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Measuring the economic impact of digital skills in Greece: challenges ahead

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The **Foundation for Economic and Industrial Research (IOBE)** is a private sector, not-for-profit, charitable research organization. It was set up in 1975 to pursue two objectives: (a) to promote scientific research on the current and emerging problems facing the Greek economy and (b) to provide objective information and make useful proposals to shape policy decisions. For more information visit the website www.iobe.gr.

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Introduction

Information Communication Technology or ICT refers to the technological means, software and hardware equipment, as well as skills that are used to achieve technologically complex ends. ICT has long been considered an enabler of improvements in economic productivity and growth. Automation, robotics, system management optimize the productive process, while data analytics and machine learning generate and use information that improve production mechanisms without the intervention of humans. Small technological hubs around the world generate technological development that, if used effectively, multiply production and growth. Despite, however, the tremendous technological renaissance going on in places such as Silicon Valley in the US, the Pearl River Delta in China, Seoul in South Korea and Tokyo, people are falling behind. The new frontier in productivity and growth enhancement is not technology, but rather ICT skills. Countries around the world are experiencing a severe dearth in ICT skills, the new set of abilities needed to manipulate the machines of our age.

An ICT skilled person has the ability to use extensively computers, mobile phones, tablets and other digital devices. Use involves document, spreadsheet and presentation manipulation, email, application use, while more advanced ICT skills include computer programming and data analysis. These skills have the potential to improve business productivity tremendously. ICT skills are important in the workplace as they enable expeditious writing of reports and letters, allow shared, non-corrigible bookkeeping and file sorting and most importantly, capacitate the communication between staff, suppliers and clients. ICT skilled personnel using ICT equipment makes office tasks simple so that they focus their productivity on actual work instead of the menial labor in between.

Besides making office work non-arduous, ICT skills may create disruptive leaps in the productivity of a workplace. ICT skills harness technology that can store, analyze and transmit large sums of data for not only eradicating small office inefficiencies, but also to open entirely new faucets of productivity enhancement. Coding of sorting and data entry programs removes the need for simple tasks such as sorting and merging spreadsheets. Spellcheck programs reduce the time needed to edit documents and presentations. E-Calendars not only notify employees about their deadlines and meetings, but also creates the habit of efficiently stratifying one’s time in manageable chunks of work. Data analysis enables the recognition of patterns in large sums of data, and machine learning creates algorithms that train from a given set of instructions, and perform tasks from logistics to coordination and management of business operation. The exploitation of these technological marvels requires an ICT adept workforce.

ICT skills are such a significant enabler of economic productivity and growth improvement because they unlock the potential for a network economy. Providing real time communication between all parts of a production chain, transmitting information of success, failure, urgency or halt of activities means that all people and systems in a production chain are informed of each other's actions and can coordinate their own activities without uncertainty about others. Coordination means that productive capacity and effort can be switched according to the latest updates in the system. This development enables the optimization of all pertinent operations. In a network economy the signaling function of consumers is transmitted rapidly across the network and received by producers that analyze and transfer the information at an incredible speed, accelerating response to consumer patterns and facilitating impeccable leaps in growth.

Businesses around the world have realized the tremendous impact ICT may have on their productivity. In the last few years, firms have increased their investment on training new hires and retraining their more senior members to bring their workforce up to date with the accelerating digital transformation. Governments are also observing the benefits of an ICT skilled labor force in economic productivity and growth enhancement. Policymakers are creating training programs to improve the digital skills of all segments of the population. Skill matching initiatives pair young graduates with firms to enhance their ICT skills in a real work environment, and train more senior members of the work force to update their desynchronized skills and reintegrate them in the economy. The digital transformation of the economy is a collective effort that requires both businesses, governments and the labor force to introduce initiatives, innovate and lead.

1. The Digital agenda for Europe

The aim of the European Commission is a digital society which benefits from a wider digital market, including access to e-Government and e-Health services, improved digital skills for workforce and consumers, broadband connection for households and businesses). The digital agenda scoreboard (European Commission, 2017) shows that EU citizens and businesses are going online more and have greater confidence and skills in ICTs. Digital technology is a fast growing sector and European digital economy is growing at 12% each year. Furthermore, there are 7 million jobs in the ICT sector in Europe, while 16 million jobs will require ICTskills by 2020. On the other side, while almost 250 million people in Europe use internet daily, still about 1/3 of the population that have never used internet up to today.

UK

Significant value can be added to the UK economy and society through better investment in digital skills. This not only relates to job creation but also firm productivity and scaling-up markets for companies including SMEs. The contribution of digital skills to the performance of the economy is substantial. The 'tech sector' alone represents 6% of the UK economy with an estimated GVA per person in the region of £91,800, well above the UK average. Given the large number of opportunities that are likely to be available, strong investment in digital skills would likely bring about a very good return on investment to the UK economy.

Source: Digital Skills for the UK economy, 2016

SPAIN

Spanish economy presents certain delay in its Digital Transformation when compared with its European peers, mainly due to the lack of a clear digital strategy, the digital talent gap, the operating complexity of companies, the limited investment in innovation and the sometimes-rigid regulation. This delay has prevented the Spanish economy from realizing a tremendous value so far, but there is a huge economic opportunity ahead if the Digital Transformation is accelerated. In fact, the digitalization in Spain accelerate, there is an estimated opportunity of incremental GDP up to USD 48.500 million by 2021.

Source: Digital Economic Opportunity in Spain, Accenture Strategy, September 2017

FINLAND

Finland has been ranked as one of the leading countries in several digital transformation related assessments. In Digital Economy and Society Index 2017, Finland ranks 2nd with particular strengths in digital skills and digital public services. According to the Global Competitiveness Report, Finland has the best availability of scientists and engineers in the world combined with one of the most digitally oriented population. The Finnish education system is one of the best globally and ICT specialists' share of the workforce (6.7%) is one the highest as well. The innovation system is based on intensive collaboration between universities and industry (ranked 2nd in the world). The Finnish industry is highly export oriented, international and dominated by high tech solutions and related digital service offerings often based on extensive use of open data and next generation business models.

Source: Digital Finland Framework, Ministry of Economic Affairs and Employment of Finland

GERMANY

The German ICT sector generated revenue of €223 bn in 2015, making it the fifth largest market after the USA, China, Japan and the UK. It accounts for 4.7% of commercial value added, ahead of mechanical engineering and behind transport and logistics, with gross value added of €99bn. Revenue generated by the German internet economy continues to grow. At €111bn or € 1,379 per capita, it is ranked fifth in the world. The German digital economy enjoys clear competitive advantages such as market access, strong demand and the links between ICT and other areas of the economy. Its three greatest weaknesses are the shortage of skilled workers, the network infrastructure as well as the slow response of regulatory bodies to new digital requirements. Existing strengths can be expanded by focusing on promoting innovative applications such as the internet of things and smart services. Robotics, sensor technology and big data should be second priority.

Source: Monitoring Report DIGITAL Economy 2016, Federal Ministry for Economic Affairs and Energy

AUSTRIA

The Digital Roadmap of Austria presents around 150 specific measures in twelve fields of action in order to ensure that the country could optimally exploit the potential of digitization. The aim is for Austria to be one of the world's leading digital business locations. Digitization is a cross-cutting political issue. In many fields and at various levels (e.g. government departments, regional authorities, unions and employers' associations, NGOs, business), strategies already exist that cover particular aspects of digitization and identify specific measures to be taken in order to support and manage the digital transformation.

Source: Digital Roadmap Austria

NETHERLANDS

In the Netherlands, ICT makes a relatively large contribution to economic growth as it is being applied within all economic and social sectors at an increasingly faster rate. ICT is a source of innovation, new business activity and new potential applications. Thanks to digitization, Dutch people have access to new insights (analysis of complex medical conditions), new products (smart meters, drones), new services (digital marketplaces, personalized healthcare services), new working processes (customer-specific production, efficient transport) and new businesses (start-ups). In the world of academia, digitization goes hand-in-hand with the movement towards Open Science (Open Access to scientific publications and research results). It also offers great opportunities for education via developments like Massive Open Online Courses (MOOCs) and open educational resources. Statistics Netherlands (CBS) has calculated that the increase in ICT capital in the period from 1996 to 2009 was responsible for a quarter of all economic growth. Research consultancy Dialogic sets the figure as high as 36% for the period 1990 – 2013. ICT not only contributes to economic growth, but can also help with social issues such as sustainable food and energy provision, sustainable use of raw materials, safety, security or healthcare.

Source: Ministry of Economic Affairs, Digital Agenda for the Netherlands: Innovation, Trust, Acceleration, 2016

FRANCE

The French digital economy accounts for over 650,000 jobs and 4% of the country's GDP. Online sales to consumers totalled €56.8bn in 2014, up by almost 600% from €8.4bn in 2005. The country's ICT sector accounts for over 1/5 of its total R&D spend.

Source: Digital innovation and the French economy, The Economist

2. The Digital Economy and Society Index (DESI)

Currently, and based on official European statistics on the digital economy, a composite indicator is compiled every year in order to measure progress and provide a comparable and comprehensive analysis between European countries. That is the Digital Economy and Society Index (DESI). DESI is a composite index published every year by the European Commission (since 2014), measuring the progress of EU countries towards digital economy and society. The DESI index brings together and summarizes a set of (30) relevant indicators on Europe's digital performance and tracks the evolution of EU member states in digital competitiveness. The five dimensions of DESI are:

1 Connectivity: Fixed Broadband, Mobile Broadband, Broadband speed and Prices

2 Human Capital: Internet use, Basic and Advanced digital skills

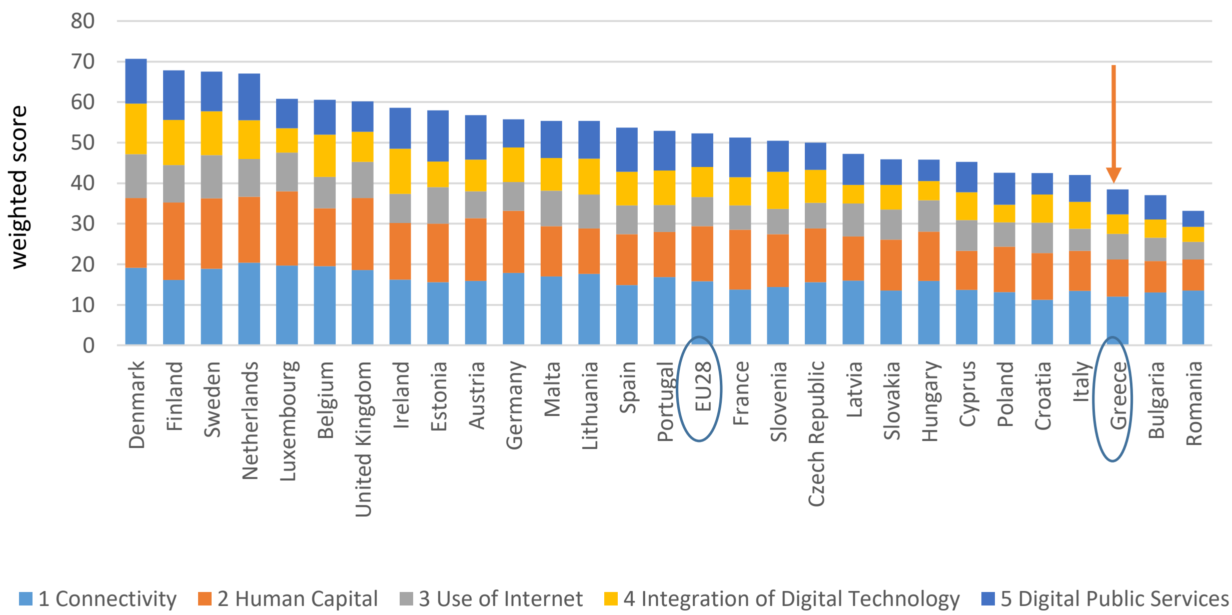
3 Use of Internet: Citizens' use of content, Communication and Online transactions

4 Integration of Digital Technology: Business digitization and E-Commerce

5 Digital Public Services: e-Government and e-Health

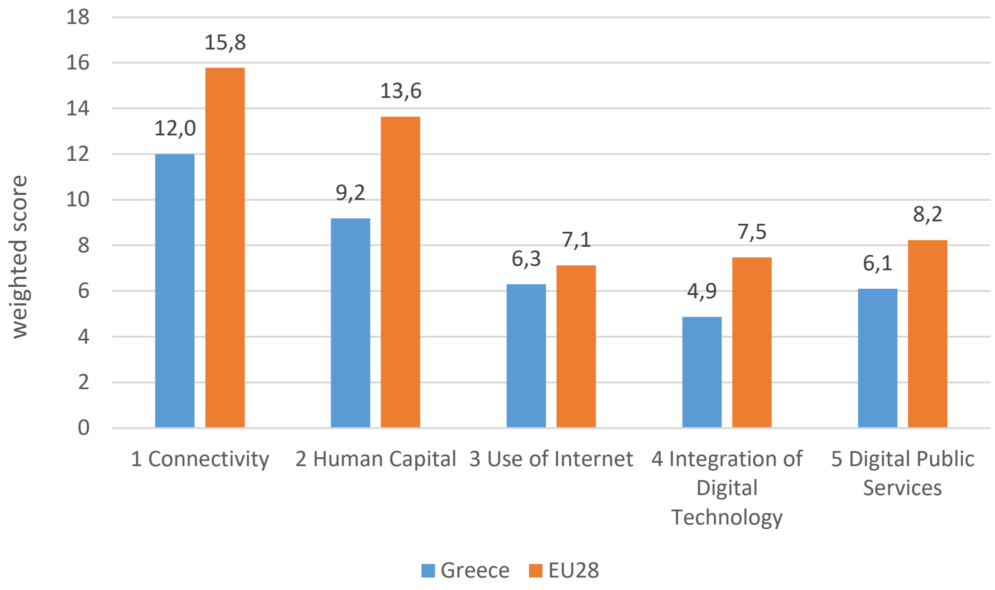
According to DESI index in 2017, Denmark, Finland and Sweden recorded the higher scores in the EU28. On the contrary, Romania, Bulgaria, and Greece had the lowest scores on the DESI index. **So Greece is clearly underperforming in this area and lags behind EU average in all dimensions, despite the fact that and slight improvement was recorded, compared to 2016.**

Figure 1: Digital Economy and Society Index (DESI) EU28 ranking, 2017



Source: European Commission, Digital Scoreboard

Figure 2: Digital Economy and Society Index (DESI) 2017, Greece & EU28



Source: European Commission, Digital Scoreboard

Other combinations of indicators are also published at the European level to support the relevant policymaking. The Digital Transformation Enablers' Index (DTEI) measures the progress made by various EU countries on the process of digitalizing their economy. Top performs include Sweden and Finland (78 and 73 respectively) while Greece scores 30, surpassing only Croatia, Bulgaria, Latvia and Romania and being included in the lagging group of countries that is characterized as "**Modest enabling environment**" (see Appendix). Across seven dimensions that are explored. Greece performs above the average only in entrepreneurial culture. On the other hand, Greece has a low integration of digital technology, low performance in ICT start-ups, e-leadership, investments and access to finance. But the dimension where Greece proves to perform very poor lowest is the supply and demand of digital skills (Digital Transformation Scoreboard 2017).

On the other hand, Digital Technology Integration Index (DTII)[1], measures the performance of Member States in terms of enabling conditions and transformation capturing changes in the digital transformation of European businesses. Again, at the bottom of the list, Romania, Latvia and Greece are lagging behind. (see Appendix).

[1] Digital Transformation Scoreboard 2017: Evidence of positive outcomes and current opportunities for EU businesses

2.1 DESI SCORES BY DIMENSION

In the following section, we present the basic facts about the current state of the digital transformation in Greece based on the structure adopted by the DESI report. This will allow us to identify our starting point for analysis and realize how underperformance in various dimensions leads to poor results in this transformation.

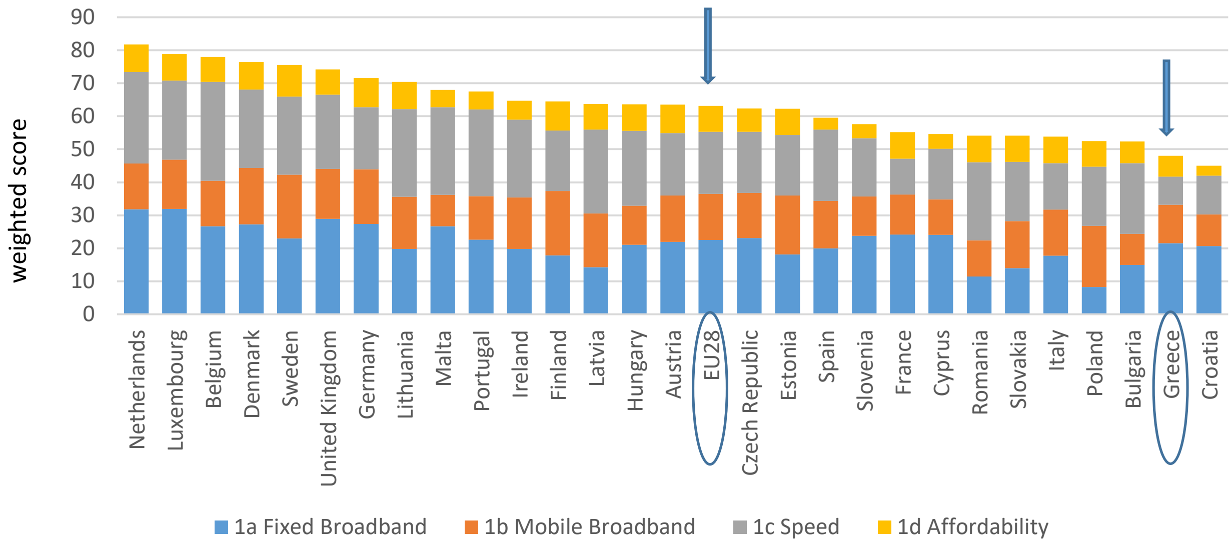
1. Connectivity (Fixed Broadband, Mobile Broadband, Broadband speed and Prices)

The digital economy is growing faster than the rest of the economy due to the development of broadband Internet. Over 218 million EU households (99.9%) have access to at least one of the main fixed or mobile broadband access technologies (excluding satellite, June 2016). Although fixed broadband coverage levels in Greece (99.3%) were higher than the EU average (97.5%) while rural areas are also at the 96.5%, (EU average: 92.6%), coverage of households with next- generation access (NGA) networks were available to only 44.2% of Greek households, very low compared to the EU average (75.9%). Furthermore, only 1.3% of rural homes passed by NGA networks in the mid-2016, the lowest level among all study countries (EU average 39.2%). At the end of June 2016, Greece remained as one of the three countries (along with Iceland and Italy) with no cable networks presence. The entire fixed broadband coverage still relied on DSL, with VDSL serving as the only source of high-speed NGA access[2].

