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MOBILE INTERNET IN THE EU: PROBLEMS AND PERSPECTIVES

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Abstract. Mobile communication has become a taken for granted condition of people's everyday lives. Internet and mobile technologies have changed our way of both doing business and dealing with our daily routine activities. Researchers have increasingly focused on the impact of the level Internet, i.e. mobile Internet level on national economies. Mobile Internet rapidly been integrated not only into people's daily lives, but also into the daily lives of companies, organizations, administration. The aim of the present research is to perform a statistical study and assessment of the level of mobile Internet development in Latvia in the context of the EU countries in the period from 2014 to 2019 years. The Mobile Connectivity Index measures performance of 150 countries according the four key enablers of mobile Internet connectivity: infrastructure (i.e., the availability of high-performance mobile internet network coverage), affordability (i.e., availability of mobile services and devices at price points that reflect the level of income across a national population), consumer readiness (i.e., citizens with the awareness and skills needed to value and use the internet) and content (i.e., availability of secure online content and services accessible and relevant to the local population). The study analyzes the impact of the Mobile Connectivity Index on the Latvian economic growth, makes recommendations for improving the Internet and mobile technologies as an endogenous factor of economic development.

Keywords: Mobile Internet; Latvia; GSMA Mobile Connectivity Index

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1. Introduction

Mobile Internet represents an emerging information technology that came out of the application of third generation (3G) mobile communication technologies. Some regard mobile Internet as wireless Internet that requires going online using a mobile phone or an extension of PC-based Internet. It is expected that mobile Internet allows people to perform the same tasks that they do via fixed, conventional Internet. Mobile Internet has benefited individuals and organizations in many ways such as in communication, education, healthcare, commerce, advertising, social network, entertainment and government (Sadiku et. al., 2017; Trubnikov, 2019; Aleksejeva et al., 2021; Torkayesh, 2021; Du et al., 2020; Jiang et al., 2021; Fakunle, Ajani, 2021).

Use of the Internet has exploded in recent years. Rapidly evolving network and computer technologies, coupled with exponential growth of services and data available on the Internet, enable hundreds of millions of people to have fast access to a huge amount of information from anywhere and everywhere (Otsetova, Otsetova-Dudin, 2019; Ronaghi, Forouharfar, 2020). According to experts' forecasts, in 2025 the mobile industry will reach new major milestones across key indicators – unique subscribers, Internet users and 4G/5G connections. The number of mobile subscribers will reach 5.9 billion by 2025, which is equivalent to 71% of the world's population (GSMA Intelligence, 2019). The COVID-19 pandemic has accelerated digital transformation around the world. The rapid transition of education, medical services, e-commerce to the online environment, as well as popularization of remote work have contributed to the development of the mobile Internet (Moreno-Llamas et.al 2020; Delaporte, Bahia, 2021).

The most critical driver from demand side is a sharp evolution and usage of mobile equipment – smartphones, media tablets, dongles (PCs, laptops, notebooks), M2M devices (Čerņakovs-Neimarks et al., 2013).

ICT also stimulate progress in entrepreneurship, innovation and positively affects society as a whole (George, Merrill, Simon, 2021). The period between 2019 and 2020 saw an increased use of Internet platforms, with e-commerce usage increasing from a global average of total retail equaling 9.5% in 2019 to 12.4% in 2020. Thus, there has been an increase in the use of Internet platforms in terms of downloads of mobile applications by smartphone users: the use time of applications in India, Mexico, Turkey and the United States was 4.2 hours per day, which is 30% more than two years ago. At the same time Brazil, Indonesia and the Republic of Korea hit five hours of mobile app usage (Redseer Consulting, 2021; Kristianto, 2021).

2. Methodology

In 2014 GSMA Corporation stared to calculate Mobile Connectivity Index. The measures performance of 150 countries, accounting for 98% of the world's population, against the four key enablers of mobile Internet connectivity: infrastructure, affordability, consumer readiness and content (GSMA Mobile…, 2020). (See Table 1).

Table 1. Mobile Connectivity Index

Infrastructure	Affordability	Consumer readiness	Content
1. Mobile infrastructure; 2. Network performance; 3. Other enabling infrastructure; 4. Spectrum	1. Mobile tariffs; 2. Handset price; 3. Income; 4. Inequality; 5. Taxation.	1.Basic skills; 2.General equality.	1. Local relevance; 2. Availability

Source: GSMA Mobile Connectivity Index, Available at: https://www.mobileconnectivityindex.com/, 2020

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Each final rating is derived from four key indicators. The enablers of mobile internet connectivity that provide the indicators selected for the Index are: 1. Infrastructure (i.e., the availability of high-performance mobile internet network coverage); 2. Affordability (i.e., availability of mobile services and devices at price points that reflect the level of income across a national population); 3. Consumer readiness (i.e., citizens with the awareness and skills needed to value and use the internet); 4. Content and Services (i.e., availability of secure online content and services accessible and relevant to the local population) (Bahia, Agnoletto, 2020).

As the Mobile Connectivity Index is an input index, it has to be underlined that each indicator within its framework is an 'input' for mobile internet connectivity rather than an output or outcome (e.g., measuring the level of take-up). It is also important to develop a set of criteria against which each indicator can be considered for inclusion in the Index. The following criteria have therefore been developed by the authors of the Index, based on guidance from the JRC and OECD. It includes:
- Relevance (the indicator should measure a barrier or an enabler in the take-up of mobile internet services);
- Accuracy (the indicator should correctly estimate or describe the quantities or characteristics they are designed to measure);
- Coverage (the data should cover as many countries as possible, as the Index is intended to be a global one Therefore, an indicator is not included into analysis if there is missing data on more than 25% of countries in the Index);
- Timeliness (the data should be collected consistently over time).
As it can be seen from the abovementioned criteria, the main point is to include, to the greatest extent possible, 'hard' indicators that are objective and can be quantified (Ibid).
For implementation of normalisation for the Mobile Connectivity Index, the minimum-maximum method is used, which transforms all indicators so that they lie within a range between 0 and 100, with the following formula:

$$I_{q,c} = \frac{x_{q,c} - min_c(x_q)}{max_c(x_q) - min_c(x_q)}$$

Where 'I' is the normalised min-max value, 'x' represents the actual value and the subscripts 'q' and 'c' represent the indicator and country respectively (Bahia, Agnoletto, 2020).

