“Digital transformation and ICT sector performance in EU countries”

AUTHORS	Eva Ivanová Eva Grmanová

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Eva Ivanová (Slovak Republic), **Eva Grmanová** (Slovak Republic)

DIGITAL TRANSFORMATION AND ICT SECTOR PERFORMANCE IN EU COUNTRIES

Abstract

Digital transformation is now one of the most important topics in all EU countries in creating and managing strategies and visions for states, businesses, organizations, and citizens. The ICT sector is currently one of the most important sectors with significant added value. The main purpose of the paper is to identify the efficiency of the digitalization of the economy and society concerning the performance of the ICT sector. This paper uses multi-criteria efficiency evaluation methods – Data Envelopment Analysis (DEA models). Inputs in the basic DEA model are the dimensions' values of the Digital Economy and Society Index (DESI), which are also used to express the DESI summary indicator, such as human capital, connectivity, digital technology integration, and digital public services. Output in the DEA model indicates the ICT share of GDP. Finally, output-oriented DEA models are used to express the efficiency score. The analysis results show that Bulgaria, Romania, Greece, and Malta have a below-average level of DESI, but they can be classified as efficient. Italy, Lithuania, and Slovenia are the worst performers in the efficiency score. The next step was to express the efficiency scores in the DEA models in terms of different combinations of inputs and outputs. Malta was efficient in all fifteen DEA models. Based on these findings, Malta is considered significantly positive. Its approaches can serve as an example for other countries.

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Eva Ivanová, Ing., CSc., Department of Economy and Economics, Faculty of Social and Economic Relations, Alexander Dubcek University of Trenci, Slovak Republic. (Corresponding author)

Eva Grmanova, Ph.D., Associate Professor, Department of Economy and Economics, Faculty of Social and Economic Relations, Alexander Dubcek University of Trencin, Slovak Republic.

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INTRODUCTION

The implementation of digital technologies in the economy and society, understood as the digitalization of the economy and society, as well as the related digital transformation, are the main objectives of EU policy. Digitalization leads to increased competitiveness and is directly linked to innovation. Furthermore, the introduction of digitalization of economies and society affects the labor market and changes the structure of the workforce.

The digitalization of the economy and society is analyzed by many studies primarily devoted to the relationship between the digitalization of the economy and society and GDP as an indicator of economic performance. The increasing digitalization of the economy and society is, however, closely interacting with the performance of the information and communication technologies (ICT) sector. The ICT sector is currently one of the most important sectors with significant added value. Development in the sector of information and communication technologies is very dynamic. The ICT sector enables the globalization of economies and the transfer of knowledge and innovation. The exploration of the relationship between the digitalization of the economy and society, on the one hand, and the ICT sector performance, on the other hand, is absent.

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1. LITERATURE REVIEW

The digital economy is interconnected with several areas of economic practice. In mutual interactions, digital transformation influences economic cooperation among actors at national and international levels. Their interrelations, as well as the development level of individual and digital economy indicators, are assessed by many studies, presenting different approaches to the digital economy definition. Gorenšek and Kohont (2018) examine the characteristics of digitization, digitalization, and digital transformation. They explain the differences between the terms. Digitization is the transfer of data from analog form to digital format. Digital transformation refers to shifting organizations to new ways of working and thinking (Gorenšek & Kohont, 2018, p. 109). Using statistical research, Bakumenko and Minina (2020) compare countries in the EU and outside the EU based on the economy's digitization level. Using cluster analysis, they divided countries into two groups, determining the specifics of each group. The first group consists mainly of countries with a large share of services. The second group consists mainly of countries with a large share of production. The first group includes, among others, developed EU countries such as Germany, Denmark, the Netherlands, and Sweden. The second group contains the Czech Republic, Poland, Latvia, and Italy. Unlike the countries in the second group, the countries in the first group have high values of the digital development of the economy and society indicators.

An overview of research focused on digital transformation based on the systematization of literary sources was conducted by Kraus et al. (2021). Kovács et al. (2022) investigate the convergence of countries based on the DESI indicator. They use the beta convergence and the sigma convergence methods. As a result, the convergence of countries based on the DESI indicator has been confirmed. However, the authors suggest that this does not mean that the countries also converge within all four dimensions.

