), upon our knowledge it has not been addressed by research papers so far. To fill this literature gap, our paper focus on the regional digital economy and frame this concept into the regional data provided by Eurostat.

The paper is structured in 4 sections. The first section, which is the Introduction, is followed in section 2 by a short review of the literature. The authors present the methods and data in section 3, while section 4 is the empirical analysis. Section 4 concludes and addresses a set of policy recommendations based on the empirical results.

Literature review

Over time, an extensive literature has developed on digital technology, high-technology, Information and Communication Technology (ICT) and their drivers, but regional digital economy remains briefly addressed in the literature, although digital economy has emerged in the literature since 1997[1]. While there is no agreed definitions of the digital sector, products or transactions (IMF, 2018), the conceptualization of digital economy ranges from activities based on online platforms, to activities that use digitized data. This ambiguous definition of digital economy leads to inconsistent estimates of the size of digital economy (Ostroom et al., 2016).

Various indicators have been used to conceptualize and operationalize the technological progress and digitalization. Initially, the digital economy was defined as an economic system characterized by a widely use of ICT's, embracing the base infrastructure, e-business and e-commerce. Over time, its scope has widen at the same pace as the development and evolution of digital technologies, so that the digital density index launched in 2015 comprises at present 50 indicators grouped in 4 activity areas and 18 groups of metrics (Macchi, 2015). Next year, in 2016, the Digital Economy and Society Index (DESI) was developed in the framework of the Europe 2020 Strategy as to capture the performances of the EU Member States in digital competitiveness.

The electronic commerce, Internet usage and human resources in ICT are among the variables used to operationalize digital economy, being included in the most popular indexes of digital, e.g. DESI. Over time, a large number of studies have examined the main drivers, dimensions and indicators of digital economy. As the digital economy represents the topic of our paper, a structured review of the most important contributions to the literature, with a focus on the electronic commerce, Internet usage and human resources in ICT, will be presented below.

Microeconomic and macroeconomic factors are usually considered when analyzing the determinants of electronic commerce. Previous studies on electronic commerce conducted at the level of small and medium enterprises are focused *inter alia* on E-readiness (Molla and Licker, 2005; Ramayah et al., 2005; Raven et al., 2007; Fathian et al., 2008; Anton, 2010), electronic commerce adoption (Lawson et al., 2003; Jeon et al., 2006; Kartiwi and MacGregor, 2007), electronic commerce diffusion (Beck et al., 2005; Raymond et al., 2005), and consequences of electronic commerce (Beck et al., 2005; Raymond et al., 2005; Fisher et al., 2007; Teo, 2007).

In the literature, different aspects at the company level related to the anticipated benefits, the variety of tasks inside the firm as well as the organizational culture are referred to as microeconomic factors (Seyal et al., 2004). For example, Grandon and Pearson (2004) explain the adoption of electronic commerce by US small and medium companies based on four factors, i.e. the perceived ease of use, anticipated usefulness, external pressure and organizational readiness. According to the studies above, companies are interesting to use the electronic commerce because it facilitates them to get higher profits and to provide higher salaries to their employees. The costumers demand, the pressure of competition and the impetuous demand of efficiently managing internal tasks are other determinants of electronic commerce.

At the company level, the benefits of using the electronic commerce results into a growth in effectiveness and efficiency. Among the most important benefits induced by the use of

[1] The concept of digital economy first mentioned by Don Tapscott in his publication (Tapscott, 1997).

electronic commerce at microeconomic level, the improvement in internal operations, the inter-organizational connectivity (Mohamad and Ismail, 2009), as well as the cost reduction, the extension of market potential and the acquiring of new business opportunities (Beck et al., 2005; Fink & Disterer, 2006; Song et al., 2017) are common findings in the literature. In the case of sellers, the benefits of electronic commerce consists of lower costs, streamlined supply chains, easy access to new markets, more revenue streams and more clients stickiness (Kasiri et al., 2017). The customers' advantages reflect in innovative services and products, new and faster shopping experiences, and entertainment (Pappas et al., 2017).

One of the most powerful determinants of the electronic commerce is the size of company. Compared to small and medium firms, large firms are more likely to the use of electronic commerce (Sharma et al., 2004; Burke, 2005), because they have lower technology capabilities and fewer resources (Thong, 2001). However, the resource constraints are generally surpassed by the simple structures of smaller firms that ensure a better adaptation to different changes in the company environment (Al-Qirim, 2004).

There is a large strand of literature studying the macroeconomic factors which stimulate the development of electronic commerce. The electronic commerce adoption and diffusion are generally separately addressed.

According to Mohamad and Ismail (2009), the adoption of electronic commerce is conditioned by various factors classified by as:

- Individual factors (IT knowledge, characteristics of management, management support);
- Organizational factors (type of industry, company's size, costs, digital skills);
- Environmental factors (government support, external expertise support, technological infrastructure, network intensity, communication channel, business location, pressures made by clients or business partners);
- Technological factors (relative advantage, perceived usefulness, compatibility).

However, the classification above doesn't take into account economic factors such as the export intensity, international market intensity (Kula and Tatoglu, 2003; Chong, 2008), or the country's welfare measured by the GDP per capita (Wand and Liu, 2015).

Apart from the empirical insights above, it has been also found that the electronic commerce adoption is influenced by the countries' economic development in the sense that the developing countries adopt the electronic commerce at a slower pace than the developed ones (Migiro, 2006). In contrast, the organizational factors represent the main barrier for adopting the electronic commerce in developing countries, while technological impediments seem to be specific especially to the developed countries (Kartiwi & MacGregor, 2007).

Another research issue examines the bi-causal relationship between electronic commerce and globalization. The electronic commerce can be considered as a tool for globalization since it facilitates the transactions between various countries in the world (Mohamad and Ismail, 2009). On the other hand, globalization itself requires the development of commercial relationships, even in the virtual form.

The electronic commerce diffusion is found to have different correlates than the electronic commerce adoption. The technologies used by firms (Al-Qirim, 2007) as well as the business functions, such as communication, interaction, transaction (Raymond et al., 2005), are the main drivers of the electronic commerce diffusion. However, there are also social and economic factors that influence the electronic commerce diffusion and are not related to firms, but to their clients, i.e. the country's welfare measured by GDP per capita (Wand and Liu, 2015), poverty (Safavi, 2009), fertility (Zotta et al., 2000), life expectancy (Olphert and Damodaran, 2013), education and medical services (Pick& Nishida, 2015).

In contrast to electronic commerce, which reflects the application of ICT in business and commerce, the Internet usage is a core indicator of the ICT usage by businesses, households and individuals (United Nations, 2005). When studying the Internet usage at the company level, the firm's size is found to be one of the most important determinants. In the case of small companies, managers use implicit managerial perceptions to take strategic decisions (Day, 1994; Caniëls et al., 2015), but large companies are more eager to use Internet resources in the decision making process (Carson, 1993).

The Internet usage is also explained in relation to the market orientation business approach. The model proposed by Celuch et al. (2007) combines market orientation (Internet efficacy, Internet usage benefits) and behavioural norms (behavioural intentions) to explain the Internet usage. Market orientation focuses on meeting the needs of its customers, based on data related to clients and their needs, competitors, suppliers and government regulations (Narver and Slater, 1990). A strong market orientation requests the intensive use of Internet which allows gathering information about customers and competitors' behaviours.