In order to aggregate indicators into dimension scores (in its turn, dimension to enabler scores and enabler scores to an overall index score), it is necessary to assign a weight to each component of the index. To construct the weights at the dimension, enabler and overall index level, a number of considerations have been taken into account by the developers of Methodology (Bahia, Agnoletto, 2020), including:
- Statistical relationship between indicators and dimensions concerning mobile internet penetration;
- Analysis of consumer survey responses regarding perceived barriers to mobile internet access;
- Principal component analysis to identify weights that correct for the overlapping information implied by grouping indicators that are correlated (rather than representing a measure of importance);
- Research carried out by the GSMA and other organisations on digital inclusion and barriers to mobile connectivity;
- Qualitative research.

Once weights have been assigned to the indicators, dimensions and enablers, they need to be aggregated to produce the relevant composite scores. Two methods of aggregation were employed: arithmetic – for dimension and enabler aggregation and geometric – for index aggregation (Bahia, Agnoletto, 2020). At the same time the main methods used by the authors of the present research to study the development of mobile Internet in Latvia in the context of the European Union countries included comparison of average indicators of the EU member states and cluster analysis.

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Researchers are studying the relationship between Internet technology and economic growth in several ways. Gruber H., Hätönen J., Koutroumpis P., as well as Katz R., Callorda F. (Gruber et al. 2014, Katz, Callorda, 2018) study this issue with the help of Structural Equations Models; Czernich N., Falck O., Kretschmer T., Woessmann L., Edquist H., Goodridge P., Haskel J, Li X., Lindquist E. – with the use of Instrumental Variables (Czernich et al., 2011, Edquist et al., 2018); Arvin B. M., Pradhan, R. P. и Giday G. employ Dynamic Panel Data models (Arvin, Pradhan, 2014; Giday, 2019). Edquist H., Goodridge P., Haskel J., Li X., Lindquist E. (Edquist et al. 2018) have studied 135 countries from 2002 to 2014, established that there is a statistically significant impact of broadband on GDP (a 10 percent increase in mobile broadband adoption translates into a 0.8 percent increase in GDP), with the impact waning over time. Amiri S., Reif B. (Amiri, Reif, 2013), examined the time series in the Nordic region, also found that the introduction of the Internet was a direct driver of GDP growth in the economy.

Andrianaivo M., Kpodar K. (Andrianaivo, Kpodar, 2012) examined the impact of mobile phone development on economic growth in a sample of African countries during the period 1988-2007 and found that mobile phone development (as measured by mobile phone penetration and the price of phone calls) contributed to economic growth in Africa.

Other researcher (Minges, 2016) concluded that a 10 percentage point increase in fixed broadband penetration increased GDP growth by 1.21% in developed economies and 1.38% in developing ones. However, while the coefficient was significant at the 1 percent level for developed economies, the significance was only 10% for developing economies. The R for the regression was 0.49.

A study of the countries in North and South America found that a 10% increase in fixed-broadband penetration would result in a 1.9 percent increase in GDP per capita. In addition, pricing remains a key driver for broadband adoption, with a 10% drop in prices boosting it by more than 3.0%. (Katz, Callorda, 2019).

Studies based on econometric model using data from 139 countries between 2007 and 2018 provide strong evidence of the importance of information and communication technology (ICT) as a driver of economic development (Katz, 2020). It is established that mobile broadband provides a greater economic contribution than fixed broadband; developing countries benefit more from mobile broadband than industrialized countries; developed countries with high fixed-broadband penetration rates benefit from technology more than developing countries; the economic contribution of digitalization, which includes not only the introduction of ICT, but also their use, more in advanced economies than in developing countries, ICT contributes significantly to increasing labor productivity and overall factor productivity; ICT is accelerating beyond an initial time lag when political and institutional support is driving structural change (Katz, 2020b; Katz, Callorda, 2018). The early adopters of broadband benefit more from the introduction of mobile broadband. The impact on the national economy reaches its maximum when investments in broadband infrastructure reach certain levels: after that, the impact on the economy slows down. Gruber and Koutroumpis (2011) found that the impact of mobile Internet on GDP growth correlates with increased wireless penetration until penetration reaches 60 percent, after which the effects tend to subside. In countries with low GDP per capita, mobile broadband is a technology with great economic impact (Katz, 2020b). Other researchers also confirm that the benefits of broadband may vary from region to region (Haller, Lyons, 2019).

Studies on the causal relationship between broadband penetration and economic output indicate a non-linear relationship between the two (in the form of an inverted U). With low broadband penetration rates, the economic impact of broadband is minimal. The impact of telecommunication infrastructure on production volumes becomes maximum only when the infrastructure reaches certain values. Therefore, countries with low economic development need to strive to significantly increase broadband penetration. (Katz, 2020b).

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Thus, studying the impact of the Mobile Connectivity Index on GDP should be based on the endogenous growth theory, which takes into account the impact of technological progress on economic development. (Gordon, 2009; Romer, 2007).

4. Research results

After analyzing the GSMA Mobile Connectivity Index data, it was established that in the period from 2014 to 2019 years. Latvia's rank among the EU countries fell from the 17th to the 24th place, though with a slight increase in the absolute values of the Index (see Figure 1).