Pouri and Hilty (2021) explore the confluence of technical and social sharing when defining the digital economy. Curtis and Lehner (2019) explore the issue of sharing economy for sustainability. Pilková et al. (2021) present the content of digital processes in Slovakia. The relationship between the degree of digitalization and macroeconomic indicators is assessed by Yalcin (2021). She assesses the efficiency of digitalization by using the DEA models where the inputs are DESI dimensions, and the outputs are GDP and unemployment rate. The study reports that developing countries use digitalization more effectively for economic growth and job creation. On the contrary, developed countries (Denmark, Finland, or Spain) do not use the analyzed inputs efficiently. This may be because they have a high degree of digitalization of their economy compared to other EU countries, which significantly impacts their competitiveness and thus the pressure on digitalization efficiency is not that big.

Vyshnevskyi et al. (2020) assess the relationship between the level of digitalization on the one hand and the dynamics of GDP changes on the other hand. However, they state that the degree of digitization of the economy in EU countries at the current technological development level does not significantly impact economic growth. In contrast, Olczyk and Kuc-Czarnecka (2022) claim that DESI is a crucial factor affecting GDP per capita changes in EU countries.

The relationship between national performance and digital transformation is also explored by Katz and Koutroumpis (2013). They argue that the digitalization index is a global measure of national performance. The index links national output and welfare growth, with some challenges for ICT public policy emerging from these findings. Another group of studies deals with the issue of the impact of economy digitalization on the competitiveness of enterprises or the whole economy based on increasing innovation performance. In terms of the digital transformation of society, the phenomenon of digital innovation is emerging and has captured the attention of both researchers and practitioners (Nambisan et al., 2019), changing the nature of their understanding to a broader conception within the complex socio-technical systems (Baygi et al., 2021). Hund et al. (2020) brought together insights on digital innovations in their conceptualization. Gao et al. (2022) provide an overview of a systematic approach to research on the development of digital transformation and innovation, allowing researchers to better manage the current situation and indicate the future development trend. Koch and Windsperger (2017, p. 1) contribute to a better understanding of how firms may achieve sustained competitive advantage in the digital economy. It outlines a network-centric view that explains the competitive environment of firms confronted with digital technology and its affordances. The need for innovation also means a change in management approaches. Managers are aware of the urgency facing them but are not making the necessary preparations. They are not dealing with the tasks that would mean re-evaluating their managerial activities, primarily in terms of soft categories (motivation, managing integrational conflicts, competence development, training, change in leadership style, shaping of culture, etc.) (Bencsik, 2020, p. 1283).

According to Laitsou et al. (2020), the performance of the digital economy is a matter of national strategies for achieving economic growth and socio-economic development. These results could be used to modify existing policies and identify aspects where further improvement is needed to achieve high standards of digital competitiveness. Other authors quantify the relationship between the adoption of digital technologies in innovation and the structural transformation of low- and middle-income economies. They state that such countries introduce digital transformation first in the service sector (Kulinich et al., 2022). In terms of the investigation, as a starting point for the current state of research, there have been relevant publications dealing with the economy digitalization issue in EU countries. Małkowska et al. (2021, p. 326) demonstrate the impact of technological transformation on the economy and society in EU countries grouped according to a similar level of development, such as countries with high, medium, and low performance. Broz et al. (2020) discuss digital transformation and economic cooperation in Western Balkan countries. It is concluded that the economic cooperation among the Western Balkan countries is expanding as well as digital transformation is increasing. The analyzed countries are moving closer to other EU countries. At the same time, however, they are lagging behind other EU countries in digital transformation.

Česnauské (2019, p. 89), using the DESI dimensions on the Balkan countries, concludes that all three countries are advanced in the dimensions of connectivity and use the internet and digital public services. However, little progress is visible in other dimensions compared to other EU countries. Hawach et al. (2022, p. 1), using the resource-based view and knowledge spillover, investigate the direct effects of Internet capabilities (communication, platform, and connection capabilities) on product and process innovation across 10 Balkan countries from 2007 to 2019. In addition, the study examines the role of foreign technology licensing in moderating these relationships. In line with findings from developed countries, the empirical results show that Internet capabilities positively influence product and process innovation.

Balcerzak and Pietrzak (2017, p. 5) evaluate the digital economy development in Visegrad Group countries. On the one hand, the analysis confirmed relatively quick progress in building a digital economy at the regional level in Poland, the Czech Republic, Slovakia, and Hungary. On the other hand, significant disparities between the analyzed regions can be seen, especially in the case of Polish regions. By systematizing professional sources, studies are mainly devoted to the relationship between the economy and society digitalization and economic growth, based on implementing innovations and increasing entities' competitiveness at the micro and macro levels. A broader assessment of the relationship between the economy and society's digitalization and the performance of different digital economy sectors is not available. However, the increasing level of economy and society digitalization should ultimately be seen in increased digital economy performance. Therefore, this study tries to fill in this research gap.

