Leveraging Opportunities for Public Sector Digitalisation: A Macroeconomic Analysis

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ABSTRACT

The aim of this study is to explain from an econometric point of view, the relationship between digitalisation in the public domain and opportunities in the environment of public sector organisations. The analysis is carried out on a set of 29 European countries, and the EU-27 average, on a specific period of time. The panel data regression analysis reveals both positive and negative relationships, as well as direct and indirect connections between variables of interest. After presenting the regression results, one can conclude that changes in the level of opportunities may influence changes in the digitisation process at the level of each country included in the analysis. Six hypotheses were tested by the econometric model. Among them, only one has been validated for 26 out of 30 cases. It is the one testing the positive link between digitisation in the public sector and the way the Internet is being used, respectively, for goods and services search activities.

KEYWORDS: *broadband coverage*, *cloud services*, *digitisation, digital skills, internet use.*

JEL CLASSIFICATION: *C23, L86, P35.*

1. INTRODUCTION

Digitisation, as a process of using information and communication technologies, was accelerated by the Sars-Cov2 pandemic, and although it has stopped, it is now desired to continue and strengthen the process, especially in the public sector. All countries in the world are in the process of digitising economic activities in the public and private sectors, even if at different stages. According to the Digital Economy and Society Index (European Commission, 2022), Romania ranks last among the 27 states of the European Union. The low level of digitisation in our country is characterised by low digital public services compared to other EU member states.

When society realised that the digital transformation can have countless effects on a personal, social, but also on an economic level, different research paths were outlined; at the moment it is considered that their multitude and diversity explain a complex nature of the process of digitisation (Zemlyak et al., 2022). Thus, the impact that digitisation exerts on the economic environment was and is of interest to researchers (Boikova et al., 2021; Radicic & Petković, 2023; Sarbu, 2022;), but also the impact produced by the resources available in an economy on digitisation, namely human, technological, financial, information and communication technology resources and infrastructure (Chwiłkowska-Kubala et al., 2023; Wu et al., 2006). We will continue to focus on those factors that will be analysed in the present research,

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namely: access to the Internet, digital skills of users, coverage of high-speed Internet services, the way of using the Internet, and the integration of digital technologies.

The objective of this study is to highlight the link between digitisation in the public domain and opportunities in the environment of public sector organisations. The analysis will be carried out at the macroeconomic level, for countries in the European Union for which statistical data are available on the elements listed above. The research will rely on regression analysis to capture how changes in digitisation depend on changes in opportunities.

2. LITERATURE REVIEW

In the first instance, we will pay attention to Internet access as a factor which growth has caused changes in the business environment, in health, education and various industries and sectors of the economy, both in the public and private spheres. Internet access is seen as a tool to develop a country's economy, as people have the opportunity to be connected, work, shop, and study (Adelore & Itasanmi, 2016; Kouton, 2019). A recent study (Rajagukguk, 2022) showed that access to and use of the Internet can lead to greater access to electricity, higher GDP, lower inflation, and greater inflow of foreign direct investment. In terms of how the Internet is used, it has been found that there are various factors that influence it, from age, gender, financial situation, and level of education (Chong, 2013; Filippova & Turutina, 2015) to the quality of the sought service or product, trust, perceived usefulness, perceived ease of use, consumer attitude (Sharma et al., 2015).

Challenges also arise when it comes to digital skills, on the one hand for users of public services and, on the other hand, for employees of public institutions. These may refer to: willingness to learn and work with new technologies (Ngereja & Hussein, 2022), adoption of digital tools and technologies and collaboration in remote work teams (Wu, 2022), digital marketing skills, cloud services, data, cyber security (Marhraoui, 2023). Within the scientific literature, the digital competences are classified as (Van Deursen & Van Dijk, 2008): 1) operational skills (these refer to the skills to operate digital environments); (2) formal skills (these refer to the abilities to manage the special structures of digital environments, such as menus and hyperlinks); (3) information skills (for instance to search for, select and evaluate information in the digital environment) (4) strategic skills (to use the information contained in the digital environment as means to achieve a certain personal or professional goal).