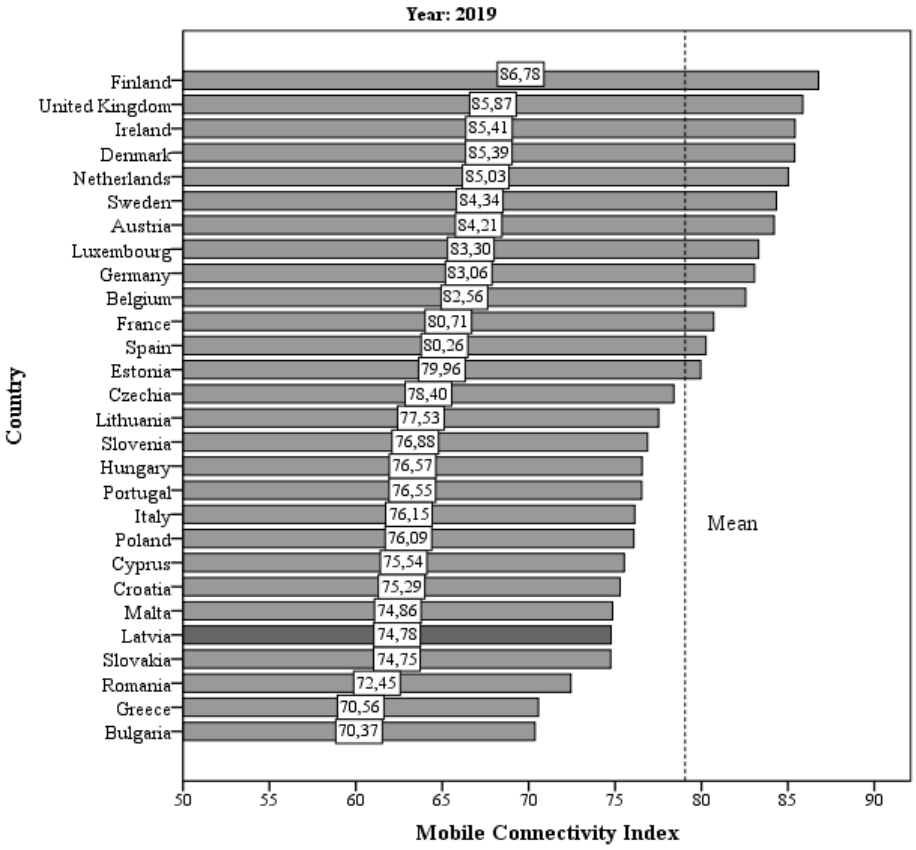

Figure 1. Absolute values of the GSMA Mobile Connectivity Index in the EU countries in 2019 (https://www.mobileconnectivityindex.com/#year=2019)

Even among the three Baltic countries, in 2014 Latvia, possessing the absolute Mobile Connectivity Index of 68.03, surpassed Lithuania (66.88) and was closer to Estonia (71.10). However, in 2016 the Lithuanian index was equal to the one of Latvia (72.06). What is more – in the period from 2017 to 2019 yy., the value of the index in Lithuania increased from 73.54 to 77.53, while in Latvia the values of the index in the same period were 73.28 and 74.78 respectively. These observations are demonstrated in Figure 2.

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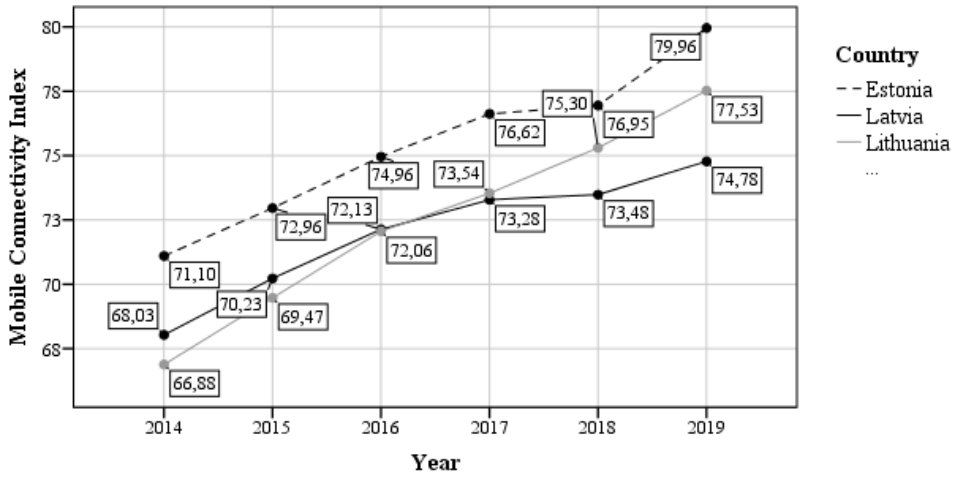

Figure 2. Absolute values of the GSMA Mobile Connectivity Index in Latvia, Lithuania and Estonia in the period from 2014 to 2019 years.

Source: Mobile Connectivity Index (https://www.mobileconnectivityindex.com/#year=2019)

Moving on to the situation in the EU countries on the whole, it has to be mentioned that Latvia, Slovakia, Romania, Greece and Bulgaria were among the five outsiders in terms of the index value in 2019. At the same time leading positions were taken by Finland, England, Ireland, Denmark, the Netherlands.

Upon the analysis of the values of sub-indices the following was established: in terms of "Infrastructure" Latvia's position fell from the 9th to the 15th place; in terms of "Content and Services" – from the 22nd to the 26th place. The situation is somewhat better in terms of "Affordability" sub-index, where the 24th place were retained by Latvia with no changes. Finally, according to the values of the "Consumer Readiness" sub-index, Latvia has improved its rank in the EU from the 12th to the 5th (see Table 2).

Table 2. Absolute and rank values of the Mobile Connectivity Index along with its sub-indices in Latvia in 2014 - 2019 years.

	Year					
	2014	2015	2016	2017	2018	2019
Mobile Connectivity Index	68,03	70,23	72,13	73,28	73,48	74,78
Rank	17	16	18	21	22	24
Infrastructure	65,04	71,03	74,20	76,36	75,88	77,25
Rank	9	9	13	14	13	15
Affordability	63,16	62,97	64,13	64,85	63,50	66,41
Rank	24	25	24	23	25	24
Consumer Readiness	88,09	88,83	89,75	90,71	91,61	91,92
Rank	12	10	6	6	5	5
Content and Services	59,19	61,22	63,40	64,22	66,05	66,30
Rank	22	22	21	22	24	26

Source: Authors' calculations in SPSS software according to the Mobile Connectivity Index sub-indices values in 2019 (https://www.mobileconnectivityindex.com/#year=2019)

To determine the dynamics of the Mobile Connectivity Index development according to selected sub-indices a comparative analysis was carried out according to spatial and temporal characteristics. To that end, the clustering of countries (in 2019) was carried out. Cluster analysis was used to carry out the classification.

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According to the hierarchical classification, two groups of countries were identified. Using the k-means method, the features of each cluster were established (Appendix 1). Thus, the first group with average value for the Infrastructure sub-index equaling 75.06, Affordability – 69.10, Consumer Readiness – 86.75, Content and Services – 71.19, included such countries as: Bulgaria, Croatia, Cyprus, Czechia, Greece, Hungary, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia. While the second group with higher averages, particularly, for Infrastructure equaling 81.57, Affordability – 79.04, Consumer Readiness – 90.21, Content and Services – 84.31, included the following countries: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Luxembourg, Netherlands, Spain, Sweden, United Kingdom. The differences between the two clusters are displayed in Figure 3.

