DIGITAL COMPETENCE RATING AND ECONOMIC DEVELOPMENT IN THE EU

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Abstract. Diffusion of information and communication technologies (ICT) in different areas has accelerated the growth of the global economy. It has large impact to the business by transforming processes, creating new services, industries. ICT development requires new technologies and new approaches to innovate and integrate. The European Commission stated: "The Internet and digital technologies are transforming the lives we lead, the way we work – as individuals, in business, and in our communities as they become more integrated across all sectors of our economy and society". The access to high-speed digital infrastructures, skills of the effective usage of highly developed digital technologies represents the prerequisite productivity and the social inclusion in the digital economy.

Development of new technologies and applications demands respective skills and competences of the citizens. That also leads to problems related to measurement of the level of digitization of the economy. There are several institutions that evaluate digital competences. The Digital Economy and Society Index (DESI), developed by the European Commission, is a composite index that summarises relevant indicators on Europe's digital performance and tracks the evolution of EU member states in digital competitiveness.

The aim of the paper is an empirical verification of the assumption that ICT factors (measured by DESI components) affect national economic development. This study uses statistical and econometrical methods to examine the relationship between ICT factors, digital competence indicators and economic development in the EU through statistical evidence.

A panel data analysis confirmed significant linkage between ICT factors (infrastructure, competence, investment and trade size) and economic growth in the EU countries. Taking into consideration the digitalization trends, could be stated that there is still a huge potential for progress and growth.

Key words: *Information and Communication Technologies, Digital Competence Rating, Economic development*

JEL code: C29, O30, C02

1. Introduction

Diffusion of information and communication technologies (ICT) in different areas has accelerated the growth of the global economy. By applying digital skills and technology, the world economy is expected to generate $2 trillion of additional economic output by the year 2020 (Knickrehm, Berthon, Daugherty, 2016). The European Commission has identified that an efficiently functioning Digital Single Market could contribute €415 billion per year to countries economies and create hundreds of thousands of new jobs (Europe Commission). Thereby can be concluded that digital economy brings a significant contribution to the economic development in the future.

Researchers define the digital economy as an economy based on the wide use of ICT in terms of publication of the information, communication, and purchasing and production of hardware and software (Moroz, 2017). Raisinghani (Raisinghani, 2004) has stated that there are four basic pillars that supports the development of digital economy: technical

changes (the development of ICT), social changes caused by the popularization of the use of ICT, microeconomic level of changes, macroeconomic level of changes. Each of these areas has experienced transformation processes that have directed to the creating new services, industries, understanding, and perception. The European Commission stated that "The Internet and digital technologies are transforming the lives we lead, the way we work – as individuals, in business, and in our communities as they become more integrated across all sectors of our economy and society."(DESI report 2018). The access to high-speed digital infrastructures, skills of the effective usage of highly developed digital technologies represents the prerequisite productivity and the social inclusion in the digital economy. The European Union and its member states support the idea of developing the digital society and economy in a number of documents - like Digital Agenda for Europe, Digital Single Market Strategy etc. Additionally, European Commission presents The Digital Economy and Society Index (DESI) - a composite index that summarises relevant indicators on Europe's digital performance and tracks the evolution of EU member states in digital competitiveness.

Statistics of ICT development in the EU member states show the continuous expansion of ICT sector. Country's economy benefits of ICT development in two main ways: as ICT producer (generates economic growth, increase productivity, enhances innovations) and as ICT users (enhances efficiency of production and organization processes and facilitates innovations). (Morin, 2014) Thus, ICT factors have several effects (direct and indirect) on productivity, competitiveness, innovation, and economic growth. Scientific literature mostly is optimistic and shows ICT-initiated economic development and subsequent improvement in quality of life. However, there are some discussions about effect of ICT factors on productivity, labour market and growth, because of negative sides of internet use (time thief), higher risks of corruption etc. Empirical studies about ICT driven economic growth have produced mixed results, mainly because of the research methodology employed, measurement issues quantifying both factors and outcome.

The aim of the paper is an empirical verification of the assumption that ICT factors (measured by DESI components) affect national economic development. This study uses statistical and econometrical methods to examine the relationship between ICT factors, digital competence indicators and economic development in the EU through statistical evidence.