The Connectivity dimension in DESI measures the deployment of broadband infrastructure and its quality, measuring both the demand and the supply side of fixed and mobile broadband. The fixed broadband sub-dimension assesses the availability as well as the take-up of basic and high-speed next-generation access (NGA) broadband and also considers the affordability of retail offers. On the other side, the mobile broadband measures the availability of 4G, radio spectrum and the take-up of mobile broadband. **Greece ranks very low regarding broadband infrastructure and take-up, despite the fact that** the index was improved compared to the previous years.

[2] The VDSL coverage and services was available to 44% of Greek households, below the EU average of 48.2%.

Figure 3: Digital Economy and Society Index (DESI) 2017, Connectivity



Source: European Commission, Digital Scoreboard

In 2017, Greece had wide availability in fixed broadband as 99% of the Greek households are covered by basic fixed broadband (EU average: 98%). Also, fixed broadband take-up remained stable at 66% (in 2015 and 2016) per household, below the EU average of 74%. In terms of mobile broadband take-up Greece was progressing slowly, while mobile broadband take-up lied at 50 subscriptions per 100 people (40 per 100 people in 2015), below EU average (84 subscriptions). Greece is performing better in terms of 4G, while 4G coverage in Greece corresponded to 80% of households, close to 84% average of EU counties. Additionally, 44% of Greek households had access high-speed broadband (at least 30 Mbps) in 2016 and Greece was last amongst the EU countries in NGA coverage, compared to 76% of European households. While subscriptions to fast broadband in Greece was only 7%, far from EU average of 37%. At the same time fixed broadband price in Greece was relatively high (1.7% price /income) compared to EU average 1.2% price/income).

Table 1: Connectivity and sub-dimensions in Greece and EU28, 2017

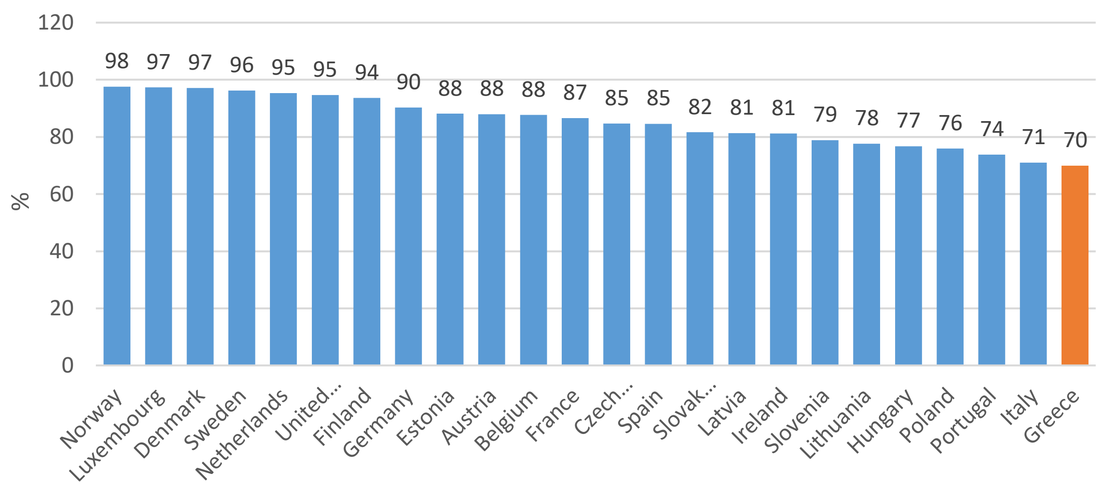
	Greece					EU28
	DESI 2017			DESI 2016		DESI 2017
	value		rank	value	rank	value
1a1 Fixed Broadband Coverage (% households)	**99%** (2016)	→	**10**	**99%** (2015)	**9**	**98%** (2016)
1a2 Fixed Broadband Take-up (% households)	**66%** (2016)	→	**21**	**66%** (2015)	**18**	**74%** (2016)
1b1 Mobile Broadband Take-up	**50**	↑	**27**	**44**	**27**	**84**

(Subscriptions per 100 people)	June 2016			June 2015		June 2016
1b2 4G coverage[4] (% households average of operators)	**80%** (2016)		**21**	**NA**		**84%** (2016)
1b3 Spectrum (% of the target)	**68%** (2016)	↓	**16**	**71%** (2015)	**15**	**68%** (2016)
1c1 NGA Coverage (% households)	**44%** (2016)	↑	**28**	**36%** (2015)	**28**	**76%** (2016)
1c2 Subscriptions to Fast Broadband (% subscriptions >= 30Mbps)	**7%** June 2016	↑	**27**	**4%** June 2015	**27**	**37%** June 2016
1d1 Fixed Broadband Price[6] (% income)	**1.7%** price 2016, income 2015	↑	**21**	**1.8%** price 2015, income 2015	**22**	**1.2%** price 2016, income 2015

Source: Europe's Digital Progress Report (EDPR) 2017 Country Profile Greece

Based on other sources (OECD, Information and Communication Technology Statistics), Greece and Portugal had the lower percentage (71%) of households with computer access at home among European countries (2017). Furthermore, 68% of individuals in Greece used a computer for minimum 3 minutes in 2017, which is the third lower among 24 European countries. Similarly, 70% of individuals in Greece used the internet at least once during the last three months, which is the lower percentage among 24 European countries.

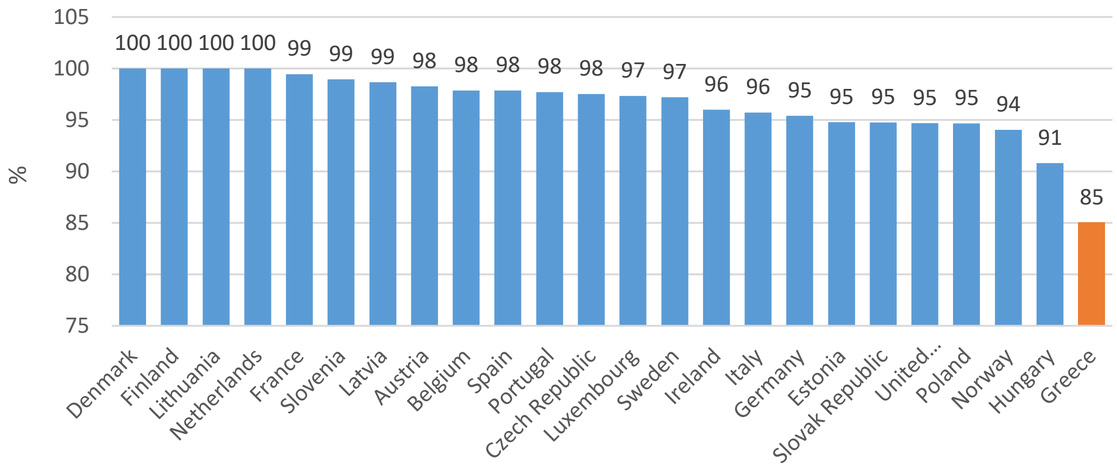
Figure 4: Individuals aged 16-74 using the internet - last 3 m (%), 2017



Source: OECD, Information and Communication Technology Statistics

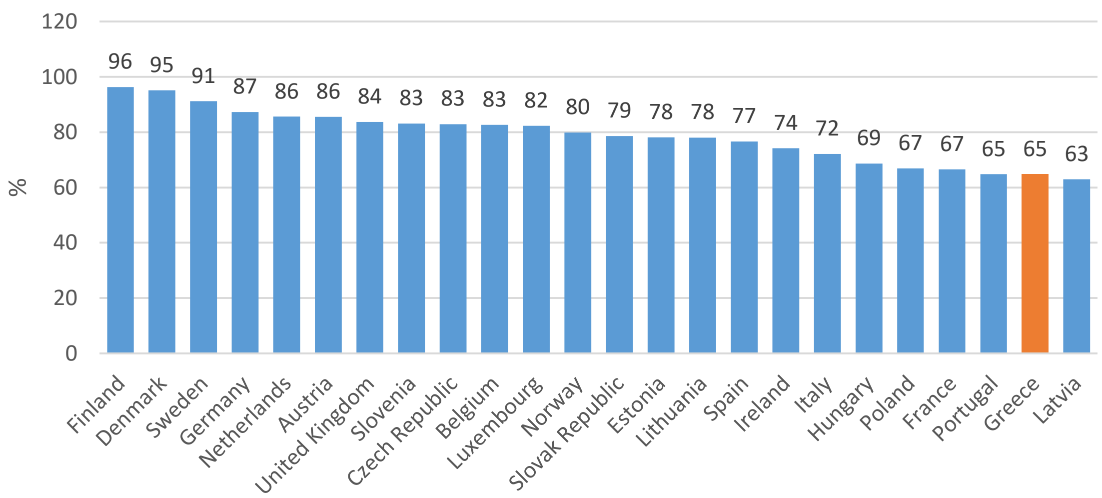
Focusing in business, only 85% of businesses in Greece had broadband connection (both fixed and mobile), which is the lowest performance in EU, while 65% have a website or homepage (second lowest in Europe.

Figure 5: Businesses with a broadband connection-both fixed and mobile (%), 2017



Source: OECD, Information and Communication Technology Statistics *All businesses (10 persons employed or more)

Figure 6: Businesses with a with a website or home page (%), 2017



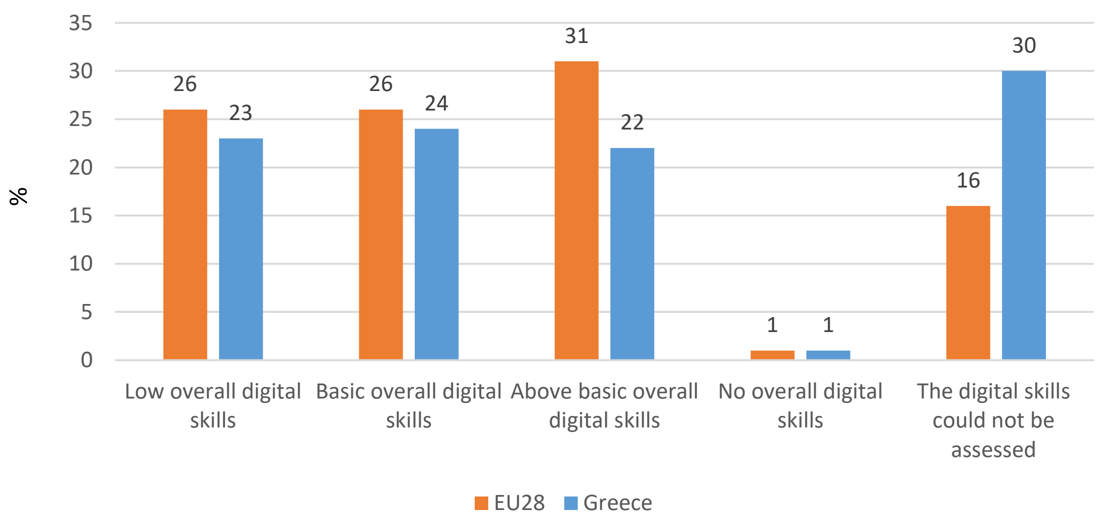
Source: OECD, Information and Communication Technology Statistics *All businesses (10 persons employed or more)

In 2016, half of all employees in the EU used a computer with access to the internet. This share was slightly higher for large businesses (53%) than for SMEs (47%). In 2017 the percentage of persons using a computer with internet access in their work was 38% in Greece and Portugal and 75% in Sweden, 73% in Denmark and 71% in Norway.

2. Human Capital/Digital skills (Basic Skills and Internet Use, Advanced skills and Development)

The spread of digital is having a massive impact on the labour market and the type of skills needed in the economy and society. Currently, digital skills and relative competences are needed for nearly all jobs where digital technology complements existing tasks. ICTs offer the promise of new business and employment opportunities along with higher productivity gains, but also make new demands on skills. According to European Commission data, 32% of the EU workforce has little or no digital skills and 15% has never used the Internet. While, a strong digital economy is vital for innovation, growth, jobs and competitiveness, shortages of digital tasks can be a significant barrier for the country's economic development. Differences vary greatly between EU Member States. The European Commission[3] estimates that 28% of the EU population has obtained some ICT skills through formal educational institutions, at school, college or university, which leaves plenty of leeway for companies to implement upskilling strategies to provide employees with the ICT skills needed. In Greece (2017), 23% of individuals in Greece had low and 24% had basic digital skills compared to EU28 average (26%). Similarly, 22% of individuals in Greece (from 16% in 2015) had above basic digital skills compared to 31% of individuals in the EU28 (2017).

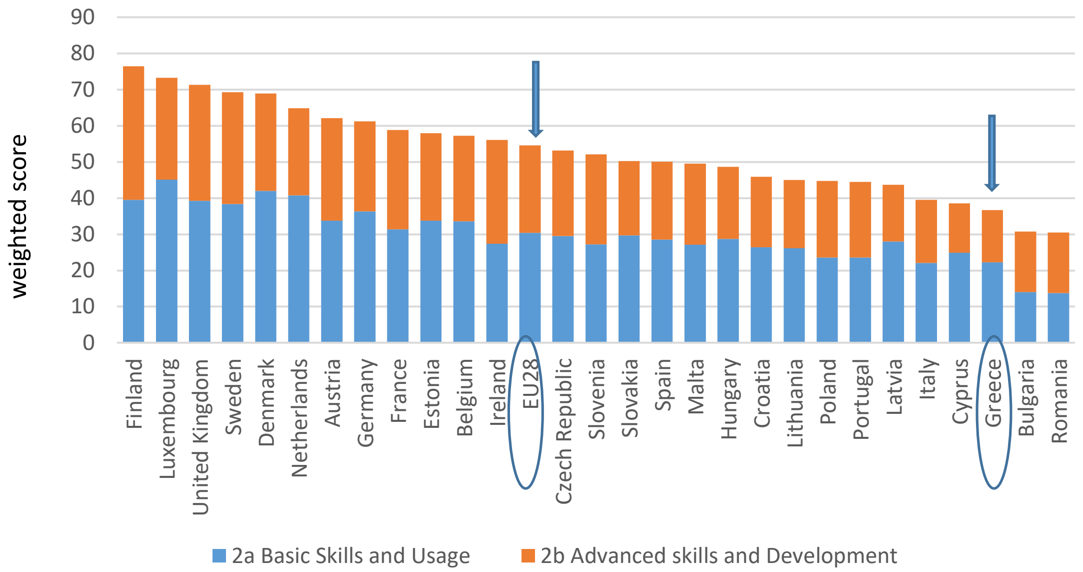
Figure 7: Individuals' level of digital skills Greece & EU28, 2017



Source: Eurostat

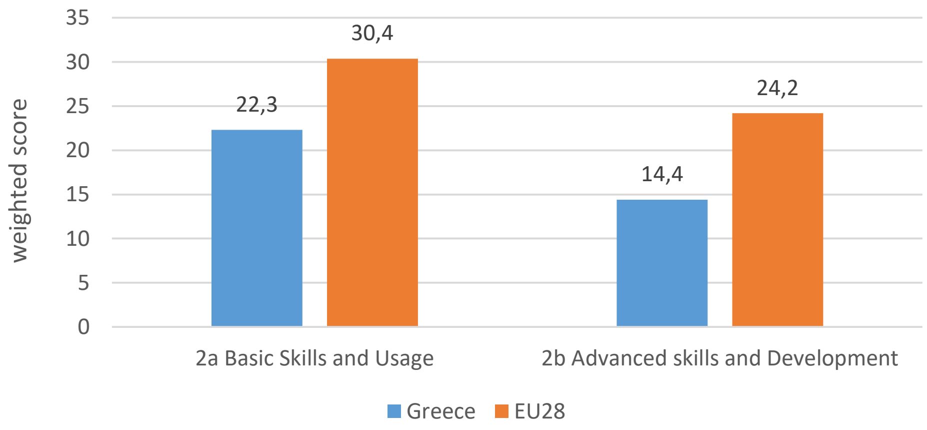
The Human Capital dimension in DESI measures the skills needed to take advantage of the possibilities offered by a digital society and has two sub-dimensions. The 'basic user skills and usage' that enable individuals to interact online and consume digital goods and services and 'advanced skills and development' that empower the workforce to take advantage of technology for enhanced productivity and economic growth. According to the latest report, Greece ranks also very low, being just above Bulgaria and Romania.

Figure 8: Human Capital Component DESI 2017, by aggregate scores of Member States



Source: European Commission, Digital Scoreboard

Figure 9: Human Capital, Component DESI 2017,by aggregate scores, Greece & EU28



Source: European Commission, Digital Scoreboard

Only the 66% of the Greek population used the internet on a regular basis, which is one of the lowest values among European countries (EU average 79%). Some 46% of individuals in Greece have at least a basic level of digital skills compared to 56% in EU. On the other hand, the share of the Science, Technology, Engineering and Math (STEM) graduates in Greece remained relatively high correspond to 16 graduates per 1000 people, despite the fact that lags behind EU average (19 graduates per 1000 people). Furthermore, Greece had the lowest percentage (1.2%) of ICT specialists from employed individuals in 2015 (vs 3.5% in EU).