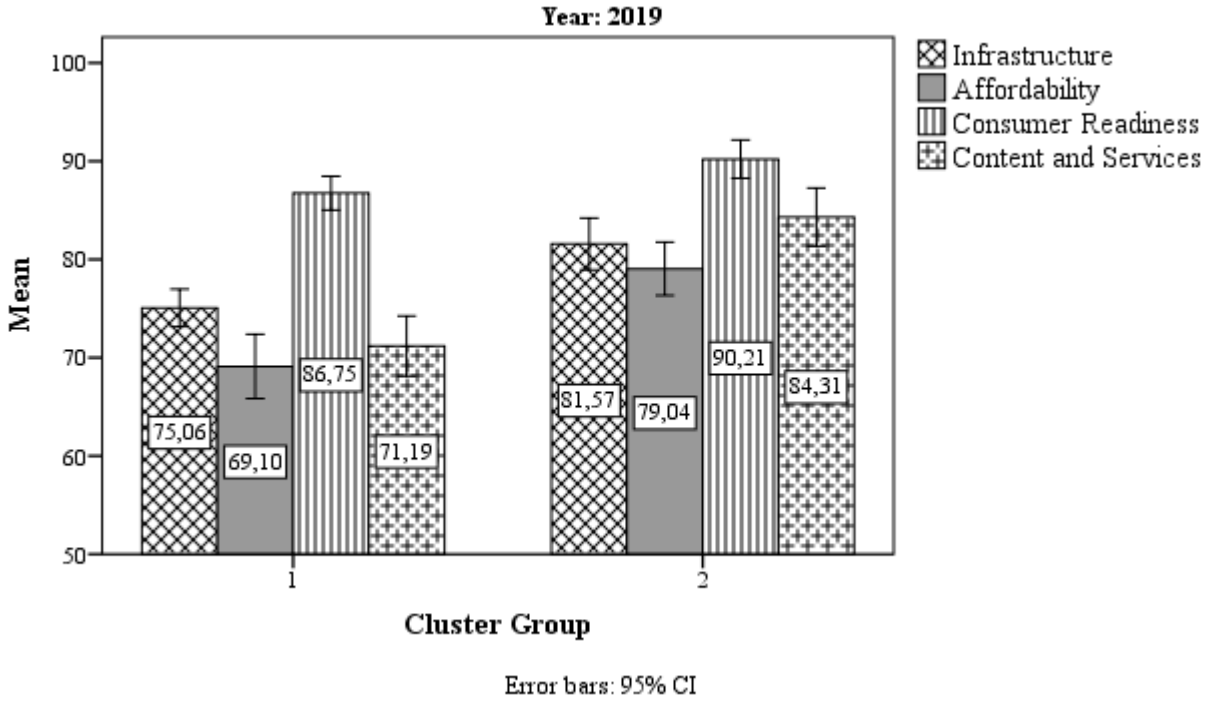

Figure 3. Cluster groups for the classification of the EU countries according to the values of the sub-indices included in the Mobile Connectivity Index, 2019

Source: Authors' calculations in SPSS software according to the Mobile Connectivity Index sub-indices values in 2019 (https://www.mobileconnectivityindex.com/#year=2019)

According to the research conducted, it is possible to identify some differences in the development of the Mobile Connectivity Index among the countries of the first and the second cluster. Particularly, it was established that lower values of the Affordability, as well as Content and Services sub-indices in the first cluster are due to lower values of the indicators included in these sub-indices, namely: Mobile tariffs (72,7), Handset price (67,2), Taxation (64,1), Inequality (71,5), Taxation (64,2), Local relevance (75), Availability (67,4). It is obvious that lower values in the first cluster in terms of the above-mentioned indicators reflect general economic development of the countries included in the cluster, and also characterize the market in the studied area in a certain way. Accordingly, investments in these areas play a crucial role, and special attention should be paid to them.

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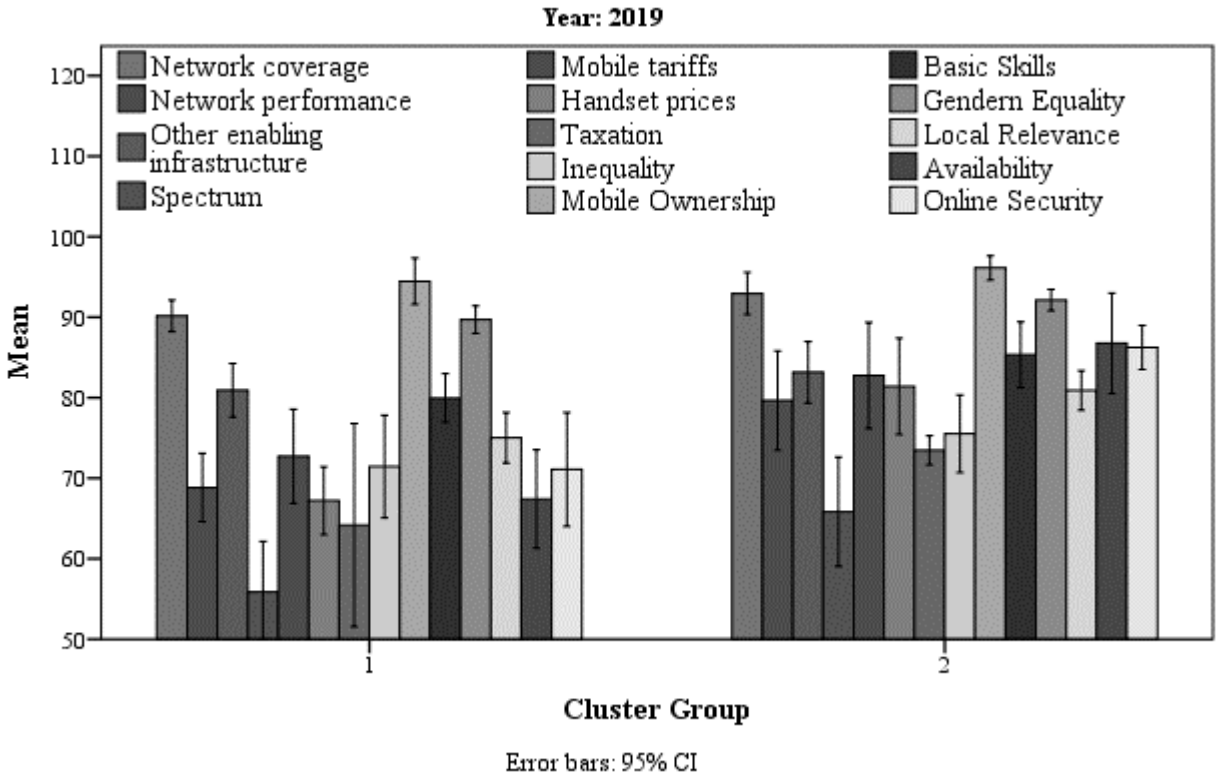