Empirical literature review finds that there are many attempts to evaluate how an economy can benefit from ICT progress, for instance Khan et.al. (2015) with detailed description of direct and indirect effects. Significant and positive linkage between ICT and productivity is found in Jalava & Pohjola (2007) and lot of other papers, Cardona et.al. (2013) gives nice survey of the empirical literature about this topic. Some of papers try to appreciate effect of ICT development on labour force: Frey & Osborne (2017), Cirrillo et.al. (2015) or competitiveness (Oprescu and Eleodor, 2014). Mainstream of the literature pays attention to economic growth theories and estimates impact of ICT development on economic growth: Jin &Cho (2015), Niebel (2018), Pradhan et.al. (2018) and Qu et.al. (2017) etc. Methodology and variables exploited in our analysis are described in Section 3.

The dataset for empirical calculations is taken from the European Commission reports about DESI indicators, Eurostat database and AMECO database. We use panel data: statistics for all 28 EU member states (current composition) for time period 2000-2017. Models are estimated using computer software program EViews.

The rest of the papers is organized as follows: section 2 reviews measurements of digital economy performance and results for EU countries. Section 3 presents model description, variables, and dataset and modelling results. Section 4 concludes.

2. Measurements of Digital economy performance

Researchers define the digital economy as an economy based on the wide use of ICT in terms of publication of the information, communication, and purchasing and production of hardware and software (Moroz,2017). Thereby the most

important characteristics of digital economy are related to degree of use of ICT, the growth of it, their impact on individuals, society, institution, they adaption by individuals, society, institution, evaluation of digital competencies.

There are more than twenty widely used e-indexes used to measure ICT adoption all over the world (Kononova,2015). To name some the most popular are: Information Society Index (developed by IDC), E-Readiness Index (developed by EIU), Knowledge Economy Index and Networked Readiness Index (both developed by World Economic Forum - WEF). Several indices are developed by International Telecommunication Union (ITU): ICT Development Index, Digital Access Index, Digital Opportunity Index, ICT Opportunity Index). European Commission researchers have developed one of the newest one in year 2014: Digital Economy and Society Index (DESI). This may reflect the period in which the expectations of the digital economy were the biggest (Kononova,2015). DESI is calculated based on the statistical data collected by the European Commission's Directorate for communication networks, content, and technology and IHS company, which represents a composite index that summarizes more than 30 significant economic indicators. It uses a weighting system to rank each country based on its digital performance with the aim to benchmarking the development of the digital economy and society. Latest DESI measures the digital economy performance of EU28 Member States and the EU as a whole in comparison with 17 other countries around the world (Australia, Brazil, Canada, Chile, China, Iceland, Israel, Japan, Mexico, New Zealand, Norway, Russia, Serbia, South Korea, Switzerland, Turkey and the United States). DESI utilises 24 datasets to enable trend analysis and comparison of the digital performance of 45 countries. The data included in DESI was mostly collected by the European Commission services - DG Connect and Eurostat8 and by ad-hoc studies launched by the Commission services. It is one of the main analytical tools developed by DG CNECT to provide evidence-based input for the assessment of digital development in the EU as a whole as well as in Member States. (Europe Commission)

Table 1

DESI dimensions and their relative importance

Dimension	Description	Sub-dimension
1 Connectivity	The deployment of broadband infrastructure and its quality Weight 25%	Fixed Broadband (weight 33%)
		Mobile Broadband (weight 22%)
		Speed (weight 33%)
		Affordability (weight 11%)
2 Digital skills (Human capital)	The skills needed to take advantage of the possibilities offered by a digital society Weight 25%	Basic Skills and Usage (weight 50%)
		Advanced skills and Development (weight 50%)
3 Citizen use of Internet	The variety of activities performed by citizens already online Weight 15%	Content (weight 33%)
		Communication (weight 16,5%)
		Transactions (weight 33%)
		Ubiquitous use (weight 16,5%)
4 Business technology integration	The digitisation of businesses and development of the online sales channel Weight 20%	Business digitisation (weight 60%)
		eCommerce (weight 40%)
5 Digital Public Services	The digitisation of public services, focusing on eGovernment Weight 15%	eGovernment (weight 100%)

(Authors representation based on European Commission DESI 2018 report)

As it is shown in the Table 1, there are 5 dimensions in the DESI:

- Connectivity: The deployment of broadband infrastructure and its quality;
- Digital skills: The skills needed to take advantage of the possibilities offered by a digital society;
- Citizen use of Internet: The variety of activities performed by citizens already online;

- Business technology integration: The digitisation of businesses and development of the online sales channel;
- Digital public services: The digitisation of public services, focusing on eGovernment.