At the level of individual, the Internet usage is explained based on personality traits (Hamburger and Ben-Artzi, 2000; Armstrong et al., 2000; Scealy et al., 2002; Leung, 2002). For example, Internet usage was positively correlated to shyness (Scealy et al., 2002), self-disclosure (Leung, 2002), low-esteem (Saling, 2000), and neuroticism and extraversion (Hamburger and Ben-Artzi, 2000; Landers et al., 2006). Beside intrinsic reasons related to the confidence in technology, there are also economic and demographic factors that condition the use of Internet.

Internet usage is positively correlated to income, given that a higher income allows buying more easily Internet access devices and paying for ongoing access. This also means that lower income consumers are discouraged to access high quality Internet (Schultz, 2005).

At the macroeconomic level, the income per capita is among the most important determinants of the Internet usage. Countries with higher income per capita also have higher rates of Internet penetration (Elie, 1998; Arnum and Conti, 1998; Hargittai, 1999; Beilock and Dimitrova, 2003). The higher Internet penetration in the developed countries is due to the developed infrastructure, which also reflects advanced telecommunications (Bazar and Boalch, 1997; Maherzi, 1997). In turn, the income concentration measured by the Gini coefficient has an insignificant effect on Internet usage (Hargittai, 1999). Other drivers of the Internet usage are the legal and political conditions (Wolcott et al., 2001), the expenditure on R&D (Nelson, 1993), and the employment status. Campos et al. (2017) finds that the employed people are more likely to use the Internet, especially at work, in comparison with the unemployed. Moreover, Blank and Groselj (2014) explain that the employment status, age and education influence the Internet diffusion.

The impact of age on the decision to use the Internet has been extensively analyzed in the literature. Older people prefer to develop relationships in order to satisfy their emotional goals (Cartensten, 1995), while younger people prefer to get information quickly using Internet rather to emotionally involve in a relationship (Porter and Donthu, 2006). Moreover, many seniors prefer to achieve their emotional goals within smaller groups of people (Charles and Carstensen, 1999), while younger individuals connect more easily with a large network of individuals using the Internet. People with higher education are more eager to use the Internet compared to the less educated ones, since innovation creates homophilous groups with higher social and economic status (Rogers, 2010).

The profile of the Internet users has dramatically changed over time. While in the '90 the American internet users were well-educated, mostly males, and had upper incomes (NTIA, 1999; Mendoza and Alvarez de Toledo, 1997; Dimitrova et al., 2001, 2005), at present older people with lower education and women equally access the Internet.

Another body of literature examines the impact of government policies on the Internet diffusion. Guillen and Suarez (2001) explain that the predictability of policymaking is a relevant determinant for the inter-country Internet diffusion. Billon et al. (2017) analyse a sample of 90 developed countries running from 1995 to 2010, and find that public policies and the quality of human capital represent key determinants of the Internet usage. Press et al. (1998) explain the Internet diffusion by a mix of 5 factors which also reflect the effectiveness of public policies: geographic dispersion within the country, connectivity infrastructure, sectorial absorption, pervasiveness, organizational infrastructure, and sophistication of Internet use.

Following Scheerder et al. (2017), we provide in Appendix 1 a classification of the common drivers of the Internet usage and electronic commerce.

The employment in the HT sector represents another indicator in the area of digital economy, which has been analysed at a lesser extent in the literature, in comparison with the digital divide indicators. Acs et al. (1999) examine 36 US cities and show that the employment in the HT sector is primarily influenced by the university R&D. Other studies confirm the central role played by universities in stimulating the development of new technology and ensuring high-skilled graduates (Segal, 1985; Agrawal and Cockburn, 2003).

The companies' location near or in large urban centres with a higher capacity to innovate than the rural areas represents another determinant of the employment in HT (Duguleana, 2017). For instance, Holm and Østergaard (2015) analyse a number of Danish regions and find that the smaller HT companies adapt easier to economic shocks (e.g. economic crises) compared to the large companies. These findings lead to the conclusion that the size of HT companies, as well as their location, carry a significant impact on the employment in HT.

For developing countries, Schmitz (2018) explains that people are interesting to work in HT especially because of the wages and employment conditions provided by the companies acting in this sector. But most jobs in HT require a higher level of education (Piva and Vivarelli, 2017), and the fast dynamic of changes occurring in this sector force employees to keep up with the technological progress, eventually by long-life learning programmes. In turn, the higher, the higher wages and the organizational support wages provided in this sector represents a key motivation for employees (Ertürk and Vurgun, 2015).

Method and data

Data

The analysis is carried out at the EU regional level, based on Eurostat data running from 2001 to 2016. According to the NUTS classifications, the EU Member States are divided into NUTS 1 regions, which in turn are subdivided in NUTS 2 regions, and then divided in NUTS 3 regions. At the 1961 Brussels Conference on Regional Economies, organised by the Commission, the NUTS 2 regions have been acknowledged as being the framework generally used by Member States to apply their regional policies. In present they are defined as "basic regions", being used for the analysis of regional and national problems. This paper uses data aggregated at the NUTS 2 regional level not only because our research aim is to examine the EU regional digital economy, but also because this kind of data allows us formulating policy recommendations at the EU regional level.

The variables of interest which enter into the regression models as dependent variables are selected as to be representative for three activity areas summarized by the Digital Economy and Society Index, i.e. (1) human capital, (2) use of internet, and (3) integration of information technologies. However, this selection is conditioned upon the data availability in Eurostat at the NUTS 2 level.

The dependent variables of our analysis are the "Individuals who ordered goods or services over the Internet for private use in the last year" (abbreviated "electronic commerce")" which belongs to the area of Integration of information technologies, "Individuals regularly using the Internet" (abbreviated "Internet usage"), which is associated to the area of Internet usage, and "Employment in HT sector" (abbreviated HT employment"), which represents here the human capital. These variables are included by Eurostat in the categories of regional indicators, i.e. "Regional science and technology statistics" and "Regional digital economy and society". They reflect the progress in the development of the EU regional digital economy.

Our selection of dependant variables is grounded in the literature on ICT and digital economy. As a proxy for IT skills (Goss & Phillips, 2002), the rate of Internet usage in a region represents a driver for location of ICT companies in that region (Giner et al, 2016). Also, it reflects the activities performed by citizens on-line. The number of employers in HT sector reflects the extension of the ICT sector in a specific region. In addition, it represents an indicator of the advanced skills that empower the workforce to take advantage of technology (Kotarba, 2018). The usage of electronic commerce into a region gives insights in the digitization of businesses, which allows businesses enhancing efficiency and reducing costs. As the development of ICT infrastructure represents a pre-condition for the e-commerce growth (Kumar et al., 2014), the latter could act as a catalyst for the growth of the high-tech industry.

The independent variables considered in the empirical section reflect several dimensions of economic development:

- Economic development: “GDP per capita”,
- Productive or main activity: “Unemployment”;
- Education: “Tertiary educational attainment” (abbreviated “Tertiary”) and “Secondary educational attainment” (abbreviated “Secondary”),
- Poverty: At risk of poverty rate (abbreviated poverty),
- Health: “Number of physicians or doctors per 100.000 inhabitants” (abbreviated Doctors”)
- R&D expenditure: “High-tech patent applications to the European patent office (EPO) per million inhabitants” (abbreviated “Patents”)
- Demographic dimension: “Fertility”, “Life expectancy”, “Pupils and students in all levels of education” (abbreviated “pupils”).