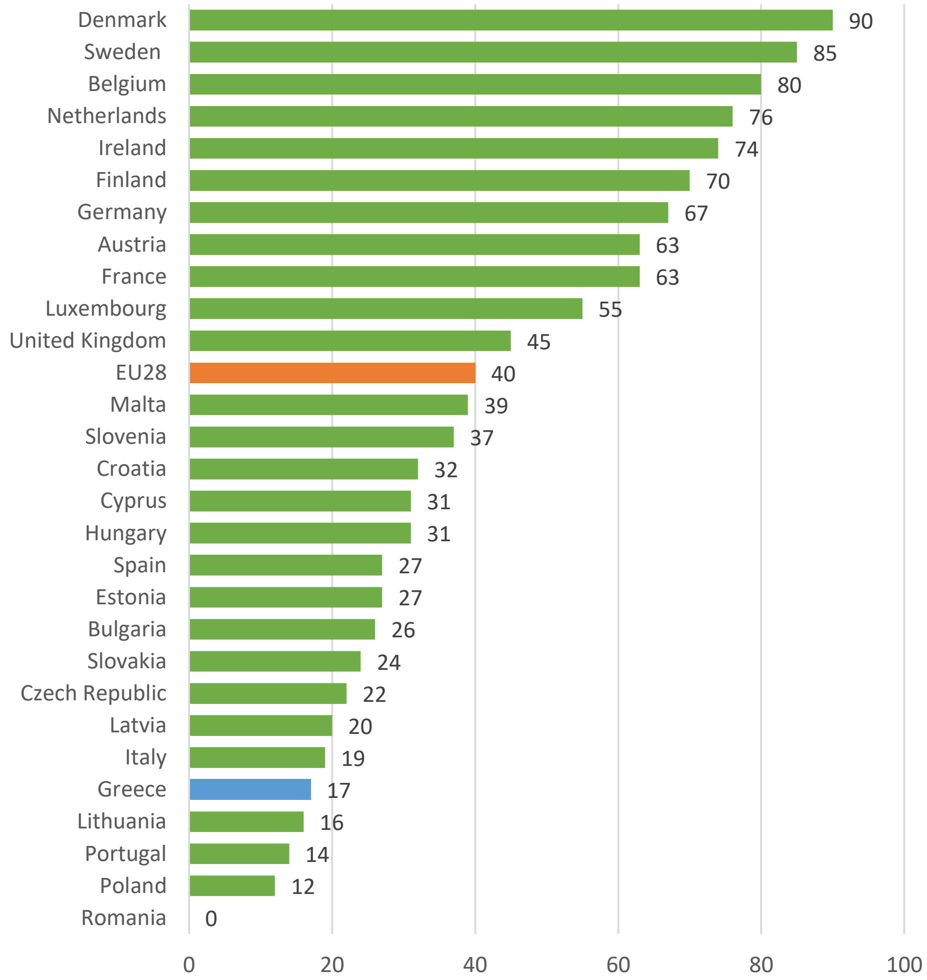
Table 2: Human capital and sub-dimensions in Greece and EU28, 2017

	Greece					**EU28**
	DESI 2017			**DESI 2016**		**DESI 2017**
	value		**rank**	**value**	**rank**	**value**
2a1 Internet Users (% individuals)	**66%** (2016)	↑	**26**	**63%** (2015)	**26**	**79%** (2016)
2a2 At Least Basic Digital Skills (% individuals)	**46%** (2016)	↑	**22**	**44%** (2015)	**23**	**56%** (2016)
2b1 ICT Specialists (% employed individuals)	**1.2%** (2015)	↓	**28**	**1.3%** (2014)	**28**	**3.5%** (2015)
2b2 STEM Graduates (Per 1000 individuals (aged 20-29))	**16** (2014)	→	**16**	**16** (2013)	**17**	**19** (2014)

Source: Europe's Digital Progress Report (EDPR) 2017 Country Profile Greece

In the dimension of “supply and demand of digital skills” Denmark with score 90 is the best performing country, closely followed by Sweden, Belgium, the Netherlands and Finland are also leaders in the dimension with a performance well above that of the EU average (40).. Greece, Lithuania, Portugal, Poland and Romania are lagging behind with a performance level well below that of the EU average.

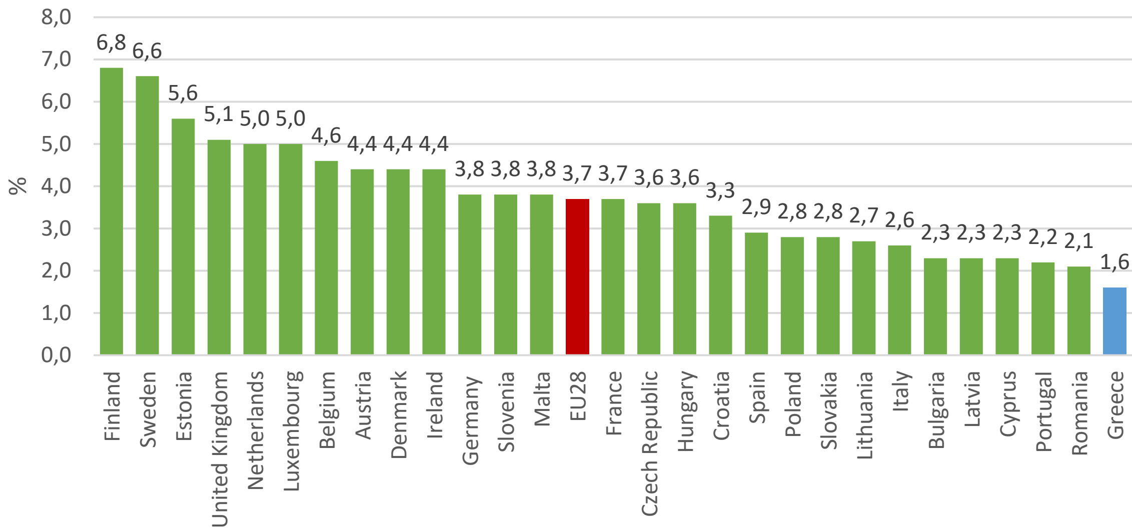
Figure 10: Supply and demand of digital skills,2017



Source: Digital Transformation Scoreboard 2017

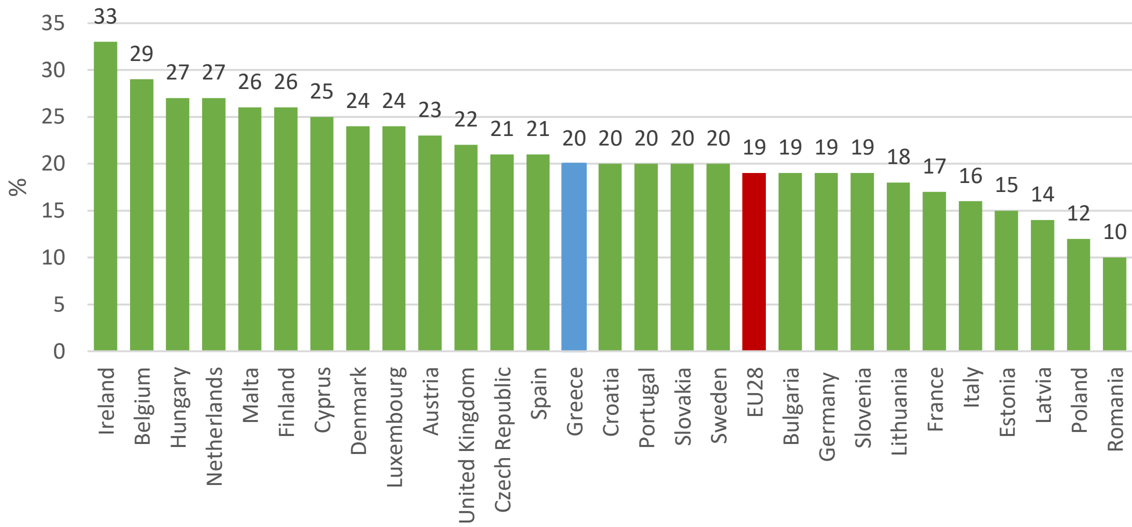
Other sources may differ slightly. For instance, in EU, 8.4 million persons were employed in 2017 as ICT specialists, representing 3.7% of total employment, with Finland being the champion in this (6.6% of its total workforce are ICT specialists). In Greece, 60 thousand people were employed as ICT specialists representing only 1.6% of total employment. On the other 1 in 5 enterprises in Greece, slightly higher than EU (19%) employed ICT specialists. **So ICT specialists may represent a smaller part of the employment, but the Greek businesses have access to them and hire them to the same extent as in EU average.**

Figure 11: Employed ICT specialists (% of total employment),2017



Source: Eurostat

Figure 12: Enterprises (%) that employ ICT specialists, 2017

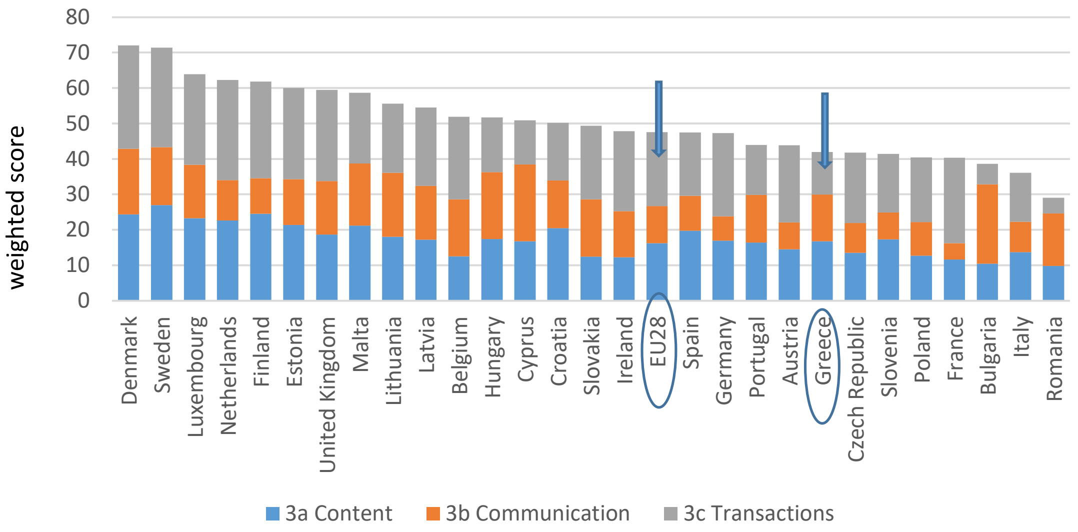


Source: Eurostat

3. Use of Internet by citizens (Citizens' use of Content, Communication and Online Transactions)

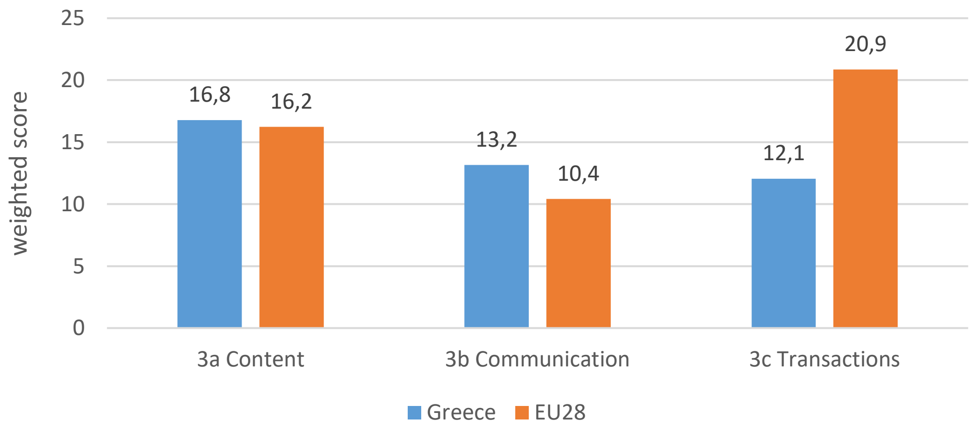
Use of internet accounts for the variety of activities performed by citizens already online (i.e. from consumption of online content, online shopping and banking). Greece score was 42 close to EU average (48).

Figure 13: Digital Economy and society (DESI), Use of the Internet, by sub-dimensions,2017



Source: European Commission, Digital Scoreboard

Figure 14: Digital Economy and society (DESI), Use of the Internet, by sub-dimensions Greece & EU28,2017



Source: European Commission, Digital Scoreboard

Greeks' online activities include mostly reading news online (85%), listening to music, watching films and playing games online (77%), voice communication (12%) or video calls (46%) and participating in social networks (68%). The Greek pattern does not differ significantly from the average European, with the exception of online banking (28% vs 9%).

Table 3: Use of internet and sub-dimensions in Greece and EU28, 2017

	Greece					EU28
	DESI 2017			DESI 2016		DESI 2017
	value		rank	value	rank	value
3a1 News (% individuals who used Internet in the last 3 months)	**85%** (2016)	→	**8**	**85%** (2015)	**8**	**70%** (2016)
3a2 Music, Videos and Games (% individuals who used Internet in the last 3 months)	**77%** (2016)		**20**	**NA**		**78%** (2016)
3a3 Video on Demand (% individuals who used Internet in the last 3 months)	**12%** (2016)		**19**	**NA**		**21%** (2016)
3b1 Video Calls% (individuals who used Internet in the last 3 months)	**46%** (2016)	↑	**13**	**44%** (2015)	**11**	**39%** (2016)
3b2 Social Networks (% individuals who used Internet in the last 3 months)	**68%** (2016)	↑	**17**	**66%** (2015)	**14**	**63%** (2016)
3c1 Banking (% individuals who used Internet in the last 3 months)	**28%** (2016)	↑	**26**	**21%** (2015)	**26**	**59%** (2016)
3c2 Shopping (% internet users (last year)	**45%** (2016)	↓	**22**	**47%** (2015)	**21**	**66%** (2016)

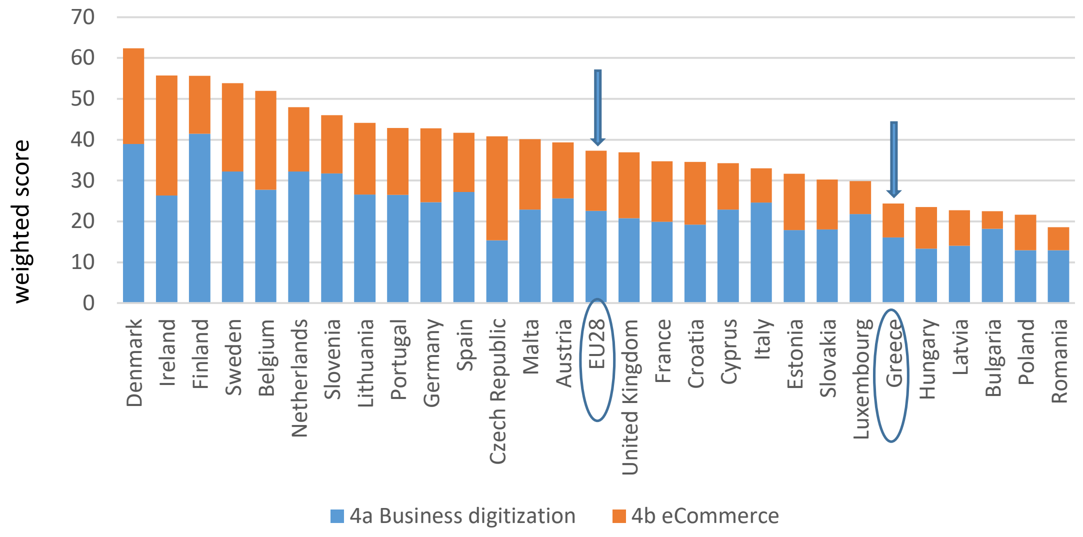
Source: Europe's Digital Progress Report (EDPR) 2017 Country Profile Greece

4. Integration of Digital Technology by businesses (Business digitization and e-Commerce)

The Integration of Digital Technology dimension measures the digitization of businesses and their exploitation of the online sales channel. By adopting digital technology businesses can enhance efficiency, reduce costs and better engage customers, collaborators and business partners. Furthermore, the Internet as a sales channel offers access to wider markets and potential for growth[3]. Greece scores around 24, which is significantly lower than EU28 average.

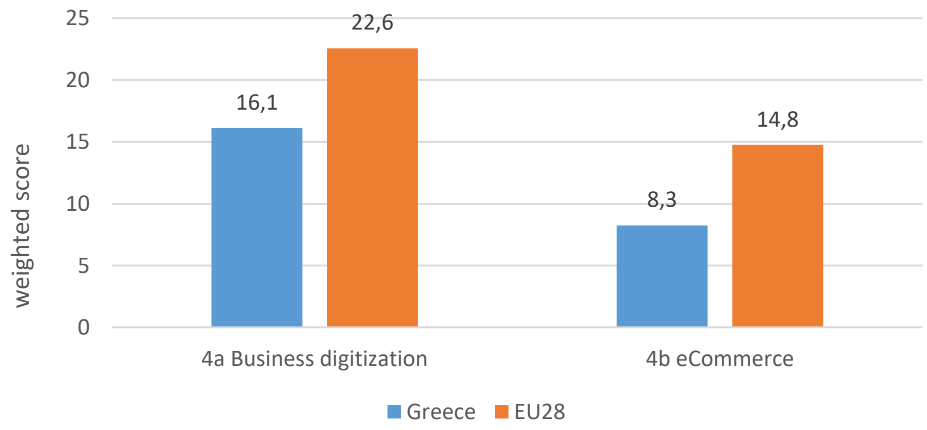
[3] Business digitization' has five indicators (as % of firms using): electronic information sharing, RFID, social media, e-Invoices and cloud solutions. E-Commerce has three indicators: the percentage of small and medium-sized enterprises (SMEs) selling online, e-Commerce turnover as a percentage of total turnover of SMEs, and the percentage of SMEs selling online cross-border

Figure 15: DESI2017 scores for the Integration of digital technology



Source: European Commission, Digital Scoreboard based on Eurostat Community survey ICT usage and e-commerce in enterprises

Figure 16: Integration of digital technology, by sub-dimensions Greece & EU28, 2017



Source: European Commission, Digital Scoreboard

Greece's overall industry performance in integrating digital technology despite recent improvement is still below the EU average. More specifically, although 37% of Greek businesses use a business software for electronic information sharing (vs 36% in EU) and 20% use social media to engage with customers and partners (the same with EU average), more advanced functions such as e-Invoices or cloud services are way below (3% vs 18% and 6% vs 13% respectively). Greek SMEs e-Commerce and use of electronic sales channels activity has also improved, but it is still lower than EU average (9.4%), with the exception of manufacturing sector, which generally scores better.