The DESI aims to help EU countries identify areas requiring priority investments and action in order to create a truly Digital Single Market, it shows gaps between the performance and capabilities of different Member States.

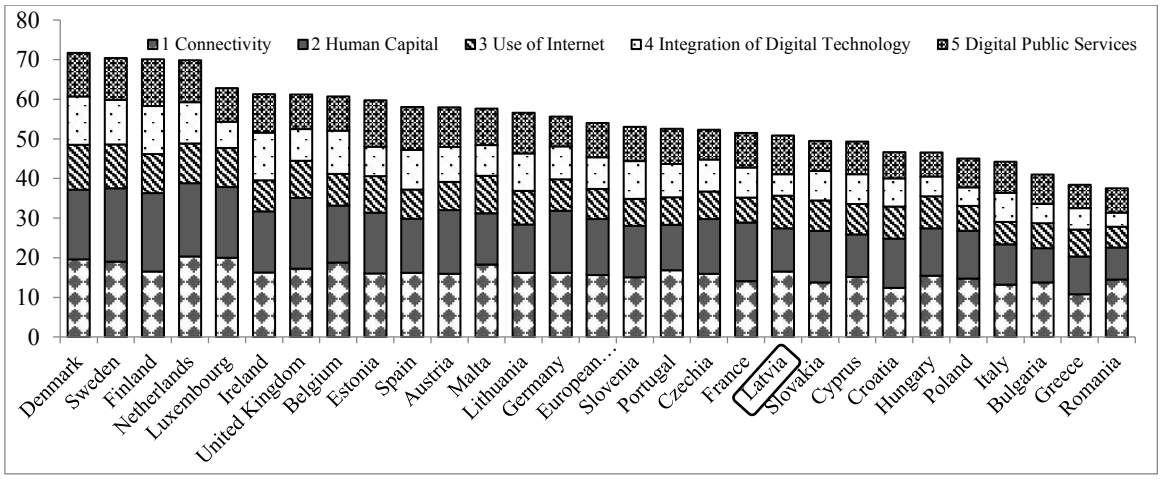

Fig.1. **Digital Economy and Society Index (DESI) 2018 ranking (Source: European Commission DESI report 2018)**

As it is shown in the figure 1, the most advanced digital economies in the EU are Denmark, Sweden and Finland. Our neighbour countries Estonia and Lithuania also have good results – above EU average level. Latvia's performance in 2018 is below EU average. Latvia belongs to the medium performing cluster of countries, and over the last two years Latvia is in the 19th position. (DESI report 2018). Next figure (fig.2) allows to recognize weakest points in digital economic performance in the Baltic countries and EU28 average. The weakest position for Latvia is sub-component of DESI, which measures performance in the Integration of Digital Technologies. Value for this position is 27points in 2018 (EU average was 40.1), what places Latvia in 23rd position among EU28 (in 2017 LV was in 25th position, so this is a good progress). Improvement was achieved through increase in the proportion of enterprises purchasing cloud computing services. European Commission suggests developing strategy for the digitization of businesses, as there are relatively few enterprises selling online across borders. Survey results suggest that this is because of high costs.

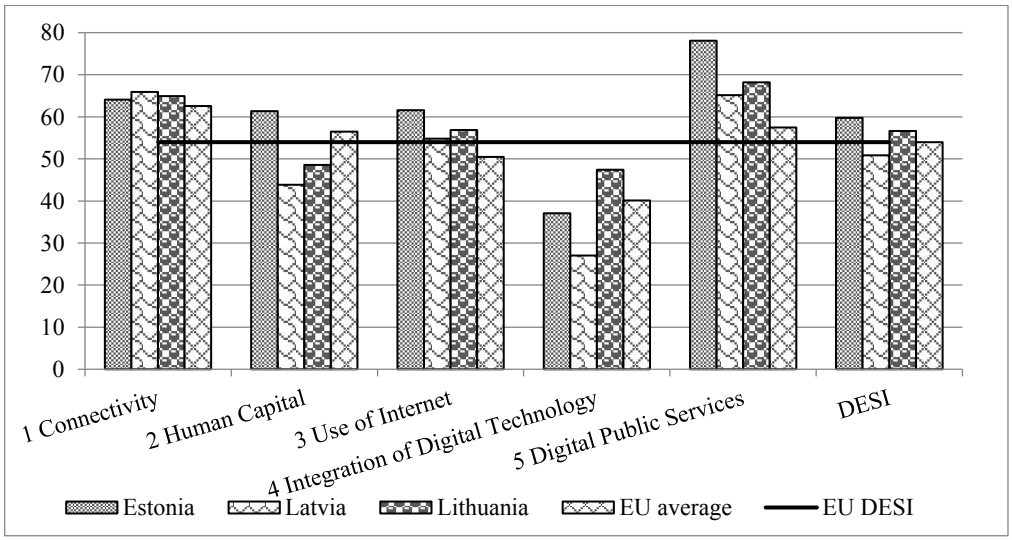

Fig.2. **Latvia's performance comparison in digital development**

(Authors representation based on European Commission DESI report 2018)