Tab.1 Descriptive statistics, 2001-2016

Descriptive statistics	Electronic commerce	Internet usage	HT employment
Mean			
NMS	22.44	57.78	3.39
OMS	43.4	70.22	3.99
St. dev.			
NMS	14.98	15.60	1.86
OMS	21.91	17.98	1.85
Minim			
NMS	1	22	0.6
OMS	4	21	0.5
Maxim			
NMS	59	90	9.5
OMS	84	99	12.8

The descriptive statistics reported in Tab. 1 give insights to the differences between the NMS and OMS with regard to the development of ICT sector and digital economy. The largest disparities are in the area of electronic commerce, while the differences in terms of HT employment are rather insignificant between OMS and NMS. The heterogeneity within the OMS is the highest for electronic commerce, while for the Internet usage the dispersion is almost similar in the NMS and OMS. The largest differences between NMS and OMS in terms of minimum and maximum values are still for the electronic commerce. These results indicate that in spite of the progress made by the EU countries in closing the ICT gaps, important differences still exist in the area of electronic commerce. These gaps hinder the achievement of the Single Digital Market and the growth of the EU regional digital economy.

Methods

Panel data regression models are used to estimate and analyse the main drivers of the regional digital economy within the EU-27, NMS and OMS, from 2001 to 2016, based on Eurostat data. The three measures of digital economy are comparatively examined through three different regression models with different specifications and estimators, according to the specific variables and data used in each model.

In the first step, a series of tests are applied to check for panel specific problems, such as heteroskedasticity, serial correlation and endogeneity. In the presence of heteroskedasticity and autocorrelation, the OLS is still unbiased but not BLUE anymore, which imposes either the use of heteroskedasticity/ autocorrelation -robust estimators of the variances, or efficient estimators by re-weighting the data appropriately to take into account the heteroskedasticity/ autocorrelation, as it is the feasible generalized least squares (FGLS). But when endogeneity occurs, the OLS and GLS will become inconsistent, and in addition, the *finite* sample bias can be substantial for *small* T. The solution to overcome the endogeneity problem is to use instrumental variable estimators (IV) which are consistent for *finite* T.

In the last 30 years, the GMM estimator has become a very popular tool among panel data researches, as well as a useful heuristic tool (Baum et al., 2003). Despite its widely use in panel analyses, the poor finite sample performance has been often addressed as a major drawback of this method (Hayashi, 2000). Consequently, if heteroskedasticity is not present in the dataset, then standard IV should be always preferred because in this case the GMM estimator is no worse asymptotically than the IV estimator. Moreover, finding good instrument might be quite challenging in empirical researches. Instruments should be always relevant and valid, i.e. correlated with the endogenous regressors and at the same time orthogonal to the errors. The correlation with the included endogenous variables can be assessed by examining the fit of the first stage regressions. The instrument's independence from an unobservable error process can be tested by the corresponding moment conditions. In the case of GMM, the overidentifying conditions are generally tested by the *J* statistic of Hansen, while in the IV context the Sargan statistics is used instead of *J*.

The general model that we use in the empirical section can be written as follows:

$$y_{it} = \alpha y_{i,t-1} + \beta X_{it} + \delta Z_{it} + \varepsilon_{it} \tag{1}$$

$$\varepsilon_{it} = u_i + v_{it} \tag{2}$$

Where, X_{it} is a vector of exogenous regressors, Z_{it} is a vector of endogenous regressors (being correlated with u_i), β and δ are two column vectors of coefficients, and y_{it} and ε_{it} are random variables. The independent variable (y_{it}) is a measure of the quality of life (e.g. self-perceived health) in our paper. As shown in eq.2, the disturbance term ε_{it} has two orthogonal components: u_i are the fixed effects, and v_{it} are the idiosyncratic shocks.

In the next section, a set of preliminary tests will be run to examine the presence of heteroskedasticity, autocorrelation and endogeneity, as to finally decide on the best estimator for each regression model. The feasible GLS and system GMM will be finally chosen as estimators of panel regression models.

Empirical analysis

The empirical analysis aims to comparatively examine the common and specific economic, social and demographic determinants of the digital economy for the EU-27, as well as for the NMS and OMS, based on panel regression models. The emergence and growth of digital economy are proxied here by the electronic commerce, Internet usage, and employment in HT, so that three regression models (models 1,2 and 3, respectively) are built and analysed, as shown in Tables 2, 3, and 4, respectively. Initially, a common set of explanatory variables were examined, but finally, according to the results of the regressions' tests and specifications, different groups of explanatory variables were selected. However, the explanatory variables are chosen as to be relevant for the policy measures implemented at regional level.

In this section we do not only report and analyse the significance of our empirical findings, but also place them into the strand of existing literature, emphasizing the novelty, conformity or contrasting results.

Preliminary tests are applied to all regression models to guide the models' identification and construction. The heteroskedasticity, autocorrelation and endogeneity are particularly examined for each model in part, in order to decide which estimator to choose. While heteroskedasticity and autocorrelation are present in all three models, endogeneity is a problem of concern only in models 3 and 4. These findings indicate us to estimate model 2 by the Feasible GLS, while using the system GMM for estimating models 3 and 4.

Table 2. The determinants of economic commerce, 2001-2016

Explanatory variables	EU-27 (model 1)	NMS (model 2)	OMS (model 3)
Dependent variable (L1)	0.88*** (0.003)	0.83*** (0.03)	0.87*** (0.005)
Log GDP per capita	0.49*** (0.21)	9.11*** (1.06)	-0.19 (0.40)
Fertility	2.07*** (0.26)	-1.32 (1.15)	2.44*** (0.34)
Life expectancy	-0.14*** (0.02)	-2.00*** (0.19)	0.11*** (0.04)
Tertiary education	0.10*** (0.006)	-0.01 (0.06)	0.09*** (0.007)
Secondary education	-0.07*** (0.005)	0.13*** (0.03)	-0.07*** (0.008)
Patents	0.36*** (0.02)	0.41*** (0.14)	0.33*** (0.04)
Doctors	-1.62 (0.10)	5.62*** (1.11)	-1.27*** (0.15)
Poverty risk	-0.21*** (0.008)	-0.34*** (0.03)	-0.30*** (0.02)

Unemployment	0.09*** (0.009)	0.19*** (0.06)	0.10*** (0.01)
Pupils	-0.04** (0.02)	-0.85*** (0.06)	0.003 (0.03)

*Notes: (1) Dynamic panel regression model, feasible Generalized Least Squares (FGLS) estimator; (2) *** p<0.01, ** p<0.05, * p<0.1; (3) Eurostat data, 2001-2016. (5) L1 denotes the first lag of the explanatory variable.*

The estimates reported in Table 2 indicate that the determinants of the e-commerce adoption are very close when moving across models (1)-(3). Still, there are some differences between them, and they will be explained below.

First, the electronic commerce in the previous year has a significant and positive impact on the e-commerce in the current year, the autoregressive behaviour being a significant measure of the technological progress from one year to another in all three models. The GDP per capita represents the most powerful determinant factor of e-commerce in the NMS, while carrying no significant effect in the OMS. Still, the overall effect at the EU-27 level remains significant and positive, as was previously found in the literature (Lund and McGuire, 2005; Wand and Liu, 2015; Raileanu Szeles, 2018).

At the EU-27 regional level, the effect of poverty risk on e-commerce is significant and negative, meaning that a higher poverty rate hampers the adoption of e-commerce. The social factors are identified in the literature among the key factors affecting the growth of e-commerce network (Savafi, 2009), and our study confirms this empirical finding.

Fertility is found to be a significant determinant of e-commerce in both EU-27 and OMS. A higher fertility is associated to a higher adoption of e-commerce. Although apparently the two variables seem to not be directly linked one to another, the relationship between them is indirectly explained by the time saving provided by the online shopping. Especially big families, and in general those societies where the fertility rates are generally higher, tend to use more the online shopping to save time (Zotta et al., 2000). Our empirical findings are therefore in line with previous papers.