Table 4: Integration of Digital Technology and sub-dimensions in Greece and EU28, 2017

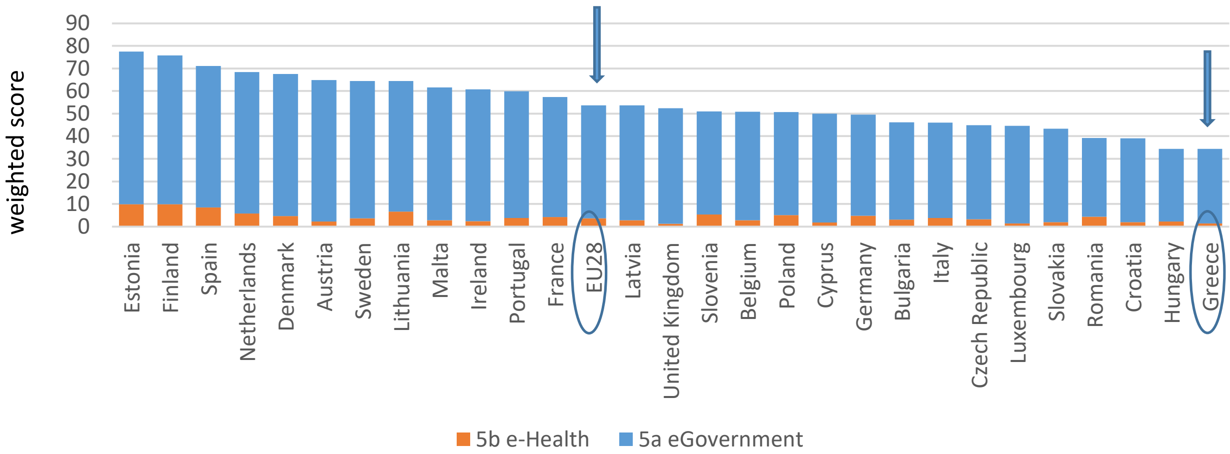
	Greece					EU28
	DESI 2017			DESI 2016		DESI 2017
	value		rank	value	rank	value
4a1 Electronic Information Sharing (% enterprises)	37% (2015)		12	37% (2015)	12	36% (2015)
4a2 RFID (% enterprises)	2.6% (2014)		26	2.6% (2014)	26	3.9% (2014)
4a3 Social Media (% enterprises)	20% (2016)	↑	11	19% (2015)	11	20% (2016)
4a4 eInvoices (% enterprises)	3% (2016)	↓	28	4% (2015)	28	18% (2016)
4a5 Cloud (% enterprises)	6% (2016)	↓	25	7% (2015)	23	13% (2016)
4b1 SMEs Selling Online (% SMEs)	10% (2016)	↑	22	6% (2015)	27	17% (2016)
4b2 eCommerce Turnover (% SME turnover)	5.9% (2016)	↑	23	1.2% (2015)	28	9.4% (2016)
4b3 Selling Online Cross-border (% SMEs)	3.4% (2015)		26	3.4% (2015)	26	7.5% (2015)

Source: Europe's Digital Progress Report (EDPR) 2017 Country Profile Greece

5. Digital Public Services (e-Government)

Finally, the Digital Public Services dimension measures the digitization of public services, focusing on e-Government and e-Health services[4]. Greece ranks last in this indicator which means that Greece is missing the opportunity for efficiency gains in public administrations and better services for the citizens.

Figure 17: Digital Public Services by Member state, 2017



Source: European Commission, Digital Scoreboard

[4] E-Government users are measured as a percentage of those internet users who need to submit forms to the public administration. E- health measures the percentage of people who used health and care services provided online without having to go to a hospital or doctor's surgery.

Although the percentage of internet users in Greece (38%) that have exchanged forms with the public administration online was above the EU average (34%), the provision of online public services is scarce: only 5/100 forms are prefilled, compared to 49/100 in EU. On the other hand, Open data has improved and is well (73% vs 56%).

Table 5: Digital Public services and sub-dimensions in Greece and EU28, 2017

	Greece					EU
	DESI 2017			DESI 2016		DESI 2017
	value		rank	value	rank	value
5a1 e-Government Users (% internet users (last year))	**38%** (2016)	↑	**14**	**37%** (2015)	**12**	**34%** (2016)
5a2 Pre-Filled Forms (Score (0 to 100))	**5** (2016)	↓	**28**	**8** (2015)	**27**	**49** (2016)
5a3 Online Service Completion (Score (0 to 100))	**63** (2016)	↑	**25**	**54** (2015)	**27**	**82** (2016)
5a4 Open Data (% of maximum score)	**73%** (2016)	↑	**10**	**63%** (2015)	**6**	**59%** (2016)

Source: Europe's Digital Progress Report (EDPR) 2017 Country Profile Greece

So to sum up Greece lags behind in almost every indicator of the five dimensions of DESI index. In Connectivity, Greece features wide availability of fixed broadband but take-up is progressing slowly, as the transition to fast broadband connections is slower than in other EU Member States. In Human Capital, Greece's performance is well below EU average but it is slightly progressing. Greece needs to address its severe digital skills gaps and the shortage of ICT specialists remains crucial for supporting the digital transformation of industry. For most of a wide range of online activities, Greeks are more actively using internet for online content and video calls than overall in Europe. Greece's overall industry performance in integrating digital technology is below EU average. Greek companies use social media at the level of EU average, but don't use more sophisticated technology such as cloud services or e-Invoices. On the positive side, the Greek startup ecosystem is viewed very favorably worldwide and investments in digital companies have multiplied over the last few years. Finally, in Digital Public Services, the percentage of internet users that have exchanged forms with the public administration online is above the EU average.

3. Digital Skills: A new frontier for Growth and Productivity

As it was highlighted in the previous sections, Greece is currently lagging behind other countries in digital skill diffusion. At the same time, other developed countries are already observing the impact of digital skills in economic productivity and growth, and many are catching up to the task of improving their educational and entrepreneurial environments to take part in the digital transformation.

In the last few years, technological advancement has penetrated every aspect of society. Likewise, the economy of the future will run on technological change. Automation, artificial intelligence and human-computer collaboration are gaining essential roles in manufacture and services. Low and middle-skill jobs are facing elimination in the hands of robotics, machine learning and optimization. However, productivity is still lagging behind the possibility boundary allowed by technology, mainly due to the lack of workers able to harness the digital revolution. Impending surges in unemployment and productivity stagnation necessitate that the workforce adjusts to the changing tide**. Research shows that those in the labor force trained in digital skills, abilities such as document manipulation, internet use, data analysis and software development increase firm productivity and thus are integral to growth.** Through a review of industry studies on digitalization and academic literature on economics, **in the following section we explore the significance of digital skills in the improvement of productivity and growth**.

Digital skill augmentation has proven successful in improving productivity according to industry data. The WEF highlights digital skills as an important factor in the return of digital investment. Industry leaders adopting digital skill innovations double their productivity while industry followers experience a slight dip in productivity. Such industry leaders have a contemporary management, digitally skilled to hone a forward strategic vision, anticipate technological development and remain innovative. Successful businesses employ workers with a digital mindset, people who constantly improve on their digital skillset. The WEF notes AT&T as a successful example of this approach. AT&T has invested $250 million on the education and professional development of its workforce, offering "nanodegrees" with curricula based on digital skills such as cloud computing and virtualization. AT&T reaps the rewards of its investment, having enjoyed a 40% decrease in its product development cycle and a 32% decrease in time to revenue in 2016. Other firms such as Amazon and Paychex are also following the trend with new training programs to enhance the digital skills of their employees, as the improvement of digital skills is becoming an increasingly recognized approach to productivity augmentation. (WEF & Accenture 2018)

The impact of digital skill improvement in productivity has been empirically tested in various studies. A European Commission study on inclusive innovation measuring the productivity of Italian firms in 1995-2003 with the use of a logit model finds that there is strong correlation between share of workers with ICT skills and productivity (EC 2014). Productivity is also found to be strongly correlated with investment in training programs. A research paper by the University of Maryland, studying the effect of digital skills dissemination in India, shows that digital skills are positively correlated with wages as well (Liu & Mithas 2009). The study observes a 10.9% increase on wages for workers who master digital skills, proving that digital skill enhancement is highly valued by businesses. The paper also suggests that digital skills influence socioeconomic areas such as the gender gap and migration patterns, and thus have the potential to enhance productivity by enabling the involvement of more people in the digital transformation, and providing a skill matching mechanism. A study on UK firms treats the superior growth of ICT sectors as an indicator that ICT skills have been overlooked in research because of the difficulty of analyzing their impact (Basu & Susanto 2003). The study suggests that ICT skill impact on productivity is larger than most research indicates, as organizational and structural changes of firms over time belie its effects. As suggested by the paper, digital skills diffusion has wide impacts in decision-making, administration and communication, opening up new outlets for productivity development.

More economic analysis suggests that the improvement of digital skills enhances growth at a national level. A European Commission study on the economic impact of digital structural reforms show strong results for programs focusing on the enhancement of e-skills (Lorenzani & Varga 2014). Digital skill enhancement is correlated with higher intra sectoral allocative efficiency, a result attributed to better ability to react to market changes. The model used in the study demonstrates a 0.65 p.p. average increase in sectoral allocative efficiency (and close to 0.5 p.p. increase in labor productivity) EU-wide. The simulation of the impact on GDP shows a 0.6% increase in the long-run. Accenture's report on Digital Disruption also predicts a high correlation between digital skills and growth. Accenture uses a 10-point index allocating points to new technology, skill training and accelerator spending to simulate the optimum investment spending for maximum growth. For countries with strong technological advancement such as Japan, investment in digital skills of 6/10 will produce a 3.3% increase in GDP in 2020, while for countries with a strong accelerator effect such as Germany, investment in skills of 5/10 will produce a 2.5% increase. The generated data shows that countries with strong technology penetration and capital structures should invest in digital skills to optimize their return on investment. These findings exhibit the significance of exploration of ways to improve digital skill as a key to new enhancements of productivity and growth (Knickrehm & Doherty 2016).

Both businesses and employees understand the importance of digital adeptness to productivity, but the market is not acting upon its awareness. **Accenture's business review of 2017 shows that 67% of business leaders anticipate human-AI collaboration to increase significantly in the near future, while 67% of employees believe that they will need new skills to work with AI.** However, according to Accenture only 3% of executives plan to invest on training and reskilling programs to provide their personnel with digital skills. SAP observes a similar scenario, finding that though 90% of business leaders expect significant changes because of the digital transformation and 64% claim that they do not have workforce with the skills necessary for the digital transformation, only 16% invest in training and recruitment based on the digital skills of the future. Both investigations demonstrate that the market does not react to its own needs for digital skills. This result may be attributed to concerns such as losing employees after investment on their training or factors such as a lack of belief in corporate training or a bias towards physical capital investment. A multinational study by OECD suggests that the lack of interest in training is a symptom of the deteriorating relationship between employers and employees (Arnal, Ok & Torres 2001). The researchers suggest that the need for external flexibility to prevent productivity lags in a shifting economic environment prompts low-tenure hire of labor. Movement towards the "gig economy", as it is better known, prevents investment spending on employee training and generates weak diffusion of technical skills within the working population.

Weak public and private investment in digital skill training is showing in productivity and income loss. A study by IDC shows that $19,732 per IT employee per year is wasted on support with simple tasks such as document help, issues that would not require assistance had the employee been more digitally adept (Webster 2012). This inefficiency amounts to 21.3% total productivity lost, a figure that creates an estimated $1.3 trillion loss to the US economy. The UK House of the Commons Science and Technology committee reported that lack of digital skills is causing £63 billion in productivity loss. UK consumers not comparing prices on the internet are losing £560 savings per year. Meanwhile, 2/3 data science firms are struggling to find new hires, while 93% of tech firms claim impact due to the digital skill gap. The report also notes that an investment of £1.65 billion in digital skills of employees in the National Health System would bring returns of £14 billion. A study on Italian firms suggests that ICT skill shortage not only hampers productivity directly, but it also slows down investment on technology. The study suggests that investment on pioneering technologies has a lower and slower upside than investment on established technologies. This phenomenon is attributed to a shortage of ICT skilled personnel to utilize new technologies. A comparative paper that researches the productivity growth gap between the UK and the US finds that, despite comparable capital investment in the two countries, the lack of technological skills in the UK caused unequal results. The study also suggests that the more prevalent ageism and low-skilled management of UK firms led lackluster technological change, which caused a slower productivity growth. As these studies show, the lack of digital skills of both employees and management causes massive losses to productivity and potential income, an inefficiency that prompts urgent address.

Greece has lagged behind in ICT development compared to the rest of Europe. Research on the inefficiency incurred by digital skill shortage is overwhelming. However, policy to address the growing divide between Greece and its European peers in ICT adoption has been unreactive. A potential reason for tepid attempts by policymakers may be the lack of information for the benefits of ICT within the Greek economy. The next section aims to fill the analytical gap in research, to demonstrate the inefficiencies wrought by the lack of ICT skills in the Greek economy, and the potential improvements in productivity and growth that an improvement of ICT skill indexes may cause.

4. The Economic Footprint of Digital Skills

In this section, we present a quantitative investigation of the relationship between the level of digital skills of a country's population and a number of aspects of the economic activity in the country. Using appropriate econometric techniques, we examine the relationship between digital skills and entrepreneurship in a country, the level of wages offered to workers and the exports performance of an economy, while we also examine the relationship between the number of ICT specialists employed in an economy and the economy's total output, as measured by its real Gross Domestic Product (GDP). We use the percentage of a country population with advanced digital skills, which is determined by Eurostat's surveys for a number of European countries throughout the period 2003-2017,[5] as the measure of the level of digital skills of a country's population. Based on the results of the analysis, we present intuitions on how a potential improvement in the e-skills of the Greek population would affect the various aspects of economic activity in the country.

4.1 Digital skills and entrepreneurship

Familiarity with new technologies, and with Information and Communications Technologies (ICTs) is particular could spur entrepreneurial initiatives, both in the broader field of ICTs themselves, as advanced digital competences allow people to offer new services in the area of software, mobile applications, internet businesses etc., and in most other fields of economic activity, as digital skills both allow easy access to information and enable people to automate tasks. In this section, we investigate the relationship between the level of the digital skills of a country's population and the intensity of entrepreneurial activity in the country's economy using statistical data on new business creation, compiled by the World Bank.[6] We perform a regression of the new business density index on the percentage of the population

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[5] See Eurostat, Individuals' level of computer skills [isoc_sk_cskl_i] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_sk_cskl_i&lang=en. In the context of Eurostat's surveys, an individual is considered to have advanced digital skills, if he/she has carried out 5 or 6 of the following computer related activities: copy or move a file or folder, use basic arithmetic formulae to add, subtract, multiply or divide figures in a spreadsheet, use copy or cut and paste tools to duplicate or move information on screen, transfer files between computer and other devices, connect and install new devices, e.g. a printer or a modem, write a computer program using a specialized programming language. The number of people with advanced digital skills is expressed as a percentage of the country's population aged 15-74.

[6] See World Bank, New Business Density Index, https://data.worldbank.org/indicator/IC.BUS.NDNS.ZS?view=chart New business density is expressed as the annual number of new registrations for businesses per 1000 people in the country aged 15-64.

with advanced digital skills on a panel of data for 28 European countries over six years in the period 2006-2014.[7] We estimate the coefficients of the regression using panel least squares, assuming fixed effects, to control for country-specific determinants of entrepreneurial activity. The results of the regression are presented in Table 6.

Table 6: Digital skills and entrepreneurship

Variable	Coefficient	Std. Error	t-Statistic
C	2.7342	0.5862	4.6644
I_CSK_HI	0.0739	0.0226	3.2662
Parameter	**Value**	**Parameter**	**Value**
R-squared	0.8969	Mean dependent var	4.6220
Adjusted R-squared	0.8742	S.D. dependent var	3.4391
S.E. of regression	1.2197	Akaike info criterion	3.4012
Sum squared resid	188.92	Schwarz criterion	3.97
Log likelihood	-236.29	Hannan-Quinn criter.	3.63
F-statistic	39.48	Durbin-Watson stat	0.8999
Prob(F-statistic)	0.0000		

The coefficient for the e-skills variable (I_CSK_HI) is statistically significant and both the coefficient of determination (R-squared) and the F-statistic of the regression are large, thus supporting the credibility of the results of the analysis as an accurate account of the quantitative relationship between the two variables.

Based on the results of the analysis, an **increase** of the number of **people with advanced e-skills by 80 thousand** is associated with an increase of annual creation of businesses by **500 additional new business registrations**.[8]

[7] Using the broadest datasets currently available, we compiled a panel of data for the years 2006, 2007, 2009, 2011, 2012 and 2014 and for the following countries: Austria, Belgium, Bulgaria, Czech Republic, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Latvia, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, Slovenia, Slovakia, Turkey and the United Kingdom.

[8] The population aged 15-74 in Greece in 2017 was 8,012,100 people. Therefore, if 80 thousand more people in Greece develop advanced digital skills, then the share of people with e-skills in the country will rise by 1 percentage point. Based on the results of the analysis, an increase in the share of the Greek population with advanced e-skills by 1 percentage point is associated with an increase in the number of new businesses created annually by 0.0739 new business per 1000 people aged 15-64. In 2017 there were 6,885,000 people aged 15-64 in Greece. Hence, 80 thousand more people with e-skills correspond to [0.0739*6,885,000/1000=] 509 new businesses registered annually.

4.2 Digital skills and wages

Digital skills allow workers to carry out tasks, especially ones related to information processing, much faster and much more easily than these tasks would be performed without using computers. Therefore, e-skills increase labor productivity and thus would be expected to have a positive relationship with wages. We examine the relationship between the level of the digital skills of a country's population and the hourly compensation offered to workers in the country using statistical data on the compensation of employees per hour worked, compiled by Eurostat.[9] We perform a regression of the hourly wage on the percentage of the population with advanced digital skills on a panel of data for 26 European countries over seven years in the period 2005-2014.[10] We estimate the coefficients of the regression using panel least squares and assuming fixed effects, to account for country-specific factors affecting the level of wages. The results of the regression are presented in Table 7.