Other position with place for improvement in Latvia is the Human Capital area, what is weak also in Lithuania. This component considers several sub-positions describing labour force and citizens in overall. Weak performance was in percentage of individuals with at least basic digital skills. This is one of key competences individual need to use benefits of the digital economy. Other position with results well below EU average is the number of ICT specialists. The proportion of STEM graduates has been decreasing in recent years in Latvia. Speaking about human capital, Latvia's authorities (ministries and associations etc.) do a lot in this area, but effect of projects and measures in this field may take some time to appear in real situation improvement.

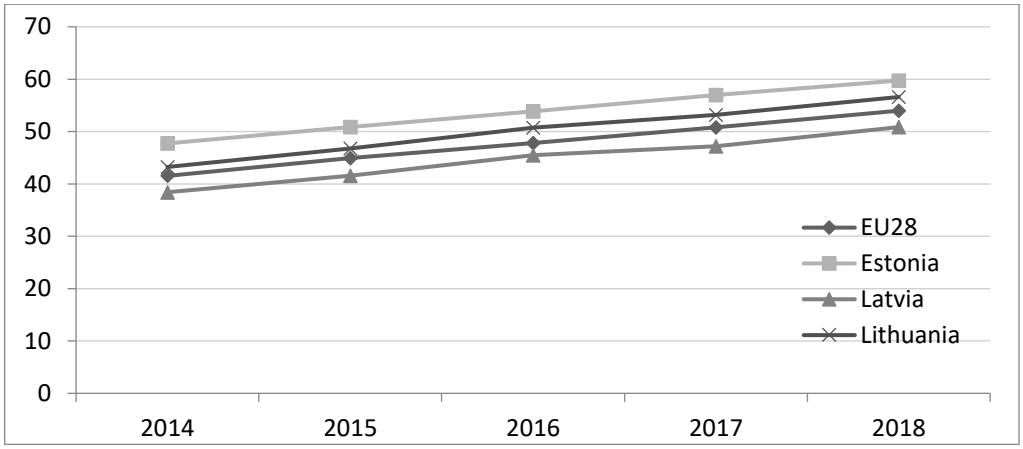

Fig.3. **DESI evolution over time in Latvia, Estonia and Lithuania. Comparison with EU28 average.**

(Authors representation based on European Commission DESI report 2018)

Other aspect of DESI is possibility to evaluate individual country's progress. Figure 3 depicts DESI evolution in the Baltic countries over time. All countries and EU28 average indices have increased over time, showing effectiveness of ICT politics in this region.