2. METHODOLOGY

The indicator ICT share of GDP determines the ICT performance sector. Several indicators are used to assess the level of digitalization. The Digital Economy and Society Index (DESI) is one of the most famous indicators. It is based on the values of 33 indicators split into four dimensions for all EU countries. It allows for assessing changes in digitalization in different years and comparing particular EU countries to each oth-

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er. The main DESI dimensions are human capital, connectivity, digital technologies integration, and digital public services (Ministry of Investments, Regional Development and Informatization of the Slovak Republic, 2022). They are expressed in scores from 0 to 100. Data on the ICT share of GDP were taken from Eurostat (2022). Data on the values of the DESI dimensions were taken from the Digital Agenda Data (2021). The year 2020 was significantly affected by the epidemiological situation. For this reason, 2018 and 2019 were used for the analysis. EU countries were the subject of the analysis. Countries such as Ireland, Spain, Cyprus, Luxembourg, the Netherlands, and Portugal were excluded due to unpublished data. Thus, 21 EU countries were analyzed.

Data envelopment analysis models (DEA models) were used to meet the objective of this paper. DEA represents a linear programming model based on two types of data (inputs and outputs), which calculate the relative performance of similar units (Georgescu et al., 2022, p. 435). The collection of units is called DMU. Full (100%) efficiency is attained by any DMU if and only if none of its inputs or outputs can be improved without worsening some of its other inputs or outputs (Cooper, 2001, p. 183). Fully efficient DMU lies on the frontier of efficiency. DEA models express the efficiency score for each unit.

These models assume variable returns to scale, and the VRS model is used. An efficient DMU has a value equal to 1 (or 100%). DMUs that are not efficient have an efficiency score bigger than 1 (or 100%). In an output orientation, the percentage of efficiency score expresses the percentage of output that needs to be increased to make the DMU efficient.

The dual output-oriented VRS model has the following form for the DMU U_q in matrix form:

to maximize

$$g = \phi_q + \varepsilon\left(e^T s^+ + e^T s^-\right),$$

under the conditions, (1)

$$X\lambda + s^- = x_q, \quad Y\lambda - s^+ = \phi_q y_q,$$
$$e^T\lambda = 1, \quad \lambda, s^+, s^- \geq 0.$$

where ϕ_q expresses an efficiency score of the DMU U_q; X is the inputs matrix; Y is the outputs matrix; s^+, s^- are the outlier variables; λ is the weights matrix; $e^T = (1,1, \ldots 1)$; ε is the infinitesimal constant (Jablonský & Dlouhý, 2004).

The requirement in the DEA model has a positive correlation between inputs and outputs (Grmanová, 2010). A negative correlation means that when the input increases, outputs will decrease, and this is not desirable.

The inputs in the DEA model (in the basic one) include DESI dimensions: human capital, connectivity, integration and digital technologies, and digital public services. A single output is the ICT share of GDP. Output-oriented VRS models are used to express efficiency scores.

The efficiency score depends on the choice of inputs and outputs. Therefore, observing the impact of inputs and outputs on the efficiency score has an important practical significance. One possible approach is to calculate efficiency scores in models with different combinations of indicators on the inputs side and on the outputs side (Cinca & Molinero, 2004). This procedure makes it possible to determine the influence of individual indicators on the efficiency score. This analysis used models with all possible combinations of inputs and output (fifteen output-oriented DEA models). Thus, the efficiency score will be expressed in both the basic DEA model and the other fourteen DEA models. The EMS software to express the efficiency score is to be used.

3. RESULTS

Table 1 shows that the dimension of digital public services had the highest arithmetic mean. In addition, the dimension of integration and digital technologies had the highest coefficient of variation.

EU countries differ significantly in their ICT share of GDP (Figure 1). Malta, Bulgaria, and Sweden had the highest values of this indicator. In contrast, Greece had the lowest values. The values for ICT share of GDP in the Slovak Republic were slightly below the arithmetic mean, while the values in the Czech Republic were slightly above the

Table 1. Characteristics of inputs and output

Source: Own processing in Statistica software based on Eurostat (2022), Digital Agenda Data (2021).