Table 7: Digital skills and wages

Variable	Coefficient	Std. Error	t-Statistic
C	12.6130	0.7906	15.9538
I_CSK_HI	0.1971	0.0303	6.5130
Parameter	**Value**	**Parameter**	**Value**
R-squared	0.9758	Mean dependent var	17.6734
Adjusted R-squared	0.9715	S.D. dependent var	11.3885
S.E. of regression	1.9212	Akaike info criterion	4.2862
Sum squared resid	538.86	Schwarz criterion	4.78
Log likelihood	-343.76	Hannan-Quinn criter.	4.49
F-statistic	226.85	Durbin-Watson stat	0.5110
Prob(F-statistic)	0.0000		

The coefficient for the e-skills variable (I_CSK_HI) is statistically significant and both the coefficient of determination (R-squared) and the F-statistic of the regression are large, thus supporting the credibility of the analysis.

[9] See Eurostat, Labour productivity and unit labour costs [nama_10_lp_ulc], http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_lp_ulc&lang=en . The compensation of employees is expressed in euros per hour worked, in current prices, before the subtraction of social security contributions and income taxes.

[10] Using the broadest datasets currently available, we compiled a panel of data for the years 2005, 2006, 2007, 2009, 2011, 2012 and 2014 and for the following countries: Austria, Belgium, Bulgaria, Czech Republic, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Latvia, the Netherlands, Norway, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia and the United Kingdom.

Based on the results of the analysis, an **increase** of the number of **people with advanced e-skills by 80 thousand** corresponds to an increase of the average **monthly salary by €35** (1.76% increase of the average monthly salary)[11], which is an **increase of the annual income of workers by more than €420**.[12]

4.3 Digital skills and exports performance

Increased labor productivity, as a result of widespread and advanced digital skills in a country's workforce, would be expected to boost the international competitiveness of the country's economy, allowing it to produce goods and services of higher quality at a lower cost. To assess the connection between e-skills and international competitiveness, we examine the relationship between the level of the digital skills of a country's population and the country's exports, of both goods and services, as a share of the country GDP, using national accounts data on GDP and exports, compiled by Eurostat.[13] In this case, we perform a regression with the dependent variable being the ratio of total annual exports of goods and services on GDP and the independent variable being the percentage of the population with advanced digital skills. We estimate the coefficients of the regression using a panel of data for 28 European countries over seven years in the period 2005-2014.[14] We estimate the coefficients of the regression, using panel least squares and assuming fixed effects, thus controlling for country-specific factors affecting each economy's export performance. The results of the regression are presented in Table 8.

[11] The average compensation of employees per hour worked in Greece in 2017 was €11.2, see Eurostat Labour productivity and unit labour costs [nama_10_lp_ulc].

[12] Based on the results of the analysis, an increase in the share of the Greek population with advanced e-skills by 1 percentage point is associated with an increase of the average hourly compensation of employees by €0.20. Assuming an average working month of 22 business days and 8 hours of work per day, an increase of €0.20 per hour worked corresponds to an increase of the monthly compensation by €35, which is €420 annually.

[13] See Eurostat, GDP and main components (output, expenditure and income) [nama_10_gdp], http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_gdp&lang=en . Exports of goods and services, as well as the GDP are expressed in real terms (million euros in 2010 chain linked volumes). The ratio of exports on GDP is expressed as a percentage (values in the range from zero to 100).

[14] Using the broadest datasets currently available, we compiled a panel of data for the years 2005, 2006, 2007, 2009, 2011, 2012 and 2014 and for the following countries: Austria, Belgium, Bulgaria, Czech Republic, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Latvia, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, Slovenia, Slovakia, Turkey and the United Kingdom.

Table 8: Digital skills and exports of goods and services as a share of GDP

Variable	Coefficient	Std. Error	t-Statistic
C	32.8297	2.3036	14.2517
I_CSK_HI	0.6783	0.0900	7.5328
Parameter	**Value**	**Parameter**	**Value**
R-squared	0.9369	Mean dependent var	49.8778
Adjusted R-squared	0.9251	S.D. dependent var	20.9966
S.E. of regression	5.7446	Akaike info criterion	6.4817
Sum squared resid	4950.02	Schwarz criterion	7.00
Log likelihood	-551.11	Hannan-Quinn criter.	6.69
F-statistic	79.57	Durbin-Watson stat	0.4650
Prob(F-statistic)	0.0000		

Indeed, the coefficient for the e-skills variable (I_CSK_HI) is statistically significant and both the R-squared and the F-statistic of the regression are large, supporting the credibility of the analysis.

On the basis of these results, an increase of the number of people in Greece **with advanced e-skills by 80 thousand** corresponds to an increase of the total annual **exports** of Greek goods and services **by €1.2 billion.**[15]

4.4 NUMBER OF ICT SPECIALISTS AND THE GDP

Furthermore, we investigate the importance of specialized, professional skills in ICTs for modern economic production by examining the relationship between the number of ICT specialists employed across an economy and the level of the real GDP of the economy. In this context, we use national accounts data on the real GDP and statistics on the number of ICT specialists employed in each country, compiled by Eurostat.[16] We perform a regression of a country's real GDP in million euros on the number of ICT specialists employed across the country's economy in thousands. We estimate the coefficients of the regression using a panel of data for 27 European countries over the entire period 2004-2017.[17] We estimate the

[15] Based on the results of the analysis, an increase in the share of the Greek population with advanced e-skills by 1 percentage point is associated with an increase of the exports to GDP ratio by 0.6783 percentage points. The Greek GDP in current prices in 2017 was €177,735.3 million and 0.6783%*177,735.3= €1,205.58 million.

[16] See Eurostat, Employed ICT specialists - total [isoc_sks_itspt], in thousand persons, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_sks_itspt&lang=en

[17] Using the broadest datasets currently available, we compiled a panel of data for the years 2004-2017 and for the following countries: Austria, Belgium, Bulgaria, Czech Republic, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Latvia, the Netherlands, Norway, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia, Turkey and the United Kingdom.

coefficients of the regression using panel least squares and assuming fixed effects, to control for country-specific determinants of each economy's level of economic activity. The results of the regression are presented in Table 9.

Table 9: Number of ICT specialists in the workforce and real GDP

Variable	Coefficient	Std. Error	t-Statistic
C	392683.9000	5885.8210	66.7169
ISOC_SKS_THS	478.7730	21.7976	21.9645
Parameter	**Value**	**Parameter**	**Value**
R-squared	0.9981	Mean dependent var	516779.4000
Adjusted R-squared	0.9979	S.D. dependent var	699191.1000
S.E. of regression	31909.2800	Akaike info criterion	23.6511
Sum squared resid	3.52E+11	Schwarz criterion	23.94
Log likelihood	-4394.76	Hannan-Quinn criter.	23.77
F-statistic	6620.08	Durbin-Watson stat	0.5592
Prob(F-statistic)	0.0000		

Indeed, the credibility of the analysis is supported by the fact that the coefficient for the e-skills variable (I_CSK_HI) is statistically significant, as well as by the fact that both the R-squared and the F-statistic of the regression are large.

The results of the analysis suggest that an increase of the number of ICT specialists employed across the Greek economy by **1000 professionals** is associated with an increase of the Greek **annual GDP by €480 million** in real terms.

4.5 Digital skills and technological adoption

When the labor force in an economy has advanced digital skills one would expected the economy to perform better in technological adoption. Workers familiar with the use of computers, software and networks can easily be trained on new equipment, which is typically operated through computers, or new services accessed through software and online platforms. In order to quantitatively investigate the link between e-skills and technological adoption, we examine the relationship between the level of the digital skills of a country's population and the country's performance in technological adoption, as measured by the respective index compiled by the World Economic Forum[18]. We perform a regression with the dependent variable being the "Technological adoption" index and the independent variable

[18] See World Economic Forum, The Global Competitiveness Report, Global Competitiveness Index data-set, http://reports.weforum.org/global-competiveness-index-2017-2018/downloads/ , index "A. Technological adoption", taking values in the range 0 through 7.

being the percentage of the population with advanced digital skills. We estimate the coefficients of the regression using a panel of data for 28 European countries over five years in the period 2007-2014[19]. We estimate the coefficients of the regression, using panel least squares and assuming fixed effects, to account for country-specific factors affecting each economy's performance in technological adoption. The results of the regression are presented in Table 10.

Table 10: Digital skills and technological adoption

Variable	Coefficient	Std. Error	t-Statistic
C	-7.4889	1.1635	-6.4367
I_CSK_HI	0.4075	0.0443	9.2085
Parameter	**Value**	**Parameter**	**Value**
R-squared	0.4625	Mean dependent var	3.0879
Adjusted R-squared	0.3218	S.D. dependent var	2.6261
S.E. of regression	2.1627	Akaike info criterion	4.5672
Sum squared resid	500.45	Schwarz criterion	5.19
Log likelihood	-281.57	Hannan-Quinn criter.	4.82
F-statistic	3.29	Durbin-Watson stat	0.4623
Prob(F-statistic)	0.0000		

Notably, the coefficient for the e-skills variable (I_CSK_HI) is statistically significant and the R-squared as well as the F-statistic of the regression are large, all of which support the credibility of the analysis.

On the basis of these results, an increase of the number of people in Greece **with advanced e-skills by 80 thousand** corresponds to an increase of the technological adoption index by 0.41 units, which translates to **Greece improving its rank** among the 28 countries examined **by 5 positions**. Based on the measured values of the index, in 2017 Greece ranked 27th out of the 28 countries examined, in terms of its performance in technological adoption. An increase of the index by 0.41 units would make Greece rank 22nd out of the 28 countries, which would be a remarkable improvement.

[19] Using the broadest datasets currently available, we compiled a panel of data for the years 2007, 2009, 2011, 2012 and 2014 and for the following countries: Austria, Belgium, Bulgaria, Czech Republic, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Latvia, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, Slovenia, Slovakia, Turkey and the United Kingdom.

5. Policy Proposals for the Enhancement of ICT Skills in Greece

The ICT skill shortage in Greece is a multidimensional issue, attributed to various interconnected factors, and thus requires an interdisciplinary policy recipe. Policy proposals will take into account the specific characteristics of the Greek economy (prevalence of SMEs, ageing management etc.) The suggested policy proposals will fall into one of the following categories:

- Public training programs
- Tax incentives, subsidies for private training programs
- Educational reform
- Skill matching programs
- Mobility subsidization programs
- Establishment of community technology centers
- Infrastructure improvement
- Public/Private sector cooperation initiatives for inexpensive equipment provision
- Business and community ICT awareness initiatives
- Bespoke ICT management consultancy
- Programs and initiative that prompt cultural shift in the way ICT is viewed

In the following section, we assess policy proposals as part of two distinct approaches: disruptive and selective. The disruptive approach will endeavor to delineate the ecosystem that fortifies the ICT skill shortage, analyzing the contribution of different factors in the phenomenon and locating the relations between factors. Suggested policies will aim to disrupt the connections between factors and undermine the structure that bolsters the skill shortage. The selective approach will pick out the different groups that fall behind the digital transformation and suggest targeted policy. Part of the selective approach will be an extended reflection on ICT policy for primary and secondary education.

5.1 Disruptive approach

The disruptive approach focuses on the structure of relations between the factors deemed most connected to the lack of ICT skills in the Greek economy. These factors are:

I. Lack of connectivity infrastructure, lack of community technology oriented spaces and difficulties in affording PCs, ICT technologies

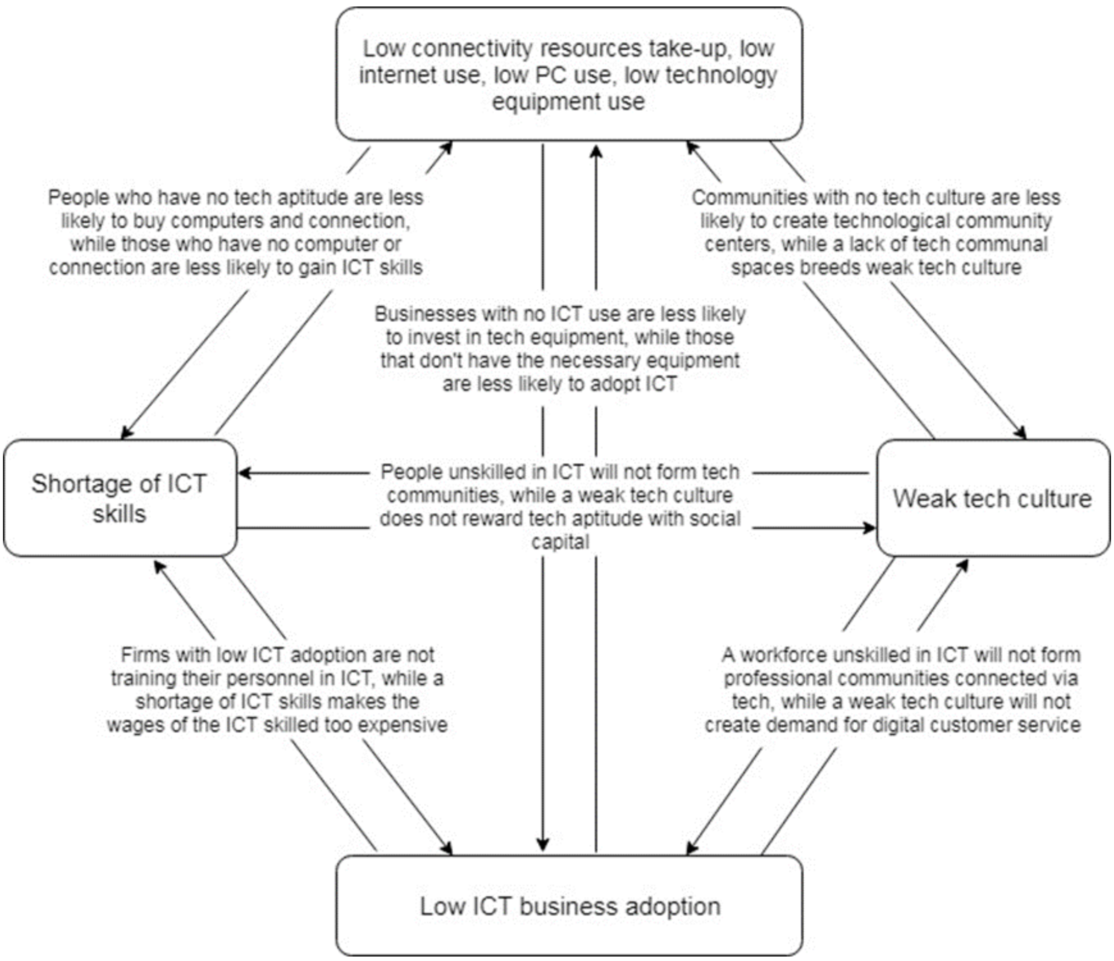
II. Low connectivity resources take-up, low internet use, low PC use, low technology equipment use

III. Shortage of ICT skills

IV. Low ICT business penetration

V. Weak tech culture

The flowchart below demonstrates the causal relations between the factors:



The shortage of ICT skills belongs to a self-sustaining ecosystem that prevents technological advancement from improving the Greek economy. A disruptive method to public policy aims to target the relations between the features of the structure and disrupt or reverse their effect.

ICT skills-connectivity and use

Beginning with the shortage of ICT skills-low connectivity relation, policymakers could focus on subsidizing the take-up of internet and mobile connectivity resources to decrease prices in rural areas, or subsidize the purchase of certain electronic devices for demographic groups that are suffering from the effects of the digital transformation (above 40 unemployed people with tertiary education qualifications). In the case of Greece, this course of action is preferable to improvement of infrastructure, as our research suggests that broadband infrastructure is up to EU28 levels, while take-up lags significantly behind. Policymakers should look to engage in public/private sector cooperation with firms to negotiate an optimal solution for all parties. On their own, however, these policies will be largely inefficient as Greece does well compared to the EU28 in use of the internet according to the Digital Scoreboard of the European Commission.

ICT skills- business ICT adoption

The focus of policymakers should be the link between ICT shortage and dearth of business ICT adoption. Policy should aim to increase both public and private ICT training initiatives. On the part of governmental efforts, training initiatives should look to match the skills required from the market both in the present and in the future. Courses should balance focus between immediately marketable skills (document, spreadsheet, presentation) and optionally to more advanced skills (data analytics, coding, digital design) or skills for the future (blockchain, big data, AI). Classes should be focusing on the skills that match the demands of the current market, with considerations of marketable learning outcomes. The system should have a built-in mechanism that reassesses business needs over time, and tailors the course load accordingly. Regarding staffing, a training initiative should consider the cascade method, a top-down approach in which a few “master” trainers, provide teach a number of assistants, who each provides training to regional peers who ultimately do the workshops. The provision of certification for graduates of the training initiative-such certificate would act as a guarantee of tech aptitude for businesses. Another effective addition to the initiative would be an office of professional resources that matches the demand for ICT skilled workforce to the supply of graduates.

The dissemination of private sector-led training is also an effective approach to disrupting the link between shortage of ICT skills and weak business ICT adoption. Encouraging training in industry is a difficult task for policymakers, as businesses training employees, face the risk of losing on their investment if employees switch jobs, while training-levy systems are not well advertised for jobs requiring ICT skills. Policymakers should prompt businesses to adopt training programs using tax reliefs or subsidies. A government agency should monitor the programs and provide information on training to businesses. An important notice is that private training programs face a number of problems in the Greek economy. To begin with, the Greek economy is dominated by SMEs that, especially for the customer and tourism industry sectors, have little optimization potential. In addition, the sheer number of SMEs makes the task of offering bespoke business consultation, rather difficult. Any potential policy should also strike cooperation with worker unions, which especially in Greece maintain a stronghold of power. Policymakers should pay attention to the public sector of the economy, and look into ways of improving productivity and digitalizing the services offered to the public. The public sector may operate as a laboratory for self-initialized training programs that are optimized and later offered to the private sector, as higher quality of service will likely increase the take-up of the service in businesses.