The effects of life expectancy on the e-commerce adoption are significant, but different in the NMS and OMS. A higher life expectancy means *inter alia* a higher amount of elderly population, which have on average lower technology and computer skills (Czaja, 2016). The difference of our empirical results between the NMS and OMS lies in the fact that in the OMS the digital divide is lower among the elderly than in the NMS (Olphert and Damodaran, 2013). At the EU-27 level, as well as in the NMS, a higher life expectancy is associated to a lower use of electronic commerce. In contrast, in the OMS the e-commerce is positively associated to a higher life expectancy, because in the EU developed countries, the ICTs, including smart home technologies and e-commerce, are expected to provide benefits to older adults who would like to remain independent (Peek et al., 2016).

A higher number of physicians or doctors per 100.000 inhabitants represents a powerful determinant factor of the e-commerce adoption in the NMS, while generating a negative effect on the e-commerce adoption in the OMS. As the number of doctors best describes the availability of health care resources, which is however much scarcer in the NMS than in the OMS, this variable could also be seen as an indicator of economic development (Finlay, 2007). From another perspective, e-commerce is found to enhance economic development (Lund and McGuire, 2005; Anvari, 2016). On average, the OMS have higher levels of spending on health as a share of GDP in comparison with the NMS, which further results in more homogenous distributions of health resources at regional level in the OMS (EXPH, 2016). As the health care resources are adequate and the unmet health needs are lower in the OMS than in the NMS, the number of doctors is found to be directly linked to the e-commerce adoption, but just in the NMS.

Contrary to our expectations, unemployment is found to enhance the e-commerce adoption under all models (1)-(3). Although in the literature of digital divide the association e-commerce - unemployment has not been directly approached so far, there are studies indicating that when being faced with high unemployment, consumers continue to take advantage of the Internet's lower prices by shifting their spending from offline retail stores, so that e-commerce has become a mainstay in consumer behaviour, driven by the attraction of both lower prices and convenience (Fulgoni, 2011).

The number of patents issued in a region determines positive effects on the adoption of e-commerce in both NMS and OMS, as well as at the EU-27 level. This result is according to our expectations since the number of patents might also be seen as a measure of technologic progress with direct impact on economic field and social life.

The positive implications of education on ICT in general and e-commerce adoption in particular have been often examined in the literature (Büchi et al., 2016; Van Deursen, Courtois and Van Dijk, 2014; Helsper, 2010; Wunnava and Leiter, 2009) and the results generally indicate a positive association between education and e-commerce. In Table 2, the tertiary education attainments are found to generate positive effects on e-commerce only in the OMS and EU-27. This is in line with previous papers which indicate that the tertiary education helps bridging digital divide, and in the same time has positive effects on the technology utilization in general (Pick& Nishida, 2015).

People holding only secondary education attainments are less open to e-commerce in the EU-27 and OMS. This negative association is explained by the lack of computer and technology skills, which is specific to the low educated people (Suciu and Litră, 2017). In contrast to the OMS, in the NMS the secondary educational attainments are associated to a higher use of e-commerce. In the NMS, as well as at the EU-27 level, a higher number of pupils and students in all levels of education is associated to a lower use of e-commerce, which is in line with other previous findings (Raileanu Szeles, 2018).

In the case of regression models 3 and 4 which are estimated by the system GMM, the output from the Sargan test indicates that the null hypothesis of the exogenous instruments has not been rejected and the joint validity of the instruments is confirmed. The Arellano-Bond test for autocorrelation in the idiosyncratic error states no autocorrelation in null hypothesis. In all models reported in Tables 2-4, the test for AR (1) and AR(2) processes in first differences rejects the null hypothesis.

In Table 3 the Internet usage within the EU-27 (model 1), NMS (model 2) and OMS (model 3) is explained upon a set of variables which are very close to those used in Table 2. The small differences between the set of explanatory variables used in Tables 2-4 come from the model identification tests.

Table 3. The determinants of Internet usage

Explanatory variables	EU-27 (model 1)	NMS (model 2)	OMS (model 3)
Dependent variable (L1)	0.66*** (0.07)	0.62*** (0.08)	0.93*** (0.04)
Log GDP per capita	15.41*** (4.10)	13.81** (6.61)	-11.21*** (4.57)
Fertility	8.87*** (2.65)	5.92 (4.25)	5.25** (2.32)
Tertiary education	0.04 (0.04)	-0.11 (0.13)	0.12*** (0.04)
Secondary education	-0.33*** (0.08)	-0.14 (0.17)	0.05 (0.06)
Doctors	-5.24*** (1.89)	-0.89 (3.78)	1.45* (0.86)
Poverty risk	0.19** (0.07)	-0.01 (0.12)	-0.22*** (0.08)
Unemployment	0.53*** (0.14)	0.62*** (0.20)	-0.04 (0.08)
Pupils in education	-0.31** (0.15)	-0.40 (0.28)	-0.13 (0.15)

*Notes: (1) Dynamic panel regression model, Arellano-Bond system GMM estimator; (2) Endogenous variable: GDP per capita, instrumented by its first two lags; (3) *** p<0.01, ** p<0.05, * p<0.1; (4) Eurostat data, 2001-2016. (5) L1 denotes the first lag of the explanatory variable.*

Even though the estimates of models 1-3 (Table 3) are very close, there are some differences between them. As expected, an autoregressive behaviour is confirmed in all models since the Internet usage become more popular reflecting the technological progress from one year to another.

The most powerful determinant of Internet usage in NMS is represented by GDP per capita, while its effect is negative in the OMS. Still, the overall effect at the EU-27 level is positive and statistically significant, according to literature (Guillén and Suárez, 2005). The positive correlation between GDP per capita and Internet use might be also explained by the culture of cosmopolitanism in the NMS. The cosmopolitans are defined by Beck (2000) as people who prefer to travel more widely and frequently, have more diverse social contacts and consume more media for arts and internal and foreign affairs. The negative correlation between GDP per capita and Internet use in the OMS might be explained by the local patterns of interpersonal influence on the communication behaviour. In Merton's (1959) opinion, these people have more friends in their town or village, travel less frequently and use less media content. Moreover, the people in the developed countries might prefer using mobile phone to communicate which is faster even if it is more expensive than Internet (Guillén and Suárez, 2005).

According to our expectations, in the OMS people at higher risk of poverty use the Internet at a lesser extent. This is in line with the literature, as a higher poverty rate is found to hamper the use of Internet (Savafi, 2009). However, in the EU-27, even if the poverty risk increases, the Internet use is more intense and widespread. This might be explained by the fast and generalized technological progress that made the use of Internet cheap and accessible to many social groups (Slater and Kwami, 2005). For the NMS, poverty risk is not found to be relevant in explaining the Internet usage.

At the level of EU-27 and NMS, the increase in unemployment is found to stimulate the Internet usage. One explanation is that unemployed people use the Internet to search for jobs (Kuhn and Skuterud, 2004; Stevenson, 2009) and also they have more time to use the Internet for personal purposes, in comparison with employed people. Moreover, unemployed people might take advantage of the Internet's lower prices (Fulgoni, 2011). In the OMS, the unemployment is not found to be relevant in explaining the Internet use.

According to our findings, tertiary education enhances the Internet usage only in the OMS. Especially in the EU developed countries, the university graduates also need ICT skills to keep up with the demands of the digital economy (European Commission, 2014 and 2016). On the other hand, students generally acquire basic ICT skills during their studies, and after graduation they get even advanced computer skills (Kubey et al., 2001; Li and Kirkup, 2007). In contrast, in the NMS this variable is not significant, meaning that here there are many jobs for university graduates that do not necessarily request ICT skills.