Figure 4. Comparison of indicators among the two cluster groups in 2019

Source: authors' calculations in SPSS software according to the value of the Mobile Connectivity Index in 2019 https://www.mobileconnectivityindex.com/#year=2019

A linear relationship between GDP (PPP) per capita (%) and Mobile Connectivity Index has been established:
- for all EU countries in 2019 (p-value = 0.000) Ln (GDP) = 4.1 * ln (Mobile Connectivity Index) -13.4; thus, with an increase in the Mobile Connectivity Index values by 1%, GDP (PPP) per capita increased by 4.1% on average in the EU countries in 2019;

- for the leading second cluster (p-value = 0.000) Ln (GDP) = 4.6 * ln (Mobile Connectivity Index) -15.4. Consequently, with an increase in the Mobile Connectivity Index values by 1%, GDP (PPP) per capita increased by 4.6% on average in the countries of the leading cluster in 2019;

- for Latvia and the entire first cluster, it was found that Ln (GDP) = 5.8 * ln (Mobile Connectivity Index) -20.7 (p-value = 0.085). Thus, the following trend can be observed: with an increase in the Mobile Connectivity Index values by 1%, GDP (PPP) per capita increased by 5.8% on average in the countries of the first cluster in 2019.

Thus, the effectiveness of the impact of mobile technologies on GDP (PPP) in the countries of the first cluster, including Latvia, is higher than in the countries of the second cluster with higher Mobile Connectivity Index, therefore, the return on mobile technologies slightly decreases with an increase in their values.

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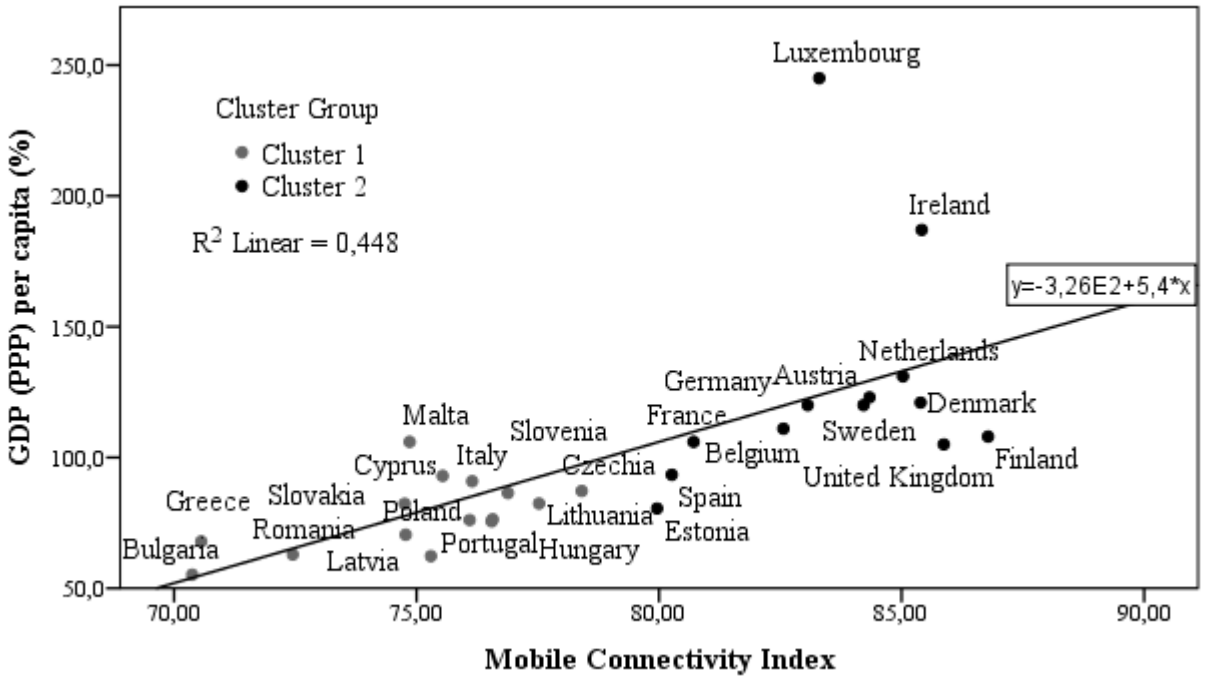
This assumption can be verified by building a regression of the growth rates of the Mobile Connectivity Index to their initial level (y=ln(Mobile Connectivity Index 2019/ Mobile Connectivity Index 2014), x=ln(Mobile Connectivity Index 2014):
Y=1,5-0,324*X (p-value=0,000). Consequently, countries with lower values of the index had higher growth rates in the period 2014-2019 than countries with higher values. It is also true that countries with lower GDP values had a higher growth rate of the index than countries with higher GDP. (y=ln(Mobile Connectivity Index 2019/ Mobile Connectivity Index 2014), x=ln(GDP 2014): Y=0,352-0,051*X (p-value=0,011).



Picture 5. Linear dependence of GDP (PPP) per capita (%) on Mobile Connectivity Index by clusters of EU countries, 2019.

Source: Authors' calculations in SPSS software according to the Mobile Connectivity Index sub-indices values in 2019 https://www.mobileconnectivityindex.com/#year=2019

Such subcomponents of the Mobile Connectivity Index as S1 (Infrastructure), S2 (Affordability), S3 (Consumer readiness), S4 (Content) affected GDP (PPP) per capita (%) in 2019 the following way
- for all EU countries the regression equation is set Ln (GDP) = 1.2 * ln (S2) + 1.7 * ln (S4) (p-value = 0.015; p-value = 0.000). Thus, with an increase in the sub-index of the availability of safe online content and services available and relevant to the local population by 1%, GDP (PPP) per capita increased by 1.7% on average in EU countries in 2019; with an increase in the sub-index of the availability of mobile services and devices at prices reflecting the level of income of the country's population by 1%, GDP (PPP) per capita increased by 1.2% on average in the EU countries in 2019;

- for the leading second cluster Ln (GDP) = 2.2 * ln (S2) + 1.6 * ln (S4) -6 (p-value = 0.002; p-value = 0.003). Consequently, with an increase in the values of the sub-index of the availability of mobile services and devices at prices reflecting the level of income of the country's population by 1%, GDP (PPP) per capita increased by 2.2% on average in the countries of the leading cluster in 2019; with an increase in the sub-index of the availability of

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safe online content and services available and relevant to the local population by 1%, GDP (PPP) per capita increased by 1.6% on average in the countries of the leading cluster in 2019;

- **for Latvia and the first cluster** on the whole, the dependence of GDP (PPP) per capita (%) on S1 (Infrastructure), S2 (Affordability), S3 (Consumer readiness), S4 (Content) has not been established (p-value> 0.05), trends (at p -value> 0.01) has not been observed either.