Furthermore, and due to the fact that most manufacturing companies but also most of the touristic services offered are located at more rural areas of the country, there is a requirement for more ICT skilled personnel in these areas. Most developed countries employ immigration of skilled workers to fill their skilled worker needs. This policy is rather incredulous at a large scale as Greece has few to offer as a developed country in comparison to other European countries and in result, experiences brain drain. We need to mobilize some ICT skilled workers from the capital to more rural areas, as one of the problems that Greek SMEs face especially in the periphery firms is this lack of human capital.

Finally, all suggested initiatives pertaining to the ICT skill shortage-ICT business adoption link, require a robust information system that provides the necessary support to the program. Greece is lagging behind the EU in terms of the DESI information it is providing, a quandary that reduces policy vision. An information system will not only provide the necessary infrastructure for the initiatives to operate, but also will increase business transparency and private-public sector cooperation.

ICT skills-tech culture

The link between shortage of ICT skills and weak tech culture is a subtle problem that policymakers may directly affect only minimally, but it still requires some consideration. There are a number of ways to influence how people view technology. The approach of government digitalization in services will necessitate that citizens acquire ICT skills. Taking into consideration the ageing population and the current lack of services offered online, most elderly and ICT unskilled people will seek assistance from tech adept members of the community. Small communities will gravitate around "local" experts, who will gain significant social capital for their assistance to other members, and become role models for others. Another approach is promoting technology through cultural events such as museum art, music and theatre, and speaking events or conferences focusing on ICT skills. Overall, cultural approaches to ICT skills are difficult and probably ineffective. Other policies should be pursued instead.

Business ICT adoption-connectivity and use

The use of technologically advanced equipment by firms is a significant driver of ICT skill development, as employees are required to acquire technical aptitude to operate advanced machinery or software. The government may intervene by providing grants to businesses that innovate technologically, and may subsidize firm packages for digital resources of document manipulation or more advanced software for design, coding or data analysis. In this case, the government may engage in public-private cooperation and strike deals with suppliers of hardware and software. In addition, policymakers should look for ways to incentivize businesses to seek the advice of consultants, to ensure that firms acquire the equipment suited to their operations. Policymakers should also incentivize the take up of broadband connections to improve internet presence and online selling for SMEs, an area in which Greece is lagging behind the rest of the EU. Other challenges exist in ICT business adoption beside cost considerations. Usually, important concerns of business owners against ICT adoption are an uncertainty over the benefit of ICT, and the potential for security hazards. Policymakers should look to ameliorate these concerns by increasing awareness of ICT productivity enhancement the security threats. A significant challenge that policymakers will have to face is the opposition from ageing staff and, most importantly, management in Greece. Older people in management are less likely to have extensive knowledge of current and potential technologies and thus to have a strategic vision for technological innovation. Other challenges that policymakers should consider before deciding on a pertinent policy include the incompatibility of past with current ICT technology, and the lack of technological penetration in businesses that are ahead or behind in the production line of a product. Businesses are more likely to adopt ICT if their suppliers, their clients or their competitors are using it. Thus, policymakers should create a holistic vision to increase ICT adoption by firms.

Business ICT adaptation-tech culture:

Changing the culture surrounding technological use in business is a difficult task but policymakers still have some potential options. To begin with, policymakers may focus once again on the public sector as they have greater regulating power upon it. A potential policy is the creation of a database for the communication of public servants between services. An online community that enables the interaction between offices and services will not only increase efficiency but also enhance the prominence of professional internet communities that will hone the digital skills of public servants. Another potential policy is an initiative that incentivizes firms to offer digital customer service through selected websites. This initiative, though certainly difficult to monitor will not only create online communities for comparison of firms online, but also increase the competition between firms and potentially prove positive for firm productivity. Finally, policymakers may turn to publicly funded annual events for innovation and technology in business. These events will harbor dialogue, exchange of ideas pertinent to tech in business, and offer a platform for networking between professionals.

Tech culture-connection and use:

Policymakers may pursue a variety of policies to ensure the entrenchment of technology in culture, most of which require the direct procurement of equipment. A common suggestion is the creation of technological community spaces, such as digital libraries and publicly funded or subsidized internet cafes. These spaces are particularly important in rural areas to boost technology use without requiring individual or business purchase which even after subsidization may be unpopular. Community spaces are hubs of dialogue and exchange for members of the community and the infusion of technology in those spaces will have positive effects in increasing the familiarity of a community with technology.

5.2 Selective approach

A popular approach in policy literature, the selective approach is aimed at demographic groups in Greece that lack ICT skills. If targeted effectively, the enhancement of ICT skills in these groups will have positive effects in the Greek economy. The proposed policies will apply to students in all sectors of education, and the structurally unemployed:

STEM Grads:

Greece is ranking averagely in comparison to the EU28 in terms of the portion of STEM graduates in the population. However, this feature does not reflect in the portion of the population who have ICT qualifications. Research positions remain limited, and many STEM graduates, mainly in the sciences and math are hired into the school system, while others follow non-STEM employment, and a large portion remain unemployed for a number of years. Policymakers may assuage this situation by integrating ICT skill development in STEM higher education. In other countries, science and math education involves a greater extent of coding, and data analysis, skills that are immediately translatable to market demands, and in result tech firms STEM graduates with various scientific qualifications for quantitative tasks. Another attractive idea, popularized in the UK is the “year in industry”. Students who choose a curriculum that involves a year spent with selected businesses in the area are more ready to take part in the workforce after graduation.

Social Science & Humanities Grads:

The Greek educational system graduates too many social science and humanities graduates, the majority of whom face structural unemployment or underemployment in the limited academic environment of Greece. Until today, the Greek public sector, both education and services, absorbed the excess graduates. However, the system of hiring humanities graduates as public servants is costly and unsustainable in contemporary Greece. A politically costly policy is to reduce the social science and humanities university departments in Greece; however, such option would face significant opposition from student groups and mainly teacher and professor unions. A more perceptive policy, is the integration of digital humanities in social science and humanities curricula. By introducing new technological methods of data analysis and digital research, universities may train social science and humanities graduates for in-demand jobs. This policy follows the pattern of integrating ICT knowledge in traditional curricula to prevent the increase of structural unemployment.

Middle-Aged Demand-Deficient Unemployed / Discouraged and out of labor force:

Since the economic crisis, Greek workers of many trades have suffered lay-offs that have permanently left them out of the labor force. Managers prefer to hire younger workers who will have lower wage demands, higher productivity and motivation and updated workplace skills. As the middle-aged remain unemployed, their experience becomes increasingly archaic and they become even harder to hire, eventually leaving the labor force, or working in underemployment. Policymakers may offer a solution; however, they must first differentiate between the different types of unemployed. Dr. Ferro, Helbig and Gil-Garcia provide a useful distinction to discern between the ICT unskilled. According to the researchers, the two kinds of ICT unskilled are the "laid-back", people who are able but not willing to train their ICT skills and the "needy", people who are unable to adopt ICT. The laid back can be tackled by policy through awareness campaigns that aim to demonstrate the benefits of ICT in landing a job. Another, more unpopular, method would be to require that people who receive unemployment benefits go through retraining. On the other hand, the needy are more difficult to target, as they will more probably be underemployed, having little to no time to spare for training, or unable to because of some disability. Policymakers may also endeavor to directly reintegrate the two groups in the workforce. "Returnships" is an attractive idea of giving internships to older individuals who have rusty skills from remaining out of the labor force for a long time. Potential policy could incentivize sectors that experience low absorption of middle and older aged workers, such as information services, to offer career re-entry programs and provide new and up to date experience to unemployed people of the trade.

Primary and Secondary Education policy interventions

Revamping the skillset of an entire population requires a comprehensive approach to public policy. ICT skill diffusion, as many demographic goals, begins at the school system. In classrooms, students acquire useful knowledge and skills for higher education and professional work. Countries-pioneers in education such as Finland, Denmark and Singapore are at various stages of the process of reorganizing their educational system around ICT, making the digitalization of the student's skillset a primary goal. Greece has lagged behind other countries in rethinking how the education of its youth should recalibrate to align to the needs of tomorrow. The education system is still focused on high-stake examinations, memorization and the material still adheres to an archaic curriculum. Despite of the voluminous teacher population, educational quality is low while the private tutoring sector thrives. This segment will analyze the benefits of rethinking education through ICT and produce policy proposals for a comprehensive integration of ICT in a new educational system.

Benefits of ICT integration in Education

The primary benefit for the integration of ICT in education is the acquisition of ICT skills by the student population. Students using computers, word processors, internet research, e-books and other digital technologies as part of learning become more digitally skilled and are more able to use ICT technologies (Kozma, 2005). In addition, students who use ICT in education gain better research (Castro Sanchez and Aleman, 2011) and information management skills (Resnick and Wirt, 1996), becoming more able to pursue self-directed, independent learning, and provide analysis to complex data. Research also suggests that students engaged in ICT are more likely to become network-based, collaborative learners (Koc, 2005), and apply interdisciplinary knowledge creatively (Lall, 2000). These skills are very important in entrepreneurial professions that require cooperation, leadership, innovation and creativity. Finally, ICT skilled students become better learners, understanding deeper concepts and acquiring critical thinking (Levin and Wadmany, 2006). Students with advanced critical learning and thinking skills are more likely to pursue advanced education in science, technology and entrepreneurship and thus have a strong effect on the output of the economy.

Public policy affecting such an important factor of the national economy as the educational system requires a comprehensive, holistic plan with specific goals. Policymakers should look at both factors affecting the integration of ICT in schools: physical capital such as computers and software, as well as human capital such as digitally skilled teachers and administrative staff. The plan should also aim to rethink the goals of education and how they are pursued through the curriculum, teaching methods, examinations and university admission. Finally, a comprehensive plan must have an evaluative and self-correcting mechanism that discards parts of the policy that are not working and keeps parts that do.

1. Comprehensive policy action plan: A successful policy is founded upon concentrated outcomes, clairvoyant planning with realistic timetables and specific checkpoints, clear delegation of duties and funding among participant institutions in the macro-level, and within unit platforms of policy application, an evaluating, recalibrating mechanism and a reward-punishment system if pertinent to ensure enforcement.

a. Goals: A committee of policy, education and technology experts should take upon the duty of setting the goals of an ICT education policy. The goals will be a balance between the diffusion of ICT skills in the student population, augmentation of learning of the current curriculum, the transformation of attitudes about education from a youth burden to a lifelong experience, the cultivation of innovation, creativity and inquisitiveness and the creation of a collaborative, group-focused educational environment that rewards both excellence and leadership.

b. Timetable: The demise of a number of national policies of tech integration is an unrealistic, miscalculated timetable that requires teachers and students who read textbooks and wrote on chalkboards to suddenly use online materials, write on word processors and communicate through the internet (Almekhlafi and Almeqdadi, 2010). Change takes time. A timetable must have an achievable set of benchmarks that includes time for teachers to reeducate themselves and students to manage the new tasks required of them. Both teachers and students need time to adjust to new software and hardware, as well as the different relationships that ICT communication shapes.

c. Logistics: Policy plans of all types often fail at the delegation of duties between the various institutions and actors involved. An education policy change requires constant communication and cooperation between the ministry of education, geographical districts and municipalities, school personnel, organizing bodies such as the teacher unions, and public partners such as universities and private cooperators such as firms. Each participatory actor must understand duties and expectations. Public-private partnerships are especially important in providing the necessary physical capital (hardware, software) as well as training for teachers and administrative staff.

d. Monitoring: In a constantly evolving field such as technology, education must be fluid, self-evaluating and self-correcting. Some ICT technologies initially thought as good ideas may stifle learning or teaching beyond an adjustment time deemed acceptable, while learning materials may turn out too simple or too complex for students. A policy with rigid requirements and no flexibility will indivertibly lead to deadweight procedures that hamper educational procedures, turn the public against the policy, and potentially make the whole initiative obsolete.

2. Educational goals: Various issues plague education in Greece. Curriculums overextend the time constrains of students and teachers. Classes are based on memorization and examinations instead of deep learning and critical thinking. High-stake examinations raise the cost of mistakes and feed a bloated private tutoring sector that disempowers teachers from

achieving educational objectives. The negative aspects of the education system cause unneeded stress in both students and teachers. In fact, the effort to finish the material and improve exam scores has been a major barrier to ICT use in the classroom (Goktas, Yildirim and Yildirim, 2009). Policymakers should not only integrate ICT in the classroom, but also to the goals of education. Acquiring a creative, innovative outlook towards education, learning collaboratively and gaining ICT skills that are useful in the job market, should become primary objectives of education. Curriculums should include courses such as “Innovation”, “Digital Design”, “IT” and “Computerization” (Chan, 2002). Students trained in ICT, infused with innovation, creativity and a collaborative spirit are more likely to follow scientific, technological and entrepreneurial professions, and use these productive skills in their everyday life.

3. Equipment: ICT skill diffusion in schools is largely affected by the availability of technology equipment (Al-Ruz and Khasawneh, 2011). Tech equipment includes computer rooms, word, spreadsheet and presentation processing software, online educational materials, projectors, smartboards and document-sharing interfaces. ICT equipment should be integrated into the learning process instead of being used in parallel. For example, teachers in a history course may use the internet to show students pictures of maps, artworks, or artifacts, and students may access primary sources in historical archives online. In physics courses, teachers may use computer programs or videos to show students how planets move in the solar system or how current flows through a circuit. ICT can offer new modes of learning through visualization and interaction, cultivating inquisitiveness and stimulating the curiosity of students while also augmenting their critical thinking skills. The integration of office tools in classes through individual and group assignments will disseminate ICT skills in the student population. In addition, online research will improve information gathering and management skills.

4. Teacher workshops: Teachers are an extremely significant component of ICT educational policy. Not only are teachers the instruments of the policy, but they are the cultural nodes, the leaders and the role models that students emulate in their early academic life. Teacher workshops should have a tertiary goal of providing teachers with the ability and confidence to use ICT, instructing them on ICT-enhanced methods of teaching and shifting their attitude toward ICT.

a. Ability to use ICT: The dearth of support in learning ICT and the lack of experience of teachers has been a significant hurdle for ICT policy (Ertmer and Otternbreit-Leftwich, 2010). Teachers are often expected to pick up ICT skills on the spot after policymakers pass ICT education legislation. This is unrealistic and counterintuitive. Teachers should attend workshops and professional development activities that aim to bring their skills up to date with current technology before being tasked to integrate ICT in the classroom. These workshops may be organized in relation to private partners and should potentially be packaged in the same initiative with private partners that provide equipment.

b. Integrating ICT in the curriculum: A significant challenge facing the integration of technology in any framework is “so what?” Namely, what use is ICT in the classroom? A common barrier to ICT use in schools is the inability of teachers to integrate ICT in teaching context (Honan, 2008) and educational material (Hutchinson and Reinking, 2011). Workshops should focus not only on ICT skills but also on how to apply ICT in the classroom. Workshops should cover new methods of teaching that incorporate ICT, such as online research for essay sources, spreadsheets to teach material and graphical programs for visualization in science courses.

c. Attitude change: Often ICT policies fail because, while they may succeed in acquiring equipment for schools and training teachers in ICT, they do pay attention to influencing the culture surrounding ICT in the classroom. The attitudes of teachers are very significant to the success of educational ICT. Research suggests that a lack of motivation (Liu and Szabo, 2009) weak tech attitudes of teachers (Palak and Walls, 2009) are strongly correlated with ICT use in the classroom. Workshops should focus on raising awareness for the significance of ICT in the learning process and encourage positive attitudes about ICT in the classroom.

In addition, reskilling teachers is a very difficult, time consuming and stressful procedure that has been often thankless. Teachers who are successful in their integration of ICT technology in the classroom should be rewarded for their efforts with bonuses, vacation time or better schedules. The opposite method, namely punishing non-compliers would be unpopular with politicians and unions.

6. Policy Conclusion

The ICT skill shortage is an extremely important issue that has the potential to stall economic growth and productivity improvement, worsen economic inequality and enhance the brain drain. Policymakers looking to improve the ICT skillset of the population are essentially requested to reform and reorient society for a technological future. Greece, now more than ever requires leadership in technological change, to ensure that it does not lag behind the digital transformation.

Legislating the ICT skillset integration in society is a multidisciplinary task that requires consistent, collective and most importantly comprehensive effort. Of course, the options of policymakers are limited, and constrained by budgetary issues as well as political power, social capital, challenges, oppositions and a system that favors inaction and rhetoric. Choosing appropriate policy is integral to achieving the ICT future Greece needs. A policy recipe should have a primary focus of public and private training of the current workforce. Spending on training will have the most immediate and substantive impact, empowering policymakers to pursue more courses of action. A secondary focus should be placed on education, skilling appropriately university students and providing the foundations for an ICT future at the primary and secondary level. A tertiary focus should be placed on facilitating business adoption of ICT through equipment and consultation, and other minor policies that affect cultural factors should fall into mix.

Greece has a wide number of ICT graduates who can act as catalysts when they join the labour force and are diffused in the productive sector. Training and advancing the digital skills of these people while taking up on the new mindset that AI and blockchain offers could boost the economy and help improve business productivity and thus spur Greece overall competitiveness.