Secondary education is a significant determinant of Internet use only at the EU-27 level. Even that pupils are asked to develop their basic digital skills at school (Valcke, 2010), they will not develop and use these skills over the lifetime since the jobs available with a secondary education degree do not request ICT skills. This finding is therefore according to the strand of literature arguing that people with secondary educational attainments have less computer skills and tend to use less the Internet benefits (Volman, 2005).

A higher number of pupils in education is correlated with a lower Internet usage, and this variable is significant only at the EU-27 level. The literature also reports that pupils tend to use the Internet less than adults. This is because adults limit the use of Internet by their children in order to avoid the Internet addiction (Weinstein and Lejoyeux, 2010). However, the interpretation of this result should be done in the context of the reference period of our study (2001-2016).

The number of physicians or doctors per 100.000 inhabitants carry significant but different effects on the Internet use for the EU-27 and OMS. In the OMS, the general population and especially professionals with a university degree, like doctors, have ICT skills and broadly utilize them in their current activity (Jadad et al., 2001). In order to keep up with the newest advances in the medical science, doctors should continuously develop their ICT skills (Chew et al., 2004).

Table 4. The determinants of employment in HT sectors

Explanatory variables	EU-27	NMS	OMS
Dependent variable (L1)	0.67*** (0.09)	0.47* (0.25)	0.67*** (0.11)
Log GDP per capita	3.93*** (1.61)	7.38*** (2.19)	3.35* (2.08)
Log GDP per capita (L1)	-4.77*** (1.46)	-6.66*** (2.52)	-2.96** (1.48)

Fertility	-1.01*** (0.40)	0.70 (0.71)	-1.03** (0.43)
Tertiary education (L4)	0.02*** (0.008)	0.06** (0.02)	0.01** (0.007)
Secondary education	-0.02* (0.01)	0.004 (0.02)	-0.01* (0.008)
Log Doctors (L1)	0.74** (0.39)	-0.24 (0.78)	0.40* (0.24)
Poverty risk (L3)	-0.01 (0.02)	-0.05 (0.08)	0.01 (0.02)
Log patents (L2)	0.26*** (0.08)	0.21** (0.09)	0.25*** (0.08)

*Notes: (1) Dynamic panel regression model, Arellano-Bond system GMM estimator; (2) Endogenous variable: GDP per capita, instrumented by its first two lags; (3) *** p<0.01, ** p<0.05, * p<0.1; (4) Eurostat data, 2001-2016. (5) L1-L4 denote lags of the explanatory variable.*

In Table 4, the employment in HT sectors in the previous year is positively associated with its level in the current year. This autoregressive behaviour is consistent across all our three measures of digital economy (Tables 2-4).

However, for both the OMS and NMS the most powerful determinant is GDP per capita. In all models reported in Table 4, the effect of GDP per capita on the employment in HT sectors is positive, while the effect of its first lag is negative. This finding is according to our expectation since the HT sectors develop especially in regions that provide comparative locational advantages for technology companies. For instance, in the literature, technological districts and large urban areas are significantly associated with the probability of firms being high-growing technology firms (Giner et al., 2017). It is also found that the greater the geographic proximity of a company to urban centres, the greater their capacity to innovate (Ferreira et al., 2017). Moreover, the HT sectors develop in ecosystems with various actors and players, and require an adequate regulatory environment (Kearny, 2014). All these aspects indicate that a more developed region is more likely to be successful in enhancing the development of HT sectors, and to therefore stimulate employment in this sector. The effect is even larger for the NMS, where the poorest regions have no the appropriate infrastructure to attract HT companies, so that finally most HT sectors grow in developed regions.

Only in the OMS, a higher fertility is associated with a lower employment in HT sectors. Upon our knowledge this relationship has not been examined in the literature, and nevertheless empirical findings on the relationship between fertility and economic performances are mixed. However EU studies indicate that women with low educational attainments had a higher fertility rate in the last ten years (Lanzieri, 2013), and also that education in general and knowledge centres (e.g. universities) in particular play a fundamental role in shaping and enabling the evolution and growth of the EU’s high-technology clusters (Keeble, 1989; Agrawal and Cockburn, 2003; Keeble and Wilkinson, 2018). These dynamics could explain the negative relationship between fertility and employment in HT sectors in the OMS.

Numerous studies have shown that scientific universities play a fundamental role in stimulating the development of new technology based companies in their region (e.g. Segal, 1985; Agrawal and Cockburn, 2003). More recently, according to the New Skills Agenda for Europe (2016), the employment in HT sectors requests high-tech skills, specialised skills, digital skills, key-enabling technologies skills, as well as leadership capabilities, which are provided by knowledge centres/ universities. In this light, our finding that increasing the tertiary educational attainments results in a higher employment in HT sectors, is in line with the literature. Moreover, our estimates indicate that the positive effect will occur with a lag of 4 years.

In turn, as shown in Table 4, increasing the secondary educational attainments carries a small negative effect on the employment in HT sectors, but this effect is only slightly significant and just for the OMS. This result is not surprising since employment in HT sectors requires high level skills (as underlined before), so that a higher proportion of population with secondary educational attainments finally means a lower proportion of population having high technology skills.

In all 3 models reported in Table 4, a higher number of doctors in a region is found to have a positive impact on the employment in HT sectors. A large strand of literature on the interdependency between regional development and formation of technology clusters (Keeble and Gould, 1985; Keeble, 1989) confirms our empirical finding. At the regional level, the environmental conditions enabling a high quality of life, which are reflected *inter alia* by the access to healthcare services (proxied here by the number of doctors) facilitate the setting up and development of HT firms and sectors.

In contrast with the models reported in Table 2 and 3, the poverty risk is not found to be a significant driver of the employment in HT sectors, which suggest that the HT sectors are rather affected by factors strongly related to the business ecosystem, and to a lesser extent by community-level social equilibrium.

The positive impact of the number of patents on employment in HT sector is a consistent result across all three models shown in Table 4. This result could be also framed in the literature. Patents are generally issued by the research-intensive universities as a result of their technology transfer experience. The co-location of university research and industrial R&D within the regional innovation system (Agrawal and Cockburn, 2003), which is a key driver of the development of HT sectors, has been discussed so far.

Discussion and conclusions

Accelerating the growth of digital economy in the EU-27 regions by a set of consistent policy measures across several indicators of digital economy, as well as across the NMS, OMS and EU groups of countries, represents a major challenge for EU policy makers on the path of the Single Digital Market. To achieve this goal as well as to facilitate a better understanding of the regional patterns of this process, the EU digital economy must be also examined by its common and specific regional drivers. But digital economy is a broad umbrella covering different aspects related to the efficient incorporation of ICT and digital technologies into the economic activities. It has various dimensions and facets, so that analysing digital economy requests *inter alia* examining a set of underlying indicators. These indicators are operationalised here by regional level- variables which are provided by cross-country datasets, such as Eurostat.

Our paper examines a set of common and specific drivers of three indicators of digital economy, based on the Eurostat panel data. In subsidiary, this empirical approach allows us analysing the effectiveness of a set of policy measures aimed to accelerate the development of the EU digital economy and of the Single Digital Market, at regional level. Moreover, by comparing the effects of a set of determinants on three different indicators of digital economy and across three different groups of countries (EU-27, NMS and OMS), the paper allows identifying the eventual negative side effects of policy measures aimed to target the regional digital economy. Given that in the previous section our empirical results are confronted to previous findings in the literature, our new contributions are clearly highlighted throughout the empirical section.