5. Discussion and conclusions

According to the results of the present study, it is established that Latvia at present moment is among the outsiders in terms of Mobile Connectivity Index value. With the help of the data obtained, it can be concluded that countries occupying leading positions in terms of the level of Mobile Connectivity Index pay special attention to the place of individual in the information and knowledge system. High values characterizing such indicators as Basic skills, General equality, Local relevance, Availability etc. provide evidence for that. Moreover, the states representing cluster 2 have a well-developed high-tech infrastructure (see Figure 3).

For Latvia, like for other countries in the 1st (lower) cluster, it is important that the entire society has the necessary skills for enjoying mobile connectivity. In order to provide sufficiently large and highly qualified staff, interest in ICTs needs to be encouraged – starting from primary school. International funding needs to be used to streamline education by creating additional ICT opportunities, training courses in the latest ICT disciplines, and, what is also very important, for improving infrastructure.

It was found that with an increase in the Mobile Connectivity Index values by 1%, GDP (PPP) per capita increased by 4.1% on average for all EU countries in 2019. For Latvia, like the entire first cluster, the following trend was observed: with an increase in the Mobile Connectivity Index by 1%, GDP (PPP) per capita increased by 5.8% on average in 2019. For the cluster with the leading positions of the index, the following statement is true: with an increase in the Mobile Connectivity Index by 1%, GDP (PPP) per capita increased by 4.6% on average in 2019. Thus, the results of the research correspond to those obtained by Edquist N., Goodridge R., Haskel J., Li X., Lindquist E. (Edquist et al. 2018), Amiri S., Reif B. (Amiri S., Reif B., 2013), Andrianaivo M., Kpodar K. (Andrianaivo, Kpodar, 2012) and other researchers (Katz, Callorda, 2019). Thus, the data on the impact of mobile Internet on GDP received within the present study have confirmed the conclusions obtained by other scientists. (Gruber и Koutroumpis, 2011; Katz, 2020b; Katz, Callorda, 2018).

It was found that the subcomponents of the Mobile Connectivity Index S2 (Affordability), S4 (Content) affected GDP (PPP) per capita (%) in all EU countries in 2019: with an increase in the sub-index values of the availability of secure online content and services available and relevant to the local population by 1%, GDP (PPP) per capita increased by 1.7% on average; with an increase in the sub-index of the availability of mobile services and devices at prices reflecting the level of income of the country's population by 1%, GDP (PPP) per capita increased by 1.2% on average. For the countries of the leading cluster, this dependence is even stronger: with an increase in the values of the sub-index of the availability of mobile services and devices at prices reflecting the level of income of the country's population by 1%, GDP (PPP) per capita increased by 2.2% on average; with an increase in the sub-index of the availability of safe online content and services available and relevant to the local population by 1%, GDP (PPP) per capita increased by 1.6% on average in the countries of the leading cluster in 2019. For the regression of the first cluster, which includes Latvia, such a dependence has not been observed (p-value> 0.01).

Consequently, countries with lower economic development need to strive to significantly increase broadband penetration. For Latvia, as well as for the entire cluster to which the country belongs, it is necessary to make strategic investment decisions in the field of ICT that maximize their economic efficiency: to promote the use of the latest technologies to meet the need for affordable digital infrastructure and services, to promote the availability of mobile broadband access (minimum 3G) for non-professionals, providing affordable prices for the most vulnerable segments of the population, promoting relevant content for residents of the country, developing

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local Internet content in the languages used in the country, promoting the development of digital skills among non-professionals, as well as promoting the development of infrastructure, especially in rural areas.
Current authors' research contributes to the mobile economy theory by providing deeper insights into the impact of mobile Internet on GDP by specifying the mobile Internet factors (infrastructure, affordability, consumer readiness and content). Similarly, other researchers show the direct effects of information technology on economy in a context of the sector development in the European Union (Sinica, 2017), the key reason for the persistent digital divide seen between countries is financial variable (Nielsen et al. 2018). In 2021 authors got the same results that mobile ICT plays an important role in increasing national productivity (Kim et al. 2021), relatively small investments in mobile Internet have effects on economic development (Edquist et al. 2021). In 2020, mobile technologies and services generated 4.6% of GDP in Europe, 5% -of global GDP (GSMA, 2021). Manyika et al. (2015) estimates suggest that mobile technologies and services will contribute approximately 11 % of total world GDP in 2025.

References

Aleksejeva, V., Lavrinenko, O., Betlej, A., Danilevič̆a, A. (2021). Analysis of disparities in the use of information and communication technology (ICT) in the EU countries. *Entrepreneurship and Sustainability Issues*, 9(2), 332-345.https://doi.org/10.9770/jesi.2021.9.2(22)

Amiri, S., Reif, B. (2013). Internet Penetration and its Correlation to Gross Domestic Product: An Analysis of the Nordic Countries. *International Journal of Business, Humanities and Technology*, 3(2), 50-60.