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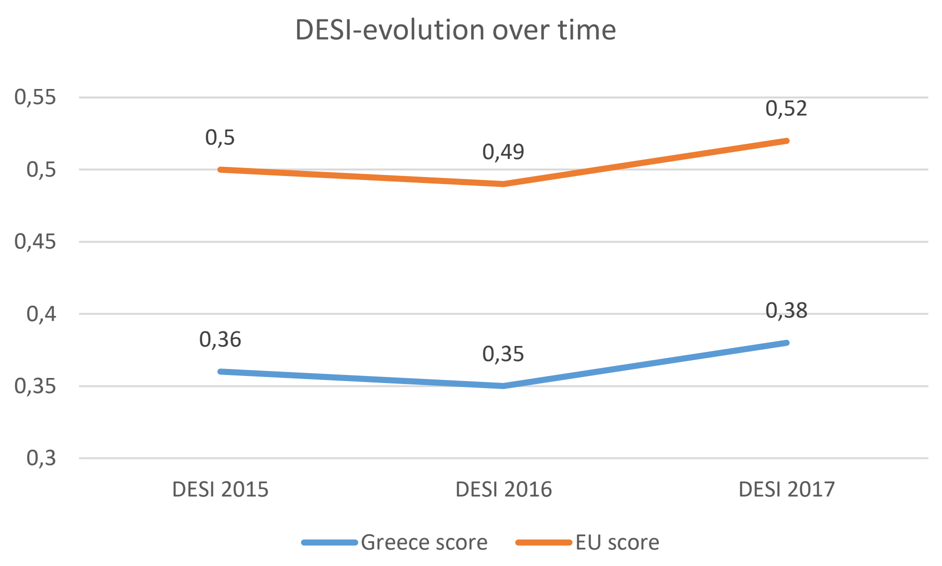
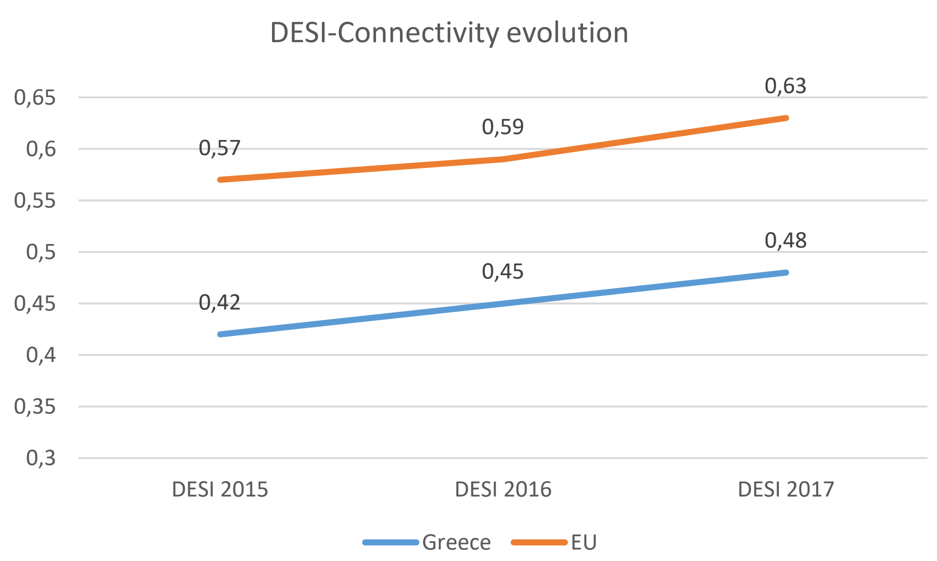
8. Appendix

Figure 18: DESI evolution over time Greece and EU28



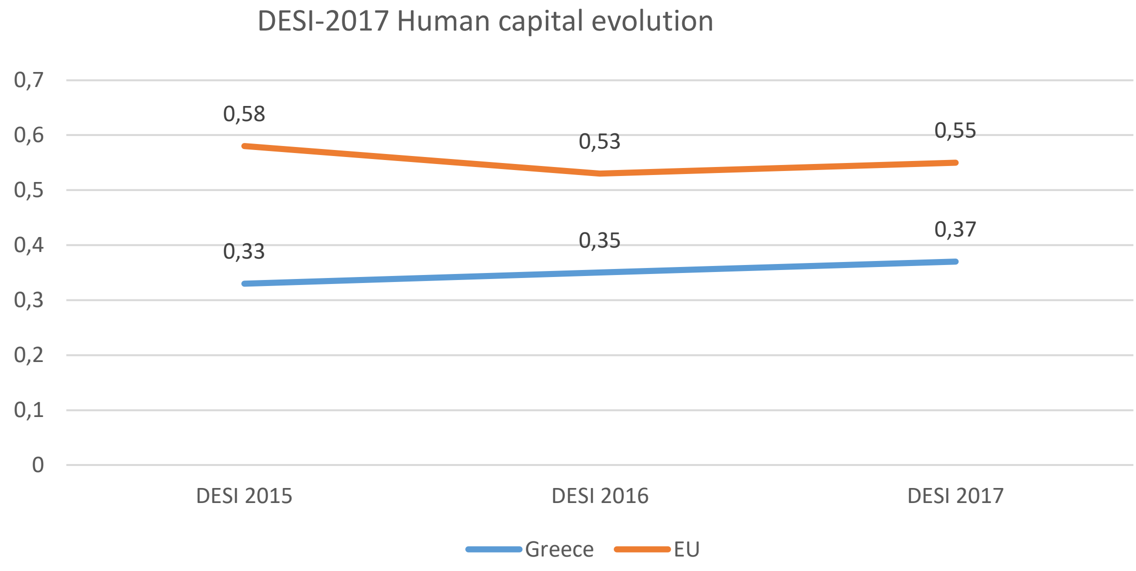
Source: Digital Economy and Society Index 2017 – Greece

Figure 19: DESI – connectivity evolution over time, Greece, EU28



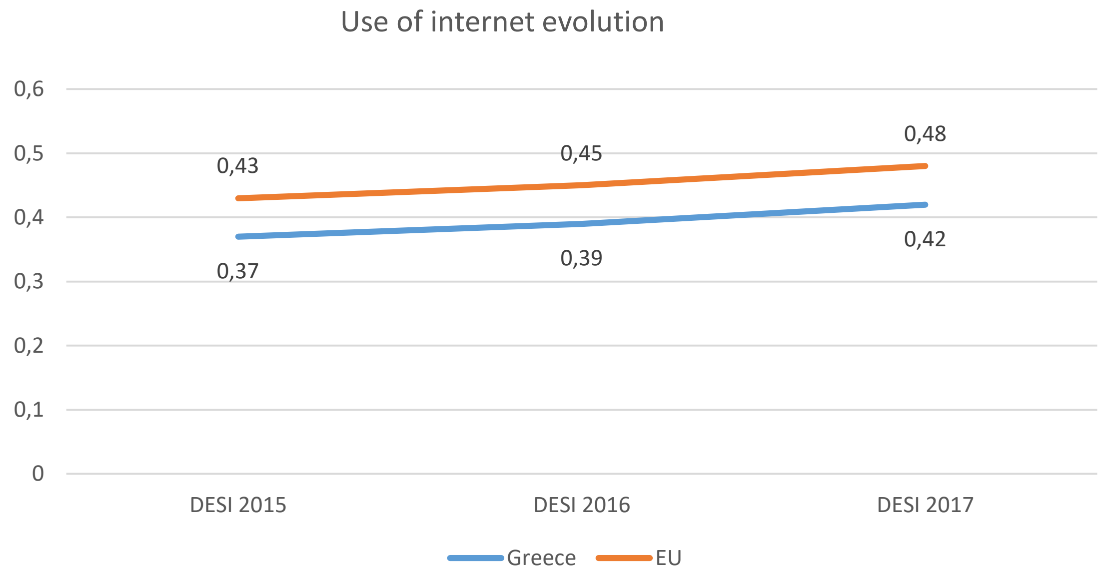
Source: Digital Economy and Society Index 2017 – Greece

Figure 20: Human Capital - evolution over time, Greece-EU28



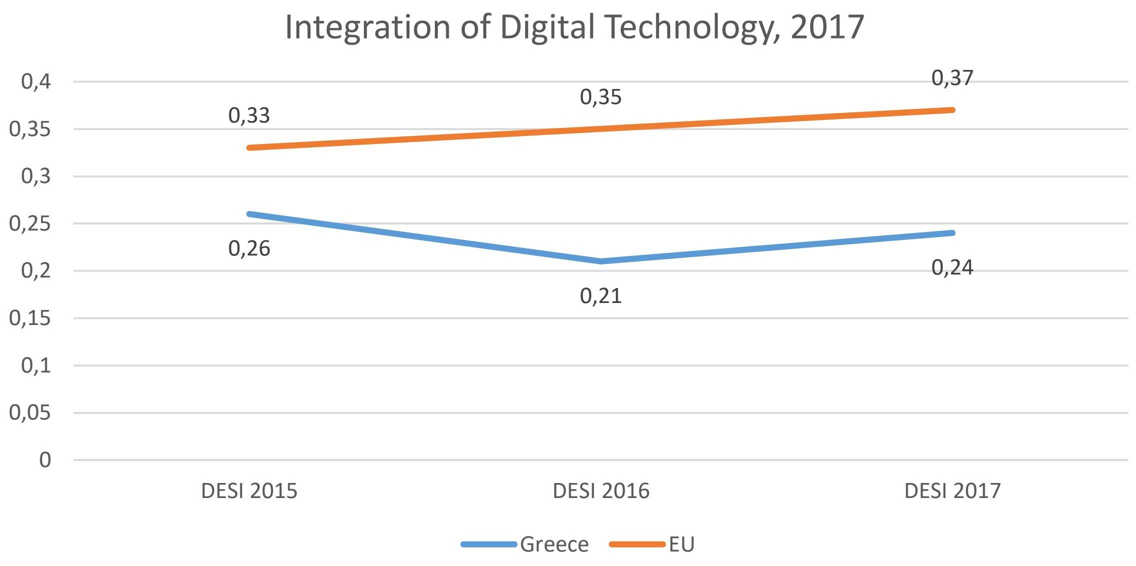
Source: Digital Economy and Society Index 2017 – Greece

Figure 21: Use of internet - evolution over time, Greece- EU28



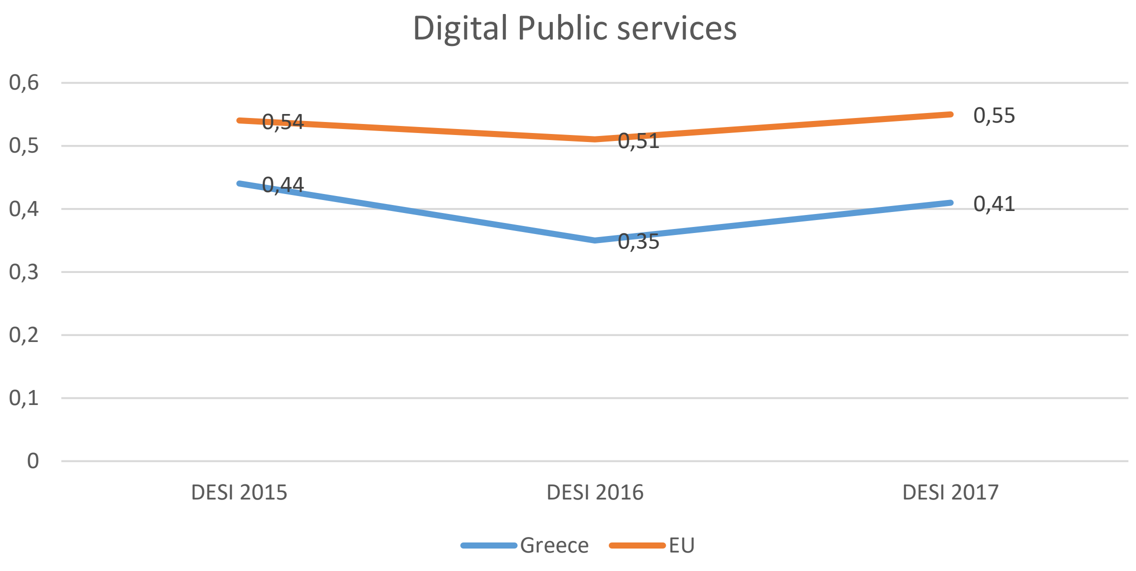
Source: Digital Economy and Society Index 2017 – Greece

Figure 22: Integration of Digital Technology - evolution over time, Greece-EU



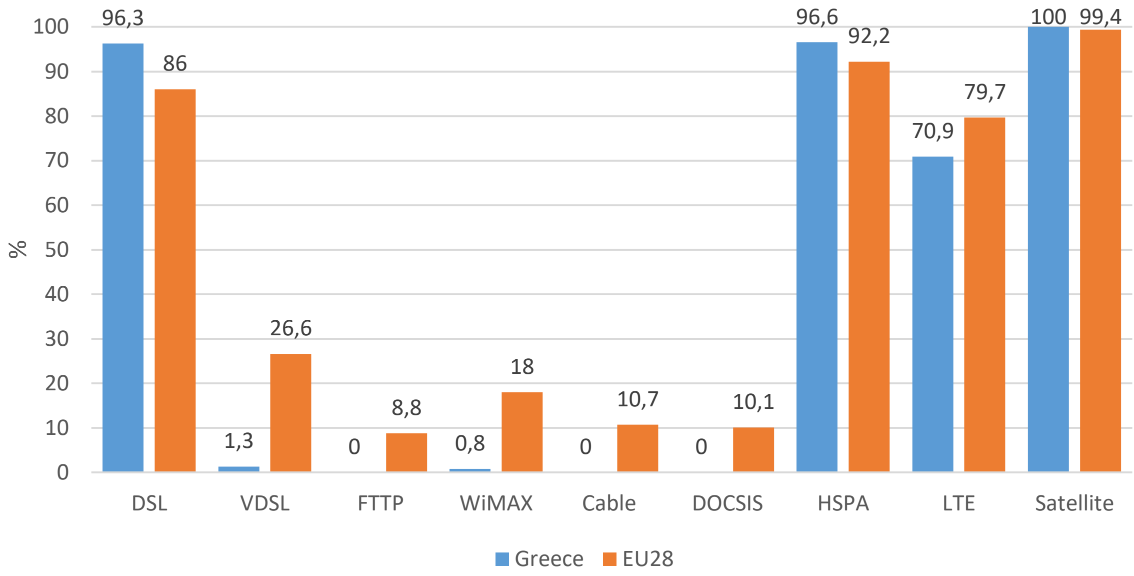
Source: Digital Economy and Society Index 2017 – Greece

Figure 23: Digital public services- evolution over time, Greece-EU



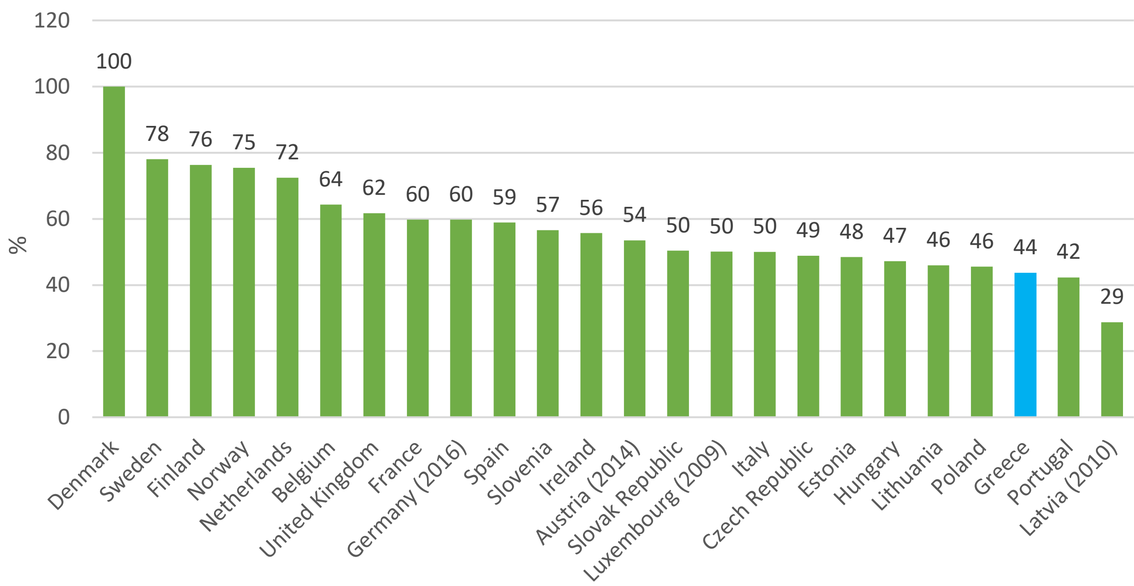
Source: Digital Economy and Society Index 2017 – Greece

Figure 24: Coverage by technology combination, 2016, rural areas, Greece-EU28



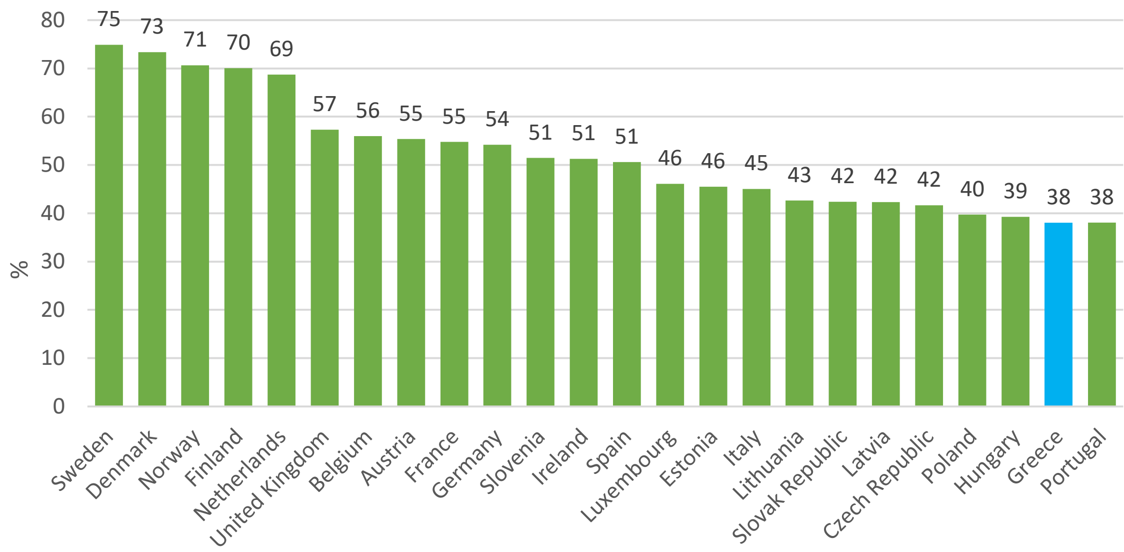
Source: Broadband in Europe 2016, a study by HIS Markit and Point Topic for the European Commission