Dimension	min	max	Standard deviation	Coefficient of variation in %
ICT share of GDP in %	2018, 2019: Greece	2018, 2019: Malta	2018: 1.20 2019: 1.30	2018: 26.79 2019: 27.85
Human Capital	2018, 2019 Romania	2018, 2019 Finland	2018:2.30 2019: 2.33	2018: 21.53 2019: 21.25
Connectivity	2018, 2019 Greece	2018, 2019 Sweden	2018: 1.59 2019: 1.67	2018: 22.76 2019: 20.85
Integration and Digital Technologies	2018, 2019 Bulgaria	2018, 2019 Finland	2018: 2.00 2019: 2.22	2018: 33.19 2019: 33.73
Digital Public Services	2018, 2019 Romania	2018, 2019 Estonia	2018: 3.87 2019: 3.96	2018: 31.45 2019: 30.05

arithmetic mean. Interestingly, countries such as Denmark and Germany had the indicator values below the average.

EU countries vary considerably within the levels achieved on each dimension (Figures 2 and 3). In the first dimension, human capital, Finland has the highest score. In contrast, Romania scores the lowest. The difference between the two countries is significant. The variability of the second-dimension values, expressed by the coefficient of variation, was the lowest compared to the other dimensions in 2018. Sweden scores the highest score within the connectivity dimension. Greece scores the lowest values. The variability of the second-dimension values, expressed by the coefficient of variation, was the lowest compared to the other dimensions in 2019. Finland achieves the maximum value for the dimension of integration and digital technologies. In contrast, Bulgaria has the lowest value there. Interestingly, Estonia scores maximum in the fourth dimension, excelling in digital public services, while Romania scores lowest.

Table 2. Pearson correlation coefficient

Source: Own processing in Statistica software based on Digital Agenda Data (2021).

Dimension	Pearson correlation coefficient with the indicator ICT share of GDP	p-level
Human Capital	2018: 0.315 2019: 0.325	2018: 0.165 2019: 0.151
Connectivity	2018: 0.361 2019: 0.399	2018: 0.075 2019: 0.073
Integration and Digital Technologies	2018: 0.090 2019: 0.080	2018: 0.697 2019: 0.731
Digital Public Services	2018: 0.425 2019: 0.456	2018: 0.055 2019: 0.038

Source: Own processing based on Eurostat (2022).

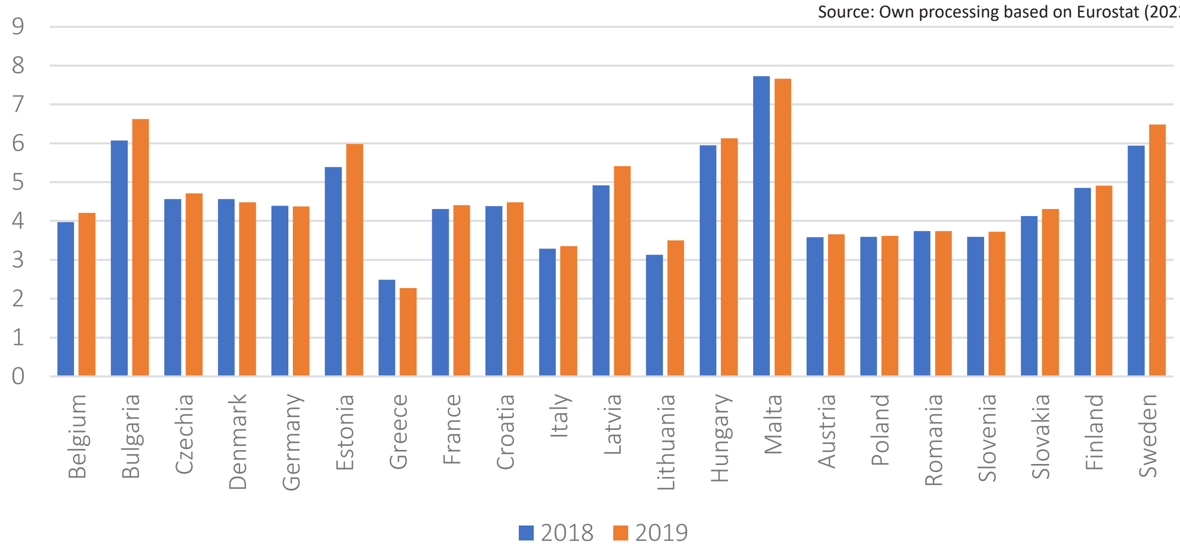

Figure 1. ICT share as % of GDP in EU countries

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Source: Own processing based on Digital Agenda Data (2021).