Last but not least, the coverage of high-speed Internet services has attracted the attention of researchers, who consider this factor as a key factor for the socio-economic development of countries, regions and communities (Cardona et al., 2013), with an impact on growth economic (Gómez-Barroso & Marbán-Flores, 2020). This is considered especially since access to such services is not evenly distributed between urban and rural environments, rural communities being the ones affected, in the sense of limiting them in terms of development opportunities, social connection, with negative effects on the quality of life (de Clercq et al., 2023).
By using digitisation in public sector organisations, the aim is to provide transparent services, to achieve them in a much faster way compared to traditional ways, and also more efficiently, sometimes maybe even cheaper, debureaucratisation, and, last but not least, improving interaction between citizens and public institutions. Rethinking public services through the use of digital technologies is both a challenge and a benefit for society and its individuals, as well as for organisations. The opportunities that can make the digitisation process faster, that can support the digital transformation of the public sector are, according to the authors,

related to: access to the Internet, digital skills of users, coverage with high-speed Internet services, ways of using the Internet (which can be diverse, depending on the interests of individuals), the integration of digital technologies.

3. METHODS

The present research study follows clear methodological steps, further presented:
(1) Selecting macroeconomic indicators for the theme of interest, for a specific period of time, for each most of the data is available and for a set of countries.
(2) Applying the moving average to those series that have missing data for some years.
(3) Proposing an econometric model to be tested.
(4) Testing the Least Squares (LS) assumptions, which are intrinsic to the method's application.
(5) Testing the hypothesis of the research by conducting the regression analysis.
(6) Discussing the results.

The European countries included in the analysis are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Great Britain, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Netherlands, Hungary. The European Union - 27 is also included.

The econometric model to be tested has the following features: (1) it uses panel data (30 cross-sections over a period of eight years, from 2014 until 2021) for studying the relationship of a dependent variable and seven independent variables; (2) it is a model with fixed effects (for each individual state, a constant will be estimated; this has the purpose of adding a small part of those elements that influence digitisation in the public sector and that were not included in the model); (3) it has the following form:

$$Y_{it} = \alpha_i + \beta_{i1} \times X_{1it} + \beta_{i2} \times X_{2it} + ... + \beta_{ik} \times X_{kit} + \varepsilon_{it} \quad (1)$$

where:
- ✓ Y_{it} – the dependent variable of the model;
- ✓ α_i – a constant term (varies on each cross-section);
- ✓ $1...k$ – range for the dependnet variable;
- ✓ β_{ik} – estimated coeficient for the "k" independent variable;
- ✓ X_{kit} - the "k" independent variable, with time-varying and cross-sectional varying values;
- ✓ ε_{it} – the error term;
- ✓ i – a cross sectional unit;
- ✓ t – a time unit.

The dependent variable proposed for this model is *Internet use: interaction with public authorities (last 12 months)* (Eurostat, 2023a). The envisaged independent variables are: *Individuals who have basic or above basic overall digital skills* (Eurostat, 2023b), *Frequency of Internet access: once a week (including every day)* (Eurostat, 2023c), *Internet use: telephoning or video calls* (Eurostat, 2023d), *Internet use: finding information about goods and services* (Eurostat, 2023e), *Broadband Internet coverage by speed (More than 100 Mbps).*

(Eurostat, 2023f), *Last Internet use: in the last 12 months* (Eurostat, 2023g), *Used Internet storage space to save documents, pictures, music, video or other files* (Eurostat, 2023h).

Taking into account the proposed model and the variables that are to be discussed, this study will focus on the following econometric model:

$$IU_{it} = a_i + b_i \times DS_{it} + c_i \times Fia_{it} + d_i \times Ia1_{it} + e_i \times Ia2_{it} + f_i \times IC_{it} + g_i \times Lia_{it} + d_i \times UC_{it}\varepsilon_{it} \quad (2)$$

where:
IU – Internet use: interaction with public authorities (last 