Figure 25: Employed persons using computer in their work (%), 2017



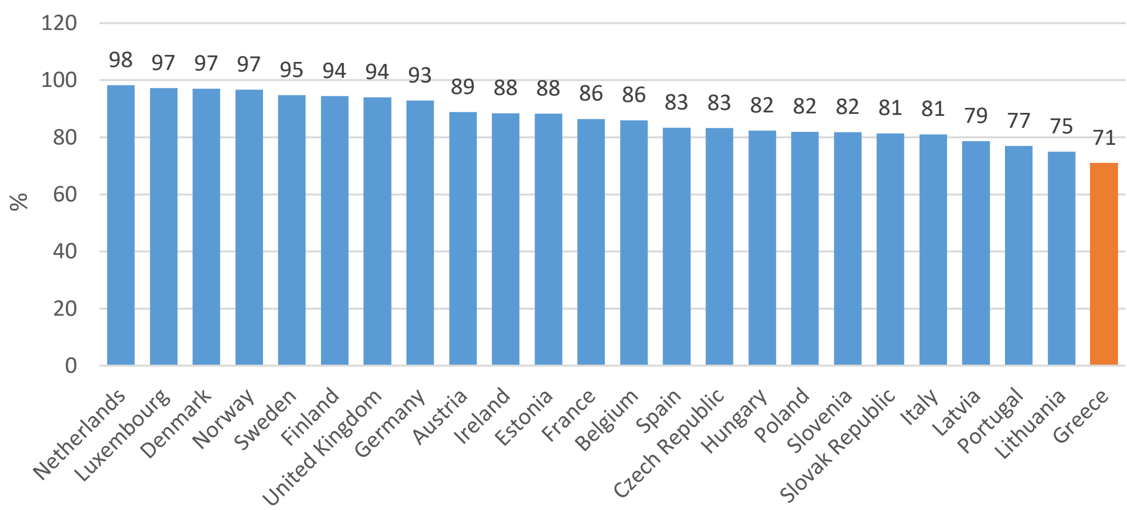
Source: OECD, Information and Communication Technology Statistics

Figure 26: Persons employed using computer with internet access in their work (%), 2017



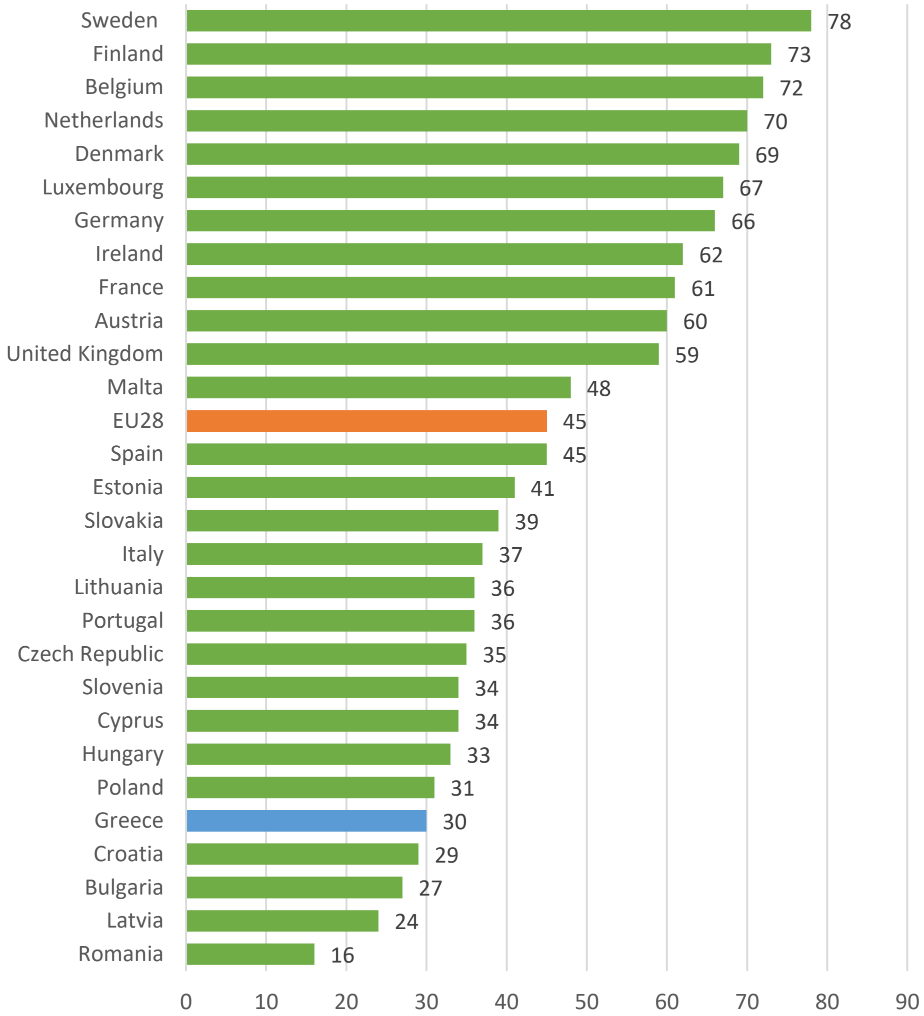
Source: OECD, Information and Communication Technology Statistics

Figure 27: Households with internet access at home (%), 2017



Source: OECD, Information and Communication Technology Statistics

Figure 28: EU Digital Transformation Enablers' Index (DTEI)

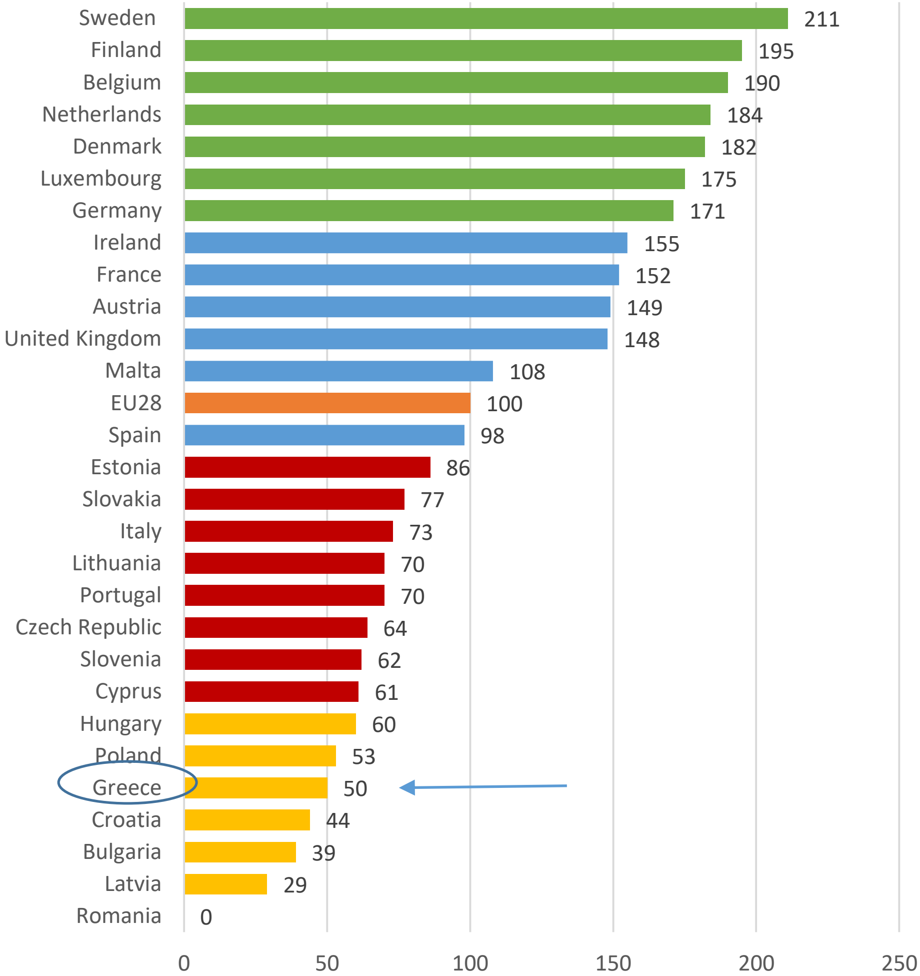


Source: Digital Transformation Scoreboard 2017

Note: The Index ranks the countries analyzed on a scale from 0 (the worst) to 100 (the best)

This Digital Transformation Enablers' Index (DTEI) provides a ranking for Member States based on the assumption that infrastructure, access to finance, and the demand and supply of skills are the most important factors driving digital transformation (with a respective weight of 20%, 30%, and 30% of the DTEI), whilst the indices on the environmental enabling conditions (e-leadership and entrepreneurial culture) are assumed to integrate the DTEI with lower weight (10% each).

Figure 29: Digital Transformation Enablers' Index and country clustering across enabling environments,2017

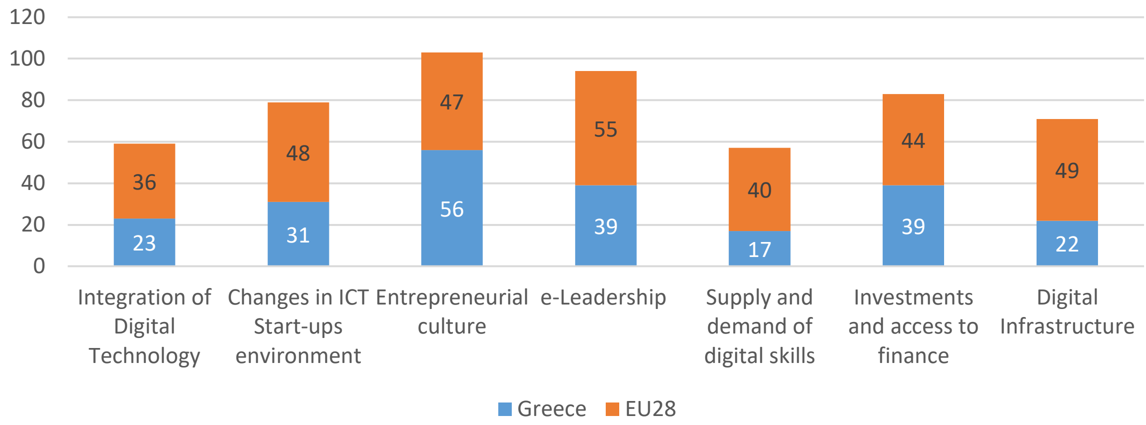


Source: Digital Transformation Scoreboard 2017

Best enabling environment	**Moderate enabling environment**
Good enabling environment	**Modest enabling environment**

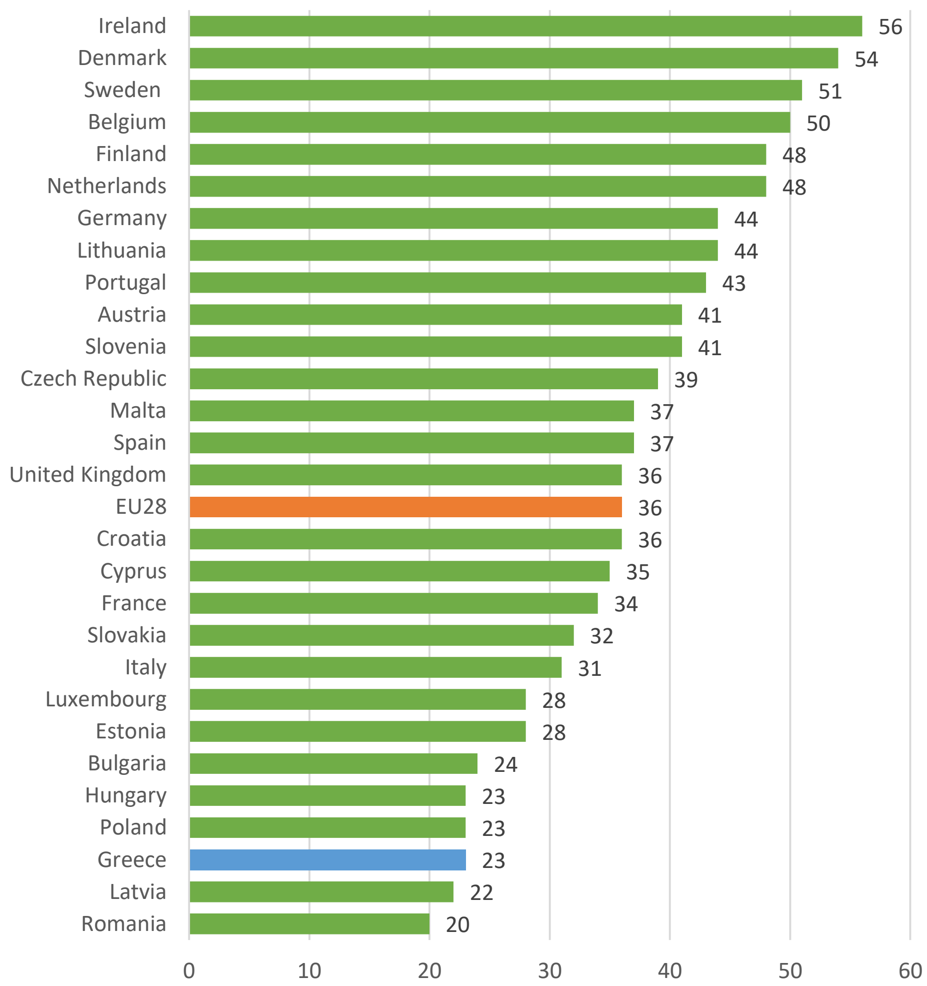
Note: Digital Transformation Enablers' Index (DTEI) comprises a linear combination of the scores associated to each country for each of the five enabling conditions (1. Digital infrastructure, 2. Investments and access to finance, 3. Supply and demand of digital skills, 4. e-leadership,) 5. Entrepreneurial culture

Figure 30: Comparison of Greece with other EU28 member states, 7 dimensions



Source: Digital Transformation Scoreboard 2017

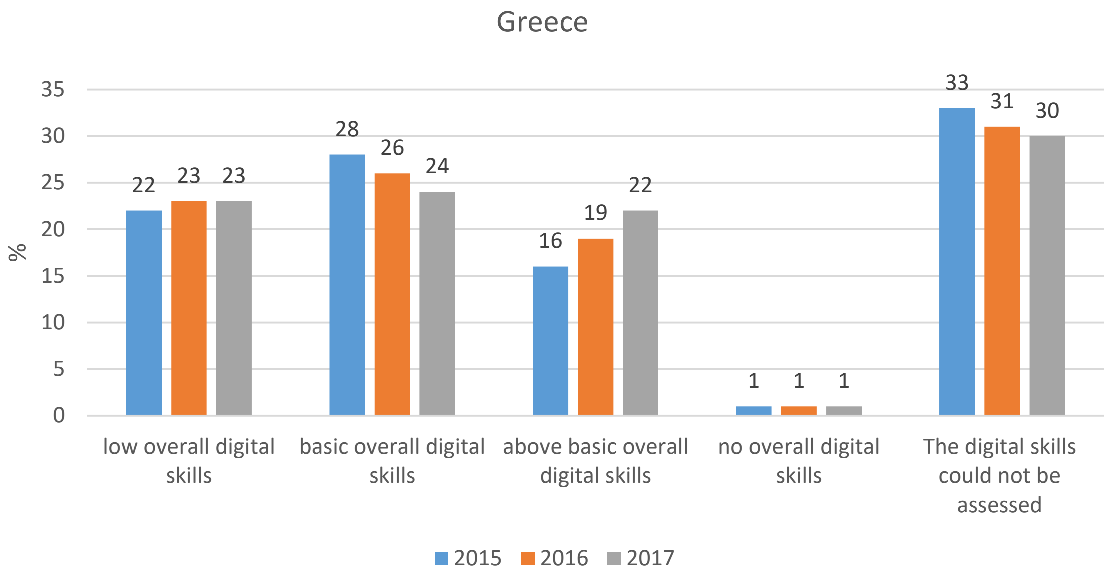
Figure 31: EU Digital Technology Integration Index (DTII)



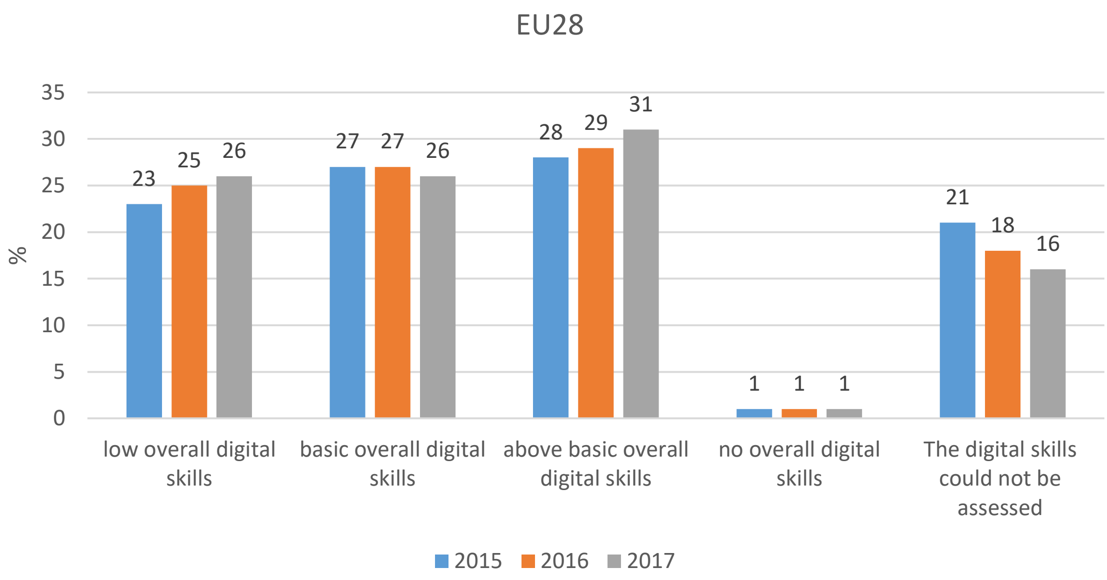
Source: Digital Transformation Scoreboard 2017

Note: The Index ranks the countries analyzed on a scale from 0 (the worst) to 100 (the best)

Figure 32: Individuals' Digital Skills Greece & EU28, (2015-2017)



Source: Eurostat



Source: Eurostat