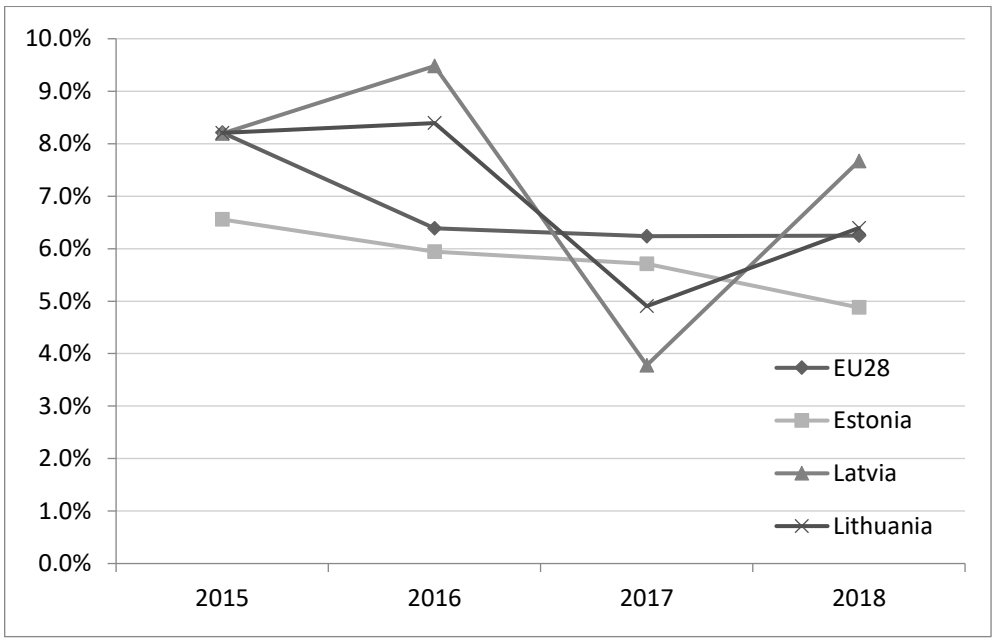

Fig.4. **DESI changes % to previous year**

(Authors calculation based on European Commission DESI report 2018)

But Figure 4 shows that the changes for Latvia have not been smooth. If EU28 average DESI increase in the last years is about 6.2% in a year, Latvia in year 2017 compering to year 2016 has increased DESI only 3.8%. It is good that there is an increase again in the last year that exceeds the average growth rate.

3. ICT factors and economic growth: an empirical analysis

To estimate the ICT impact on economic growth several indicators from DESI database were used. As DESI index is calculated just from 2014, and it is aggregated from several components, for the modelling we use separate DESI components. Data is collected from DESI database (if available), other variables are from Eurostat and AMECO.

Dependent variable representing economic growth is log of GDP per person employed. To catch ITC development's impact on economic growth, we have chosen classical production function approach, additionally involving ICT factors in the model's right-hand side.

Table 2

Modelling results

Dependent variable: log of GDP per person employed		
Variables	Coefficients Model (1)	Coefficients Model (2)
Log of Digital Public Services	0.115 *** (0.027)	0.100*** (0.019)
Log of Connectivity	0.127*** (0.031)	0.011 (0.02)
Log of Business technology integration	0.058*** (0.021)	0.056*** (0.014)
Log of Digital skills	0.334*** (0.071)	0.286*** (0.038)
Log of Use of internet	0.031 (0.039)	-0.028 (0.023)
Log of Capital stock per person employed		0.445*** (0.052)
Constant	8.48***	0.845***
Adjusted R square	0.928	0.967

Source: Authors' calculation.

Notes: *** p-value <0.01; ** p-value<0.05; * p-value<0.1. Numbers in the brackets are standard errors.

Balanced panel data regressions were estimated with EViews, using fixed effects for countries. Because of heterogeneity of data, White diagonal standard errors and covariances are used. Modelling results are described in the next – concluding section.

Conclusions, proposals, recommendations

Along to the traditional economic models emphasizing the importance of human capital, financial capital and technology in economic growth process, there are more and more scientific discoveries showing that the digital economy brings a significant contribution to the economic development. The Organization for Economic Co-operation and Development (OECD) indicates that productivity in business is growing by 5– 10% year to year using ICT (OECD, 2016).

Estimating digitization effects one of challenging tasks is measurement of digital economic performance and its development. Digital Economy and Society Index (DESI) is one of quite good examples. DESI allows rating countries according to their ICT development performance. Latvia is ranked in the middle cluster, taking 19th position between 28

EU countries. Now weakest positions are Human Capital and Integration of Digital Technologies. Respective authorities perform projects for improvement, but materialization of effects takes time.

In this paper empirical evaluation of impact of different ICT factors on GDP growth is realized via panel data regression modelling taking DESI dimensions as cross-sectionally comparable measurements. DESI indicator has five dimensions: broadband infrastructure, digital competences (measured as digital skills), use of internet, business technology integration (business digitization and eCommerce) and digital public services (mainly eGovernment). Panel data models are estimated with several specifications, keeping change in log of GDP as dependent variable (representing economic growth). In all specifications we have found highly significant positive effect of ICT investment. This conclusion is in line with previous empirical research papers.

Other finding from modelling is significance of human capital. Jin & Cho (2015) for basic model specification concluded that human capital (measured as proportion of ICT specialists) has no effect on economic development, and only adding control variables (higher national transparency and management of consumer inflation) this was found as important factor. In our model human capital variable describes digital skills of employment. It is found to be statistically significant factor.

It is not surprising that variable Use of internet is insignificant. Just use of internet (for example, reading news, using social networks etc.) is not generating any value added.

It is necessary to proceed analysis exploiting firm level data to better understand spillovers and externalities of ICT.

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