The main results derived from the empirical analysis can be summarize as follows. First, we identify a common set of "effective" policy measures that stimulates the development of the EU regional digital economy, as defined by our three indicators. The regional economic development is found to be the main engine of the EU regional digital economy, especially at the NMS and EU-27 levels. Increasing the tertiary education attainments results in stimulating the development of the OMS regional digital economy, while the increase in the secondary education attainments hinder it. The number of patents issued at regional level represents a significant driver of digital economy, while a higher rate of poverty discourages the growth of digital economy, especially in the OMS.

Second, our data lead us to identify another set of policy measures whose effects are contrasting across countries and measures, like increasing the number of doctors, stimulating the population growth and fertility, as well as increasing the proportion of population with secondary education attainments. This suggest that the policy measures which are elaborated based on these contrasting results should be applied with precaution within the EU-27.

Among the policy measures derived from the empirical analysis, only a small set of them could enhance the development of the regional digital economy without producing negative side effects, not across indicators, and nor across groups of countries. These policy measures, which are the increase in the tertiary education attainments and the stimulation of patents development, are found to be the most effective ones, according to our data and variables. They should be primary implemented within the EU.

In conclusion, stimulating the growth of digital economy in the EU regions represents a complex task for the EU policy makers, which requests addressing different dimensions/ indicators of this composite measure through a set of effective policies. To be effective, the policy measures need to improve each indicator of digital economy, without worsening the others. Previous papers have shown that most policy measures produce contrasting effects when targeting different dimensions or indicators, so that finding an effective mix of policies designed as to improve a multidimensional measure, such as it is here the digital economy, could be a very difficult task (Raileanu Szeles, 2015, 2018).

The contribution of our paper to the literature is threefold. First, it develops a regional analysis of the EU digital economy, focusing on the regional drivers that are relevant for a set of policy measures at country- and EU levels. As also stated in Introduction, upon our knowledge, the regional digital economy has not been approached by research papers so far. Examining the regional digital economy could bring additional empirical insights to the literature. For example, when moving the analysis from the country level to the regional level, the impact of some drivers could be different, such as the influence of regional economic development in the OMS. Therefore, drawing a regional picture of the EU digital economy enriches the global overview. Second, it introduces new social and demographic variables into the analysis of the regional digital economy, such as the number of doctors and fertility rate. This attempt provides additional empirical evidence to the existing literature. Third, it examines whether a set of policy measures aimed to accelerate the growth of regional digital economy also produces negative side effects across different measures of regional economy or different groups of EU countries. Finally, our empirical approach is intended to help EU policy makers to stimulate the EU regional digital economy through a set of effective policy measures.

References

1. Acs, Z. J., Fitzroy, F. R., & Smith, I. (1999). High technology employment, wages and university R&D spillovers: Evidence from US cities. *Economics of innovation and new technology, 8*(1-2), 57-78.
2. Anton, C. (2010). Consideration related to the attitudes, behaviours and opinions of the Managers of the micro, small and medium enterprises of Brasov, related to the tender of the financial –accounting services companies. ICBE Conference Proceedings, Brasov, Romania.
3. Agrawal, A., & Cockburg, I. (2003). The anchor tenant hypothesis: exploring the role of large, local, R&D-intensive firms in regional innovation systems. *International Journal of Industrial Organization*, 21(9), 1227-1253.
4. Al-Qirim, N. A. (2004). A framework for electronic commerce research in small to medium-sized enterprises. *Electronic Commerce in Small to Medium-Sized Enterprise: Frameworks, Issue and Implications*.
5. Al-Qirim, N.A. (2007). The adoption of eCommerce communications and applications technologies in small businesses in New Zealand. *Electronic Commerce Research and Applications*, *6*(4), 462-473.
6. Anvari, R.D., & Norouzi, D. (2016). The Impact of E-commerce and R&D on Economic Development in Some Selected Countries. Procedia - Social and Behavioral Sciences, 229, 354-362.
7. Armstrong, L., Phillips, J. G., & Saling, L. L. (2000). Potential determinants of heavier Internet usage. *International Journal of Human-Computer Studies*, *53*(4), 537-550.
8. Beck, R., Wigand, R. T., & Konig, W. (2005). Integration of e-commerce by SMEs in the manufacturing sector: a data envelopment analysis approach. *Journal of Global Information Management (JGIM), 13*(3), 20-32.

9. Beck, R., Wigand, R. T., & König, W. (2005). The Diffusion and Efficient Use of Electronic Commerce among Small and Medium-sized Enterprises: An International Three-Industry Survey. *Electronic Markets*, *15*(1), 38-52.
10. Beck, U. (2000). The cosmopolitan perspective: sociology of the second age of modernity. *The British journal of sociology*, *51*(1), 79-105.
11. Billon, M., Crespo, J., & Lera-López, F. (2017). Internet, Educational Disparities, and Economic Growth: Differences Between Low-Middle and High-Income Countries. In *Catalyzing Development through ICT Adoption* (pp. 51-68). Springer, Cham.
12. Blank, G., & Groselj, D. (2014). Dimensions of Internet use: amount, variety, and types. *Information, Communication & Society*, *17*(4), 417-435.
13. Britain: the case of the Cambridge phenomenon. *Environment and Planning C: Government and Policy*, 7, 153-172.
14. Büchi, M., Just, N., & Latzer, M. (2016). Modeling the second-level digital divide: A five-country study of social differences in Internet use. New Media & Society, 18(11), 2703–2722.
15. Burke, K. (2005). The impact of firm size on Internet use in small businesses. *Electronic Markets*, *15*(2), 79-93.
16. Campos, R., Arrazola, M., & de Hevia, J. (2017). Economic crisis and benefits of the Internet: differentiated Internet usage by employment status. *Economics of Innovation and New Technology*, *26*(3), 269-294.
17. Caniëls, M. C., Lenaerts, H. K., & Gelderman, C. J. (2015). Explaining the internet usage of SMEs: the impact of market orientation, behavioural norms, motivation and technology acceptance. *Internet Research*, *25*(3), 358-377.
18. Carson, D. (1993). A philosophy for marketing education in small firms. *Journal of Marketing management*, *9*(2), 189-204.
19. Carstensen, L. L. (1995). Evidence for a life-span theory of socioemotional selectivity. *Current directions in Psychological science*, *4*(5), 151-156.
20. Celuch, K., Murphy, G. B., & Callaway, S. K. (2007). More bang for your buck: Small firms and the importance of aligned information technology capabilities and strategic flexibility. *The Journal of High Technology Management Research*, *17*(2), 187-197.
21. Charles, S. T., & Carstensen, L. L. (1999). The role of time in the setting of social goals across the life span. In *Social cognition and aging* (pp. 319-342).
22. Chew, F., Grant, W., & Tote, R. (2004). Doctors on-line: using diffusion of innovations theory to understand internet use. *Family Medicine-Kansas city*, *36*, 645-650.
23. Czaja, S. J. (2016). Long-term care services and support systems for older adults: The role of technology. *American Psychologist*, 71(4), 294-301.
24. Day, G. S. (1994). Continuous learning about markets. *California management review*, *36*(4), 9-31.
25. Dimitrova, D. V. (2002). Internet diffusion in the post-communist countries. *Medienjournal: Innovative Approaches to ICT Research*, 64-71.
26. Dimitrova, D. V., & Beilock, R. (2005). Where freedom matters: Internet adoption among the former socialist countries. *Gazette (Leiden, Netherlands)*, *67*(2), 173-187.