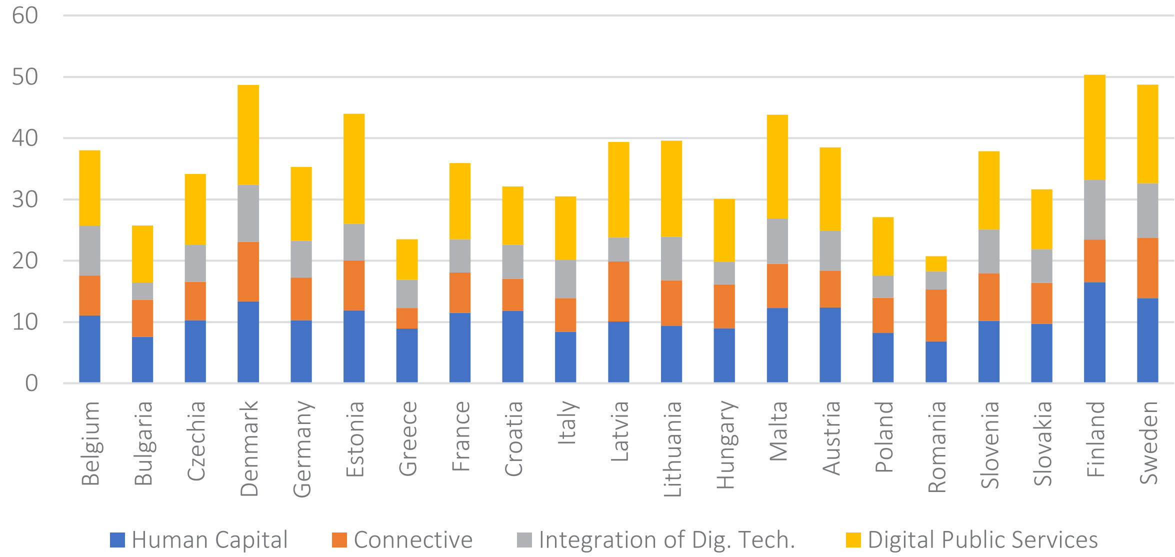

Figure 2. DESI in EU countries in 2018

Source: Own processing based on Digital Agenda Data (2021).

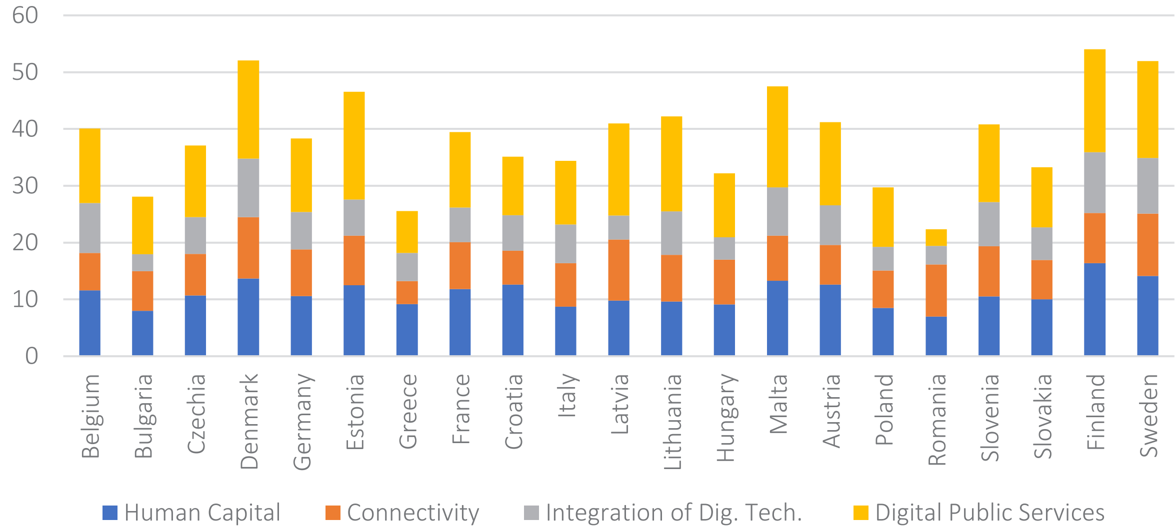

Figure 3. DESI in EU countries in 2019

Table 2 shows the correlation coefficient values between inputs and output. None of the inputs are negatively correlated with the output. Therefore, none of the inputs need to be excluded. The dimension integration and digital technologies were independent of the output (Pearson correlation coefficient close to zero). The other dimensions had a weak or moderately tight linear dependence. At the 0.05 significance level, the Pearson correlation coefficient between the dimension of digital public services and the output ICT share of GDP was statistically significant in 2019.