Andrianaivo, M., Kpodar, K. (2012). Mobile Phones, Financial Inclusion, and Growth. *Review of Economics and Institutions*, 3(2), https://doi.org/10.5202/rei.v3i2.75

Arvin, B. M., Pradhan, R. P. (2014). Broadband Penetration and Economic Growth Nexus: Evidence from Cross-country Panel Data. *Applied Economics*, 46(35), 4360-4369. https://doi.org/10.1080/00036846.2014.957444

Bahia, K., Agnoletto, F. (2020). Methodology. Connected Society. Mobile Connectivity Index 2020. Retrieved October 2, 2021 from: https://www.gsma.com/r/wp-content/uploads/2020/09/GSMA-Mobile-Connectivity-Index-Methodology-2020.pdf

Baldwin, R., Robert-Nicoud, F. (2014). Trade-in-goods and Trade-in-tasks: An Integrating Framework. *Journal of International Economics*, 92(1), 51-62. https://doi.org/10.1016/j.jinteco.2013.10.002

Becker, N., Cieślik, A. (2020). Determinants of German Direct Investment in CEE Countries. *Journal of Risk and Financial Management*, 13(11), 268-285. https://doi.org/10.3390/jrfm13110268

Čerņakovs-Neimarks, A., Karnītis, E., Rutka, G., Virtmanis, A. (2013). Mobile Services in Baltic States: Development to Improve Sustainability and Quality. *Journal of Security and Sustainability Issues*, 2(3), 71-84. https://doi.org/10.9770/jssi.2013.2.3(6)

Czernich, N., Falck, O., Kretschmer, T., & Woessmann, L. (2011). Broadband Infrastructure and Economic Growth. *The Economic Journal*, 121(552), 505-532. https://doi.org/10.1111/j.1468-0297.2011.02420.x

Delaporte, A., Bahia, K. (2021). The State of Mobile Internet Connectivity https://www.gsma.com/r/wp-content/uploads/2021/09/The-State-of-Mobile-Internet-Connectivity-Report-2021.pdf

Du, J., Peng, S., Song, W., Peng, J. (2020). Relationship between Enterprise Technological Diversification and Technology Innovation Performance: Moderating Role of Internal Resources and External Environment Dynamics. *Transformations in Business & Economics*, Vol. 19, No 2 (50), 52-73.

Econometric Modelling. Retrieved October 2, 2021 from: file:///C:/Users/Admin/Downloads/Global%20econometric%20modelling.pdf

Edquist, H., Goodridge, P., Haskel, J., Li, X., Lindquist, E. (2018). How important Are Mobile Broadband Networks for the Global Economic Development?. *Information Economics and Policy*, 45, 16-29. https://doi.org/10.1016/j.infoecopol.2018.10.001

Edquist, H., Goodridge,P., & Haskel, J. (2021) The Internet of Things and economic growth in a panel of countries. *Economics of Innovation and New Technology*, 30(3), 262-283. https://doi.org/10.1080/10438599.2019.1695941

Fakunle, S. O., Ajani, B. K. 2021. Peculiarities of ICT adoption in Nigeria. *Insights into Regional Development*, 3(4), 51-61. http://doi.org/10.9770/IRD.2021.3.4(4)

Gerard, G., Merrill, R.K., Simon J. D. (2021). Schillebeeckx Digital Sustainability and Entrepreneurship: How Digital Innovations Are Helping Tackle Climate Change and Sustainable Development. *Entrepreneurship Theory and Practice*, 45(5) https://journals.sagepub.com/doi/10.1177/1042258719899425

Giday, G. (2019). Information communications technology and economic growth in Sub-Saharan Africa: A panel data approach. *Telecommunications Policy*, 43(1), 88-99. https://doi.org/10.1016/j.telpol.2018.03.010

Gordon, R. J. (2009). Macroeconomics (11th ed.). New York: Pearson Education.

Gruber, H., Hätönen, J., Koutroumpis, P. (2014). Broadband Access in the EU: An Assessment of Future Economic Benefits. *Telecommunications Policy*, 38(11), 1046-1058. https://doi.org/10.1016/j.telpol.2014.06.007

GSMA Intelligence. (2019). Definitive data and analysis for the mobile industry. https://www.gsma.com/services/wp-content/uploads/2019/06/GSMAIntelligence_Product_Brochure_2019.pdf

GSMA. (2020). Mobile Connectivity Index. Available at: https://www.mobileconnectivityindex.com/, 2020 https://www.gsma.com/mobileeconomy/wp-content/uploads/2020/03/GSMA_MobileEconomy2020_Global.pdf

GSMA. (2021). The Mobile Economy. Europe. https://www.gsma.com/mobileeconomy/wp-content/uploads/2021/09/GSMA_ME_Europe_2021_R_Web_Singles.pdf

Haller, S., and Lyons, S. (2019). Productivity is higher among service firms when broadband becomes available, but not all. ESRI *Research Bulletin*, January. Available at: http://aei.pitt.edu/101972/1/RB201904_0.pdf

Jiang, P., Zheng, X., Huang, P. (2021). The Impact of Accounting Information Quality on Technological Innovation-A Case Study of Chinese Information Technology Enterprises. *Transformations in Business & Economics*, Vol. 20, No 3C (54C), pp.605-623.

Edquist, H., Goodridge,P. Haskel, J. Li, X., Lindquist, E. (2018). How important are mobile broadband networks for the global economic development? *Information Economics and Policy*, 45, 16-29. https://doi.org/10.1016/j.infoecopol.2018.10.001

Katz, R. (2020a). How broadband, digitization and ICT regulation impact the global economy. Retrieved October 2, 2021 from: http://handle.itu.int/11.1002/pub/816ff1af-en

Katz, R. (2020b). The economic contribution of broadband, digitization and ICT regulation. *Regional Initiatives* https://www.itu.int/dms_pub/itu-d/opb/pref/D-PREF-EF.BDT_CIS-2020-PDF-E.pdf

Katz, R., Callorda, F. (2018). The economic contribution of broadband, digitization and ICT regulation. Expert reports series. Retrieved October 2, 2021 from: https://www.itu.int/en/ITU-D/Regulatory-Market/Documents/FINAL_1d_18-00513_Broadband-and-Digital-Transformation-E.pdf

Katz, R., Callorda, F. (2019). The economic contribution of broadband, digitization and ICT regulation Econometric modelling for the Americas. Retrieved October 2, 2021 from: file:///C:/Users/Admin/Downloads/Economic%20contribution%20of%20broadband%20digitization%20and%20ICT%20regulation%20Econometric%20modelling%20for%20the%20Ame.pdf

Kim, J., Park, J.C., Komarek T. (2021). The impact of Mobile ICT on national productivity in developed and developing countries. *Information & Management*, 58(3). https://doi.org/10.1016/j.im.2021.103442

Kristianto, D. (2021). Winning the attention war: consumers in nine major markets now spend more than four hours a day in Apps. App Annie. Retrieved October 2, 2021 from: https://www.appannie.com/en/insights/market-data/q1-2021-market-index/

Matthew, N.O. Sadiku, A. E. Shadar, S. M. M. (2017). *International Journal of Engineering Research*, 6(9), 429-430. https://doi.org/10.5958/2319-6890.2017.00055.1