27. Duguleana, C., Duguleana, L., & Busuioceanu, S. (2017). Identifying the Effects of Migration Flows within the Countries of the European Union. In “East-West migration in the European Union”: Cambridge Scholars Publishing.
28. Ertürk, A., & Vurgun, L. (2015). Retention of IT professionals: Examining the influence of empowerment, social exchange, and trust. *Journal of Business Research*, *68*(1), 34-46.
29. European Commission (2014). Digital Agenda for Europe.
30. European Commission (2016) New Skills Agenda for Europe.
31. Expert Panel on effective ways of investing in Health (EXPH) Report on Access to Health Services in the European Union, 3 May 2016.
32. Fathian, M., Akhavan, P., & Hoorali, M. (2008). E-readiness assessment of non-profit ICT SMEs in a developing country: The case of Iran. *Technovation*, *28*(9), 578-590.
33. Ferreira, J.J.M., Fernandes, C.I., & Raposo, M.L. (2017). The effects of location on firm innovation capacity. *Journal of the Knowledge Economy*. 8(1), 77-96.
34. Fink, D., & Disterer, G. (2006). International case studies: To what extent is ICT infused into the operations of SMEs?. *Journal of Enterprise Information Management*, *19*(6), 608-624.
35. Finlay, J. (2007). The role of health in economic development. Harvard Initiative for Global Health, *PGDA Working Paper*, 21.
36. Fulgoni, J.G. (2011). Webinar Series: State of the U.S. Online Retail Economy through Q1 2011.
37. Giner, J.M., Santa-María, M.J. & Fuster, A. (2016). High-growth firms: does location matter?. *International Entrepreneurship and Management Journal*, 13(1), 75-96.
38. Goss, E.P. & Phillips, J.M. (2002). How information technology affects wages: Evidence using internet usage as a proxy for IT skills. *Journal of Labour Research*, 3(23), 463–474.
39. Grandon, E. E., & Pearson, J. M. (2004). Electronic commerce adoption: an empirical study of small and medium US businesses. *Information & management*, *42*(1), 197-216.
40. Guillén, M. F., & Suárez, S. L. (2001). Developing the Internet: entrepreneurship and public policy in Ireland, Singapore, Argentina, and Spain. *Telecommunications policy*, *25*(5), 349-371.
41. Guillén, M. F., & Suárez, S. L. (2005). Explaining the global digital divide: Economic, political and sociological drivers of cross-national Internet use. *Social forces*, *84*(2), 681-708.
42. Hamburger, Y. A., & Ben-Artzi, E. (2000). The relationship between extraversion and neuroticism and the different uses of the Internet. *Computers in human behavior*, *16*(4), 441-449.
43. Hanna, N (2016). *Mastering digital transformation*. Emerald: UK.
44. Hanna, N.K., & Knight, P.T. (2012). *National strategies to harness information technology, innovation, technology and knowledge management*. Springer Sciences: New York.
45. Helsper, E.J. (2010). Gendered Internet use across generations and life stages. Communication Research, 37(3), 352–374.

46. Holm, J. R., & Østergaard, C. R. (2015). Regional employment growth, shocks and regional industrial resilience: a quantitative analysis of the Danish ICT sector. *Regional Studies*, *49*(1), 95-112.
47. International Monetary Fund (2018). *Measuring the digital economy*. IMF Policy Papers.
48. Jadad, A. R., Sigouin, C., Cocking, L., Booker, L., Whelan, T., & Browman, G. (2001). Internet use among physicians, nurses, and their patients. *Jama*, 286(12), 1451-1452.
49. Jeon, B. N., Han, K. S., & Lee, M. J. (2006). Determining factors for the adoption of e-business: the case of SMEs in Korea. *Applied Economics*, *38*(16), 1905-1916.
50. Kartiwi, M., & MacGregor, R. C. (2007). Electronic commerce adoption barriers in small to medium-sized enterprises (SMEs) in developed and developing countries: A cross-country comparison. *Journal of Electronic Commerce in Organizations (JECO)*, *5*(3), 35-51.
51. Kasiri, L. A., Cheng, K. T. G., Sambasivan, M., & Sidin, S. M. (2017). Integration of standardization and customization: Impact on service quality, customer satisfaction, and loyalty. *Journal of Retailing and Consumer Services*, *35,* 91-97.
52. Kearny, A.T. (2014). *Rebooting Europe's High-tech industry*. Research report on:
53. https://www.atkearney.com/documents/10192/7828589/Rebooting+Europes+HighTech+Industry. pdf/531ff9a7-3bba-4274-8ce7-d4b20b71d508.
54. Keeble, D. &Wilkinson, F. (2018). High-Technology SMEs, Regional Clustering and Collective Learning: An Overview. In (eds. Keeble, D. & F. Wilkinson): “High-technology clusters, networking and collective learning in Europe”, 1-21, Routledge: New York.
55. Keeble, D. (1989). High-technology industry and regional development in
56. Keeble, D., & Gould, A. (1985). “Entrepreneurship and manufacturing firm formation in rural regions: the East Anglian case", in The Industrialization of the Countryside (Eds. M J Healey & B.W. Ilberg, Geo Books: Norwich, 197-220.
57. Kotarba, M. (2018). Digital Transformation of Business Models. *Foundations of Management*, 10, 123-142.
58. Kubey, R. W., Lavin, M. J., & Barrows, J. R. (2001). Internet use and collegiate academic performance decrements: Early findings. *Journal of communication, 51*(2), 366-382.
59. Kuhn, P., & Skuterud, M. (2004). Internet job search and unemployment durations. *American Economic Review*, *94*(1), 218-232.
60. Kumar, V., Arif, T. & Malik, M. (2014). Role of ICT in driving e-commerce business in developing countries. Paper presented at the conference: National Conference on Recent Innovations and Advancements in Information Technology-RIAIT'2014.
61. Landers, R. N., & Lounsbury, J. W. (2006). An investigation of Big Five and narrow personality traits in relation to Internet usage. *Computers in Human Behavior*, *22*(2), 283-293.
62. Lanzieri, G. (2013). Towards a “baby recession” in Europe. *Eurostat Statistics in focus*, 13.
63. Lawson, R., Alcock, C., Cooper, J., & Burgess, L. (2003). Factors affecting adoption of electronic commerce technologies by SMEs: an Australian study. *Journal of small business and enterprise development*, *10*(3), 265-276.