The next step expresses efficiency scores in fifteen output-oriented VRS models. The values of the efficiency scores are shown in Tables A1 and A2.

4. DISCUSSION

In the models of four inputs and an output, four of the EU countries analyzed are efficient: Bulgaria, Greece, Malta and Romania. The finding that Bulgaria and Romania are efficient is consistent with Yalcin (2021), who employed the VRS model with the same inputs (DESI dimensions) and used GDP and unemployment rate as outputs. Although both countries have below-average values of the dimensions, the transformation of multiple inputs for output can be assessed as efficient.

In the model with four inputs and the output, the Slovak Republic and the Czech Republic are inefficient. The ICT share of GDP in the Slovak Republic and the Czech Republic is low. If both countries want to increase competitiveness, they should strongly support the growth of ICT specialists, ICT-focused start-ups, ICT-focused businesses, and ICT-focused technology innovation. This could also increase the productivity and efficiency of the ICT sector within a few years. Similarly, Poland and Hungary, which are states of the Visegrad Group, could have been more efficient. Hungary, Croatia, and Sweden were slightly below the efficiency frontier. All three countries belong to the group of countries that, by the used level of input, should keep the ICT share of GDP relatively high. Vice versa, Italy, Lithuania, and Slovenia should significantly improve the efficiency of the digital economy. All three countries had the highest efficiency score in the basic output-oriented model.

However, more is needed to calculate only the efficiency score in the basic model. Furthermore, it is also essential to monitor the impact of individual inputs on the efficiency score. Therefore, in the next step, this study expresses efficiency scores in fourteen VRS models. By comparing efficiency scores in different models, it is possible to draw conclusions about the impact of inputs on efficiency.

Malta was efficient in all fifteen DEA models in both years. It is inefficient only for ratios that measure (Cinca & Molinero, 2004, p. 523 cited in Zhu, 1998, p. 55) some input utilization by the output. Malta also had the highest values of ICT share of GDP. Based on these findings, Malta is considered significantly positive. Its approaches can serve as an example for other countries.

Greece and Romania are other countries for which the efficiency score in DEA models is compared. In both years, in all models (seven models) where the second input, connectivity, was absent, Greece was not efficient. Thus, connectivity can be considered a dimension strongly influencing Greece's efficiency. Its values are shallow compared to the other three values of Greece's inputs. Therefore, Greece is efficient only with respect to ratios that measure (Cinca & Molinero, 2004, p. 523 cited in Zhu, 1998, p. 55) the second input utilization by the output. At the same time, Greece has low values of the output – ICT share of GDP. This means that Greece is on the efficiency frontier only due to the extremely low value of some of its input.

In both years, in all models where the first input (human capital) and the fourth input (digital public services) were missing at the same time, Romania was not efficient (in three models). In models where the first or the fourth dimension was present, Romania was efficient. Thus, human capital and digital public services can be dimensions that strongly influence Romania's efficiency. Their values are shallow compared to the other input values. Therefore, Romania should focus on increasing the values of these inputs.

Like efficient countries, inefficient countries can also be divided into groups of those for which the efficiency score does not change in the fifteen models and those for which the efficiency score does change. The change in the efficiency score in the fifteen models does not occur only in Denmark and Finland. The omission of any dimension would not affect the efficiency score in any of the fifteen models. Some dimension (input) does not affect efficiency significantly. There are also minimal differences in the efficiency scores in Sweden within the fifteen models. Thus, it is typical for Finland, Denmark, and Sweden that none of the four dimensions affects efficiency more strongly than the other dimensions. Sweden, Finland, and Denmark are characterized by a balanced development in the observed areas (dimensions).

The previous results indicate that when evaluating efficiency, it is also essential to monitor the impact of individual inputs and outputs on efficiency. Some units can be efficient only with respect to the ratio of one of its inputs or outputs. An exciting result is the efficiency score of Malta. Malta has become one of the leaders in the field of ICT. In further research, it is necessary to explore its approaches further, which can be an example for other countries.

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CONCLUSION

The main purpose of the paper was to identify the efficiency of the digitalization of the economy and society concerning the performance of the ICT sector. DESI dimensions representing the digitalization of the economy and society were used. To express the performance of ICT sector, the indicator ICT share of GDP was used. The analysis also included the identification of the impact of the dimensions used in the DESI aggregate indicator on the efficiency scores. In the paper, the output-oriented VRS-DEA models with different combinations of inputs were used.