Methodology. Connected Society. Mobile Connectivity Index 2020. (2020). Retrieved October 2, 2021 from: https://www.gsma.com/r/wp-content/uploads/2020/09/GSMA-Mobile-Connectivity-Index-Methodology-2020.pdf

Minges, M. (2016). Exploring the Relationship between Broadband and Economic Growth. Background Paper prepared for the World Development Report 2016. Retrieved October 2, 2021 from: https://documents1.worldbank.org/curated/en/178701467988875888/pdf/102955-WP-Box394845B-PUBLIC-WDR16-BP-Exploring-the-Relationship-between-Broadband-and-Economic-Growth-Minges.pdf

Mobile Connectivity Index. (2019). Retrieved October 2, 2021 from: https://www.mobileconnectivityindex.com/#year=2019

Manyika, J., Chui,M., Bisson, P., Jonathan Woetzel, J., Bughin, J., Dan Aharon, D. (2015). *The Internet of Things: Mapping the Value Beyond the Hype.* San Francisco: McKinsey Global Institute.

Moreno-Llamas, A, Garcia-Mayor, J., De la Cruz-Sanchez, E. (2020). The impact of digital technology development on sitting time across Europe. *Technology in Society*, 63, 101406. https://doi.org/10.1016/j.techsoc.2020.101406

Nielsen, M.M., Rohman, I.K., Lopes, N.V. (2018). Empirical analysis of the current digital divides since 2010. In *Proceedings of the 11th International Conference on Theory and Practice of Electronic Governance* (*ICEGOV '18*). Association for Computing Machinery, New York, NY, USA, 616–625. https://doi.org/10.1145/3209415.3209493

Otsetova, A., Otsetova-Dudin, E. (2019). Growth and Opportunities in Mobile Internet Market in Bulgaria. *Transport and Communications*, 2, 21-27. https://doi.org/10.26552/tac.C.2019.2.5

Nielsen M.M., Rohman I.K., Lopes N.V. (2018). Empirical analysis of the current digital divides since 2010. In *Proceedings of the 11th International Conference on Theory and Practice of Electronic Governance* (*ICEGOV '18*). Association for Computing Machinery, New York, NY, USA, 616–625. https://doi.org/10.1145/3209415.3209493

Redseer consulting. (2021). MENA Startups. Going the IPO way. Retrieved October 2, 2021 from: https://redseer.com/newsletters/mena-startups-going-the-ipo-way/

Romer, P. M. (2007). Economic Growth. In D. R. Henderson (Ed.). Indianapolis: Liberty Fund.

Ronaghi, MH, Forouharfar, A. (2020).A contextualized study of the usage of the Internet of things (IoTs) in smart farming in a typical Middle Eastern country within the context of Unified Theory of Acceptance and Use of Technology model (UTAUT). *Technology in Society*, 63, 101415. https://doi.org/10.1016/j.techsoc.2020.101415

Sinica, L. (2017). Information technology sector in the European Union: the direct economic impact. *Social Sciences Bulletin*, 1 (24), 59-75.

Torkayesh, AE.; Torkayesh, SE. (2021). Evaluation of information and communication technology development in G7 countries: An integrated MCDM approach. *Technology in Society* 66, 101670. https://doi.org/10.1016/j.techsoc.2021.101670

Trubnikov, D. (2019). The Russian Telecommunications experience: a positive outcome of the competitive order in the industry. *Journal of Industry. Competition and Trade*, 20, 35–58. https://doi.org/10.1007/s10842-019-00304-5

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Appendix 1

The EU countries divided into two clusters according to the sub-indices of the Mobile Connectivity Index in 2019

			Country	Infrastructure	Affordability	Consumer Readiness	Content and Services
Cluster Group	1	1	Bulgaria	71,08	62,78	86,64	63,43
		2	Croatia	74,01	70,60	84,80	72,54
		3	Cyprus	73,02	67,48	82,90	79,69
		4	Czechia	81,90	77,66	87,74	67,71
		5	Greece	74,17	55,08	89,71	67,62
		6	Hungary	77,25	75,43	84,85	69,52
		7	Italy	77,76	64,61	85,27	78,48
		8	Latvia	77,25	66,41	91,92	66,30
		9	Lithuania	80,56	71,24	90,21	69,77
		10	Malta	73,85	64,36	83,92	78,73
		11	Poland	68,49	72,35	89,66	75,45
		12	Portugal	74,90	68,96	85,35	77,88
		13	Romania	74,99	69,61	81,81	64,51
		14	Slovakia	73,11	75,21	85,47	66,44
		15	Slovenia	73,60	74,78	90,96	69,79
		N	15	15	15	15	15
		Minimum	Bulgaria	68,49	55,08	81,81	63,43
		Maximum	Slovenia	81,90	77,66	91,92	79,69
		Mean		75,06	69,10	86,75	71,19
		Median		74,17	69,61	85,47	69,77
		Std. Deviation		3,45	5,91	3,11	5,54
	2	1	Austria	82,87	79,10	89,91	85,34
		2	Belgium	79,11	82,66	92,13	77,11
		3	Denmark	86,48	73,91	93,99	88,50
		4	Estonia	81,32	75,54	89,77	74,12
		5	Finland	92,34	79,46	94,89	81,46
		6	France	77,07	76,03	87,00	83,24
		7	Germany	80,81	79,94	89,83	82,03
		8	Ireland	76,98	86,54	90,74	88,06
		9	Luxembourg	79,54	85,04	82,14	86,66
		10	Netherlands	85,02	78,04	90,79	86,76
		11	Spain	77,15	70,51	90,02	84,74
		12	Sweden	81,93	78,13	92,68	85,28
		13	United Kingdom	79,84	82,66	88,81	92,76
		N	13	13	13	13	13
		Minimum	Austria	76,98	70,51	82,14	74,12
		Maximum	United Kingdom	92,34	86,54	94,89	92,76
		Mean		81,57	79,04	90,21	84,31
		Median		80,81	79,10	90,02	85,28
		Std. Deviation		4,36	4,49	3,22	4,89
		N	28	28	28	28	28

	Minimum	Austria	68,49	55,08	81,81	63,43
	Maximum	United Kingdom	92,34	86,54	94,89	92,76
	Mean		78,09	73,72	88,35	77,28
	Median		77,25	74,99	89,69	78,18
	Std. Deviation		5,06	7,25	3,56	8,42

a. Year = 2019

Source: Authors' calculations in SPSS software

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