64. Leung, L. (2002). Loneliness, self-disclosure, and ICQ (" I seek you") use. *CyberPsychology & Behavior*, *5*(3), 241-251.
65. Li, N., & Kirkup, G. (2007). Gender and cultural differences in Internet use: A study of China and the UK. *Computers & Education*, *48*(2), 301-317.
66. Lund, M.J.F., & McGuire, S. (2005). Institutions and development: Electronic commerce and economic growth. *Organization Studies*, 26 (12), 1743-1763.
67. Margaras, V. (2018). *The regions in the Digital Single Market*. Briefing, European Parliament Research Service.
68. Mendoza, M. R. H., & Alvarez de Toledo, J. A. (1997). Demographics and behavior of the Chilean Internet population. *Journal of Computer-Mediated Communication*, *3*(1), JCMC315.
69. Merton, R. K. (1957). Patterns of influence: Local and cosmopolitan influentials. *Social theory and social structure*, *2*, 387-420.
70. Migiro, S. O. (2006). Diffusion of ICTs and E-commerce adoption in manufacturing SMEs in Kenya. *South African Journal of Libraries and Information Science*, *72*(1), 35-44.
71. Mohamad, R., & Ismail, N. A. (2009). Electronic commerce adoption in SME: The trend of prior studies.
72. Molla, A., & Licker, P. S. (2005). Perceived e-readiness factors in e-commerce adoption: An empirical investigation in a developing country. *International Journal of Electronic Commerce, 10*(1), 83-110.
73. Narver, J. C., & Slater, S. F. (1990). The effect of a market orientation on business profitability. *The Journal of marketing*, 20-35.
74. NTIA (1999). Falling Through the Net: Defining the Digital Divide. http://www.infodev.org/library/WorkingPapers/wilsonrodriguez.doc
75. Olphert, W., & Damodaran, L. (2013). Older people and digital disengagement: a fourth digital divide?. *Gerontology*, 59, 564-570.
76. Oostrom, L., Walker, A., Staats, B., Slootbeek-Van Laar, M., Azurduy, S., & Rooijakkers, B. (2016). Measuring the Internet Economy in the Netherlands: A Big Data Analysis. *CBS Discussion paper*, 14.
77. Pappas, I. O., Kourouthanassis, P. E., Giannakos, M. N., & Lekakos, G. (2017). The interplay of online shopping motivations and experiential factors on personalized e-commerce: A complexity theory approach. *Telematics and Informatics*, *34*(5), 730-742.
78. Peek, S.T. et al. (2016). Older Adults' Reasons for Using Technology while Aging in Place. *Gerontology*, 62, 226-237.
79. Pick, J.B., & Nishida, T. (2015). Digital divides in the world and its regions: A spatial and multivariate analysis of technological utilization, Technological forecasting and social change, 91, 1-17.
80. Piva, M., & Vivarelli, M. (2017). Technological Change and Employment: Were Ricardo and Marx Right?.
81. Porter, C. E., & Donthu, N. (2006). Using the technology acceptance model to explain how attitudes determine Internet usage: The role of perceived access barriers and demographics. *Journal of business research*, *59*(9), 999-1007.

82. Press, L., Burkhart, G., Foster, W., Goodman, S., Wolcott, P., & Woodard, J. (1998). An Internet diffusion framework. *Communications of the ACM*, *41*(10), 21-26.
83. Răileanu Szeles, M. (2015). Explaining the dynamics and drivers of financial well-being in the European Union. *Social Indicators Research*, 120(3), 701-722.
84. Răileanu Szeles, M. (2018). New insights from a multilevel approach to the regional digital divide in the European Union. *Telecommunications Policy*, 42(6), 452-463.
85. Ramayah, T., Yan, L. C., & Sulaiman, M. (2005). SME e-readiness in Malaysia: Implications for Planning and Implementation. *Sasin Journal of Management*, *11*(1), 103-120.
86. Raven, P. V., Huang, X., & Kim, B. B. (2007). E-business in developing countries: a comparison of China and India. *International Journal of E-Business Research (IJEBR)*, *3*(1), 91-108.
87. Raymond, L., Bergeron, F., & Blili, S. (2005). The assimilation of E-business in manufacturing SMEs: Determinants and effects on growth and internationalization. *Electronic Markets*, *15*(2), 106-118.
88. Rogers, E. M. (2010). *Diffusion of innovations*. Simon and Schuster.
89. Safavi, R. (2009). Human/social factors influencing usability of E-commerce websites and systems. Conference paper, Conference "Application of Information and Communication Technologies", AICT.
90. Scealy, M., Phillips, J. G., & Stevenson, R. (2002). Shyness and anxiety as predictors of patterns of Internet usage. *CyberPsychology & Behavior*, *5*(6), 507-515.
91. Scheerder, A., van Deursen, A., & van Dijk, J. (2017). Determinants of Internet skills, uses and outcomes. A systematic review of the second-and third-level digital divide. *Telematics and informatics*.
92. Schmitz, H. (2018). *Technology and employment practices in developing countries* (Vol. 47). Routledge.
93. Schultz, R. A. (Ed.). (2005). *Contemporary issues in ethics and information technology*. IGI Global.
94. Seyal, A. H., Awais, M. M., Shamail, S., & Abbas, A. (2004). Determinants of electronic commerce in Pakistan: Preliminary evidence from small and medium enterprises. *Electronic Markets*, *14*(4), 372-387.
95. Sharma, S. K., Ahmed, N., & Wickramasinghe, N. (2004). E-commerce adoption in small and medium enterprises (SMEs) in Asia: a study of the early stages of e-commerce uptake. *International Journal of Internet and Enterprise Management*, *2*(3), 221-240.
96. Slater, D., & Kwami, J. (2005). Embeddedness and escape: Internet and mobile use as poverty reduction strategies in Ghana. *Information Society Research Group (ISRG) report*.
97. Song, Z., Sun, Y., Wan, J., Huang, L., & Zhu, J. (2017). Smart e-commerce systems: current status and research challenges. *Electronic Markets*, 1-18.
98. Stevenson, B. (2009). The Internet and job search. In *Studies of labor market intermediation* (pp. 67-86). University of Chicago Press.
99. Suciu, T., & Litră, A. (2017). The education crisis and Homo Zappiens. *Journal of Smart Economic Growth*, 2(1), 35-47.

100. Teo, T. S., & Pian, Y. (2003). A contingency perspective on Internet adoption and competitive advantage. *European Journal of Information Systems*, *12*(2), 78-92.
101. Thong, J. Y. (2001). Resource constraints and information systems implementation in Singaporean small businesses. *Omega*, *29*(2), 143-156.
102. United Nations (2005). *Core ICT indicators*. Beirut.
103. Valcke, M., Bonte, S., De Wever, B., & Rots, I. (2010). Internet parenting styles and the impact on Internet use of primary school children. *Computers & Education*, *55*(2), 454-464.
104. Van Deursen, A.J., Courtois, C. & van Dijk, J.A. (2014). Internet Skills, Sources of Support, and Benefiting from Internet use. International Journal of Human-Computer Interaction, 30(4), 278-290.
105. Volman, M., Van Eck, E., Heemskerk, I., & Kuiper, E. (2005). New technologies, new differences. Gender and ethnic differences in pupils' use of ICT in primary and secondary education. *Computers & Education*, *45*(1), 35-55.
106. Wang, X., & Liu, L. (2015). Empirical Research on the Influence Factors of E-commerce Development in China. *The Open Cybernetics & Systemics Journal*, 9, 76-82.
107. Weinstein, A., & Lejoyeux, M. (2010). Internet addiction or excessive internet use. *The American journal of drug and alcohol abuse*, *36*(5), 277-283.
108. Wunnava, P.V., & Leiter, D.B. (2009). Determinants of intercountry Internet diffusion rates. The American Journal of Economics and Sociology, 68(2), 413–426.
109. Zotta, C., Amitb, R., & Donlevya, J. (2000) Strategies for value creation in e-commerce: best practice in Europe. *European Management Journal*, 18(5), 463-475.

Appendix 1

Table 1. Determinants of electronic commerce and Internet usage in literature

Type of factors	**Most common examples**
Economic factors	Income Poverty Wealth Social and economic status Employment status Working hours Type of activity Job seeking Level of education Educational resources
Social factors	Household composition Family size Parental status Number of children Social orientation Social activity Social support

Social and demographic factors	Gender Age Marital status Living conditions Type of environment (urban/rural) Life space
Cultural factors	Religion Ethnicity Internet usage language Cultural capital Cultural possessions Cultural status
Motivational factors	Attitude towards ICTs Attitude towards computers Internet attitude Internet motivation Computer skills Digital skills Internet skills Internet literacy Perceived Internet benefits Frequency of Internet use Technological efficacy
Material factors	Internet access Internet availability Access locations Number of electronic devices PC at home Type of access Alternative technologies
Personal factors	Information seeking Entertainment Online news Language skills Academic performance Quantity of media Health status Satisfaction with physician Personality traits

Source: adaptation after Scheerder et al. (2017)