Bulgaria, Greece, Malta, and Romania were efficient in the model with four inputs and an output (in the baseline model). The following countries were slightly below the efficiency frontier in the baseline model: Hungary, Croatia, and Sweden. All three countries are countries that do not need to increase the ICT share of GDP significantly, but a slight increase (relative to the other countries analyzed) is sufficient. Italy, Lithuania, and Slovenia are the countries that should most significantly improve the efficiency score. In all fifteen models, Malta was efficient. None of the country inputs has a highly different value than the other inputs that significantly affect efficiency. The levels of Malta's inputs relative to those of the other countries are balanced. The other three efficient countries, Greece, Bulgaria, and Romania, have never had the same efficiency level in the models. All of their all inputs were not balanced. Based on these findings, Malta is considered significantly positive.

The limitations of this study are that the European Commission (EC) has changed the methodology for evaluating the DESI. Compared to previous years, the EC has made changes in the index concerning individual indicators but also reduced the number of areas for the indicators monitored, which may distort the results of observing the evolution of the index over a more extended time series.

AUTHOR CONTRIBUTIONS

Conceptualization: Eva Grmanová.
Data curation: Eva Grmanová.
Formal analysis: Eva Ivanová.
Investigation: Eva Ivanová.
Funding acquisition: Eva Ivanová.
Resources: Eva Grmanová.
Methodology: Eva Grmanová.
Project administration: Eva Ivanová.
Supervision: Eva Ivanová.
Validation: Eva Grmanová.
Visualization: Eva Ivanová.
Writing – original draft: Eva Grmanová.
Writing – review & editing: Eva Ivanová.

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APPENDIX A

Table A1. Efficiency scores in fifteen output-oriented VRS models in 2018

Source: Own processing in EMS software based on Eurostat (2022), Digital Agenda Data (2021).

Model	1234	1	2	3	4	12	13	14	23	24	34	123	124	134	234
Belgium	169.4	184.08	171.56	194.71	169.4	171.05	184.08	169.4	171.56	169.4	169.4	171.05	169.4	169.4	169.4
Bulgaria	big	73.75	102.04	big	93.39	big	big	73.75	43.55	81.98	big	big	big	big	big
Czechia	140.47	154.09	142.44	158.04	144.13	141.57	154.09	144.13	141.89	140.74	144.13	141.57	140.74	144.13	140.74
Denmark	166.67	169.52	169.52	169.52	166.64	169.52	169.52	166.64	169.52	166.64	166.64	169.52	166.64	166.64	166.64
Germany	152.2	160.06	171.08	163.51	152.2	160.06	160.06	152.2	163.51	152.2	152.2	160.06	152.2	152.2	152.2
Estonia	133.3	140.80	143.41	133.3	143.41	140.80	133.3	140.80	133.3	143.41	133.30	133.3	140.8	133.3	133.3
Greece	big	262.98	big	268.56	207.85	big	262.98	207.85	big	big	207.85	big	big	207.85	big
France	156.55	172.82	159.62	162.77	156.55	159.42	162.77	156.55	158.46	156.55	156.55	158.46	156.55	156.55	156.55
Croatia	114.1	172.47	115.41	161.24	139.73	115.41	161.24	139.73	115.13	114.10	139.73	115.13	114.1	139.73	114.10
Italy	161.27	193.48	163.66	221.68	191.80	161.27	193.48	191.8	163.66	162.09	191.80	161.27	161.27	191.80	162.09
Latvia	131.08	141.39	157.11	131.08	151.34	141.39	131.08	141.39	131.08	151.34	131.08	131.08	141.39	131.08	131.08
Lithuania	214.72	214.72	246.96	242.58	238.59	214.72	214.72	214.72	242.58	238.59	238.59	214.72	214.72	214.72	238.59
Hungary	105.69	110.41	128.76	106.93	105.69	110.41	106.93	105.69	106.93	105.69	105.69	106.93	105.69	105.69	105.69
Malta	78.53	78.53	78.53	78.53	78.53	78.53	78.53	78.53	78.53	78.53	78.53	78.53	78.53	78.53	78.53
Austria	170.97	215.92	171.09	206.45	195.79	171.09	206.45	195.79	171.04	170.97	195.79	171.04	170.97	195.79	170.97
Poland	158.04	175.15	160.68	177.12	170.54	158.06	175.15	170.54	158.19	158.04	170.54	158.06	158.04	170.54	158.04
Romania	big	big	206.68	163.46	big	big	big	big	163.46	big	big	big	big	big	big
Slovenia	189.77	194.75	215.32	212.71	189.77	194.75	194.75	189.77	212.71	189.77	189.77	194.75	189.77	189.77	189.77
Slovakia	149.62	165.37	169.90	170.04	146.62	165.37	165.37	149.62	168.65	149.62	146.62	165.37	149.62	149.62	149.62
Finland	153.16	159.38	153.16	159.38	159.38	153.16	159.38	159.38	153.16	153.16	159.38	153.16	153.16	159.38	153.16
Sweden	127.19	130.13	130.13	130.13	127.19	130.13	130.13	127.19	130.13	127.19	127.19	130.13	127.19	127.19	127.19

Note: The model is denoted by the combination of inputs, e.g., "2" is a model with the first input and the second input; "14" is a model with two inputs, the first and the fourth. Note 2: The EMS program also expresses the score of super-efficiency. They are denoted as big or by a value less than 100.

Table A2. Efficiency scores in fifteen output-oriented VRS models in 2019

Source: Own processing in EMS software based on Eurostat (2022), Digital Agenda Data (2021).

Model	1234	1	2	3	4	12	13	14	23	24	34	123	124	134	234
Belgium	142.28	174.07	142.28	181.95	166.87	142.28	174.07	166.87	142.28	142.28	166.87	142.28	142.28	166.87	142.28
Bulgaria	big	73.18	95.3	big	87.40	48.38	big	73.18	big	77.01	big	big	big	big	big
Czechia	147.72	151.86	148.06	154.68	147.72	148.06	151.86	147.72	148.06	147.72	147.72	148.06	147.72	147.72	147.72
Denmark	169.47	170.98	170.98	170.98	169.47	170.98	170.98	169.47	170.98	169.47	169.47	170.98	169.47	169.47	169.47
Germany	160.14	163.23	175.29	167.19	160.14	163.23	163.23	160.14	167.19	160.14	160.14	163.23	160.14	160.14	160.14
Estonia	121.48	125.48	128.09	121.48	128.09	125.48	121.48	125.48	121.48	128.89	121.48	121.48	125.48	121.48	121.48
Greece	big	301.69	big	308.14	242.59	big	301.69	242.59	big	big	242.59	big	big	242.59	big
France	159.91	167.06	173.7	163.34	159.91	167.06	163.34	159.91	163.34	159.91	159.91	163.34	159.91	159.91	159.91
Croatia	114.96	167.93	114.96	161.42	148.37	114.96	161.42	148.37	114.96	114.96	148.37	114.96	114.96	148.37	114.96
Italy	201.92	201.92	219.06	219.30	202.05	201.92	201.92	201.92	219.06	202.05	202.05	201.92	201.92	201.92	202.05
Latvia	126.50	128.86	141.59	126.50	137.60	128.86	126.50	128.86	126.50	137.60	126.50	126.50	128.86	126.50	126.50
Lithuania	198.29	198.29	218.86	214.60	214.61	198.29	198.29	198.29	214.60	214.61	214.60	198.29	198.29	198.29	214.60
Hungary	110.64	111.62	124.43	110.71	110.64	111.62	110.71	110.64	110.71	110.64	110.64	110.71	110.64	110.64	110.64
Malta	86.42	86.42	86.42	86.42	86.42	86.42	86.42	86.42	86.42	86.42	86.42	86.42	86.42	86.42	86.42
Austria	181.75	205.56	181.75	201.61	197.48	181.75	201.61	197.48	181.75	181.75	197.48	181.75	181.75	197.48	181.75
Poland	167.13	185.62	167.13	188.89	184.37	167.13	185.62	184.37	167.13	167.13	184.37	167.13	167.13	184.37	167.13
Romania	big	big	204.81	178.18	big	big	big	big	178.18	big	big	big	big	big	big
Slovenia	191.03	191.23	205.91	202.32	191.03	191.03	191.23	191.03	202.32	191.03	191.03	191.23	191.03	191.03	191.03
Slovakia	152.55	162.79	152.55	165.66	155.16	152.55	162.79	155.16	152.55	152.55	152.16	152.55	152.55	155.16	152.55
Finland	156.01	156.01	156.01	156.01	156.01	156.01	156.01	156.01	156.01	156.01	156.01	156.01	156.01	156.01	156.01
Sweden	116.75	118.21	118.21	118.21	116.75	118.21	118.21	116.75	118.21	116.75	116.75	118.21	116.75	116.75	116.75

Note: The model is denoted by the combination of inputs, e.g., "2" is a model with the first input and the second input; "14" is a model with two inputs, the first and the fourth. The EMS program also expresses the score of super-efficiency. They are denoted as big or by a value less than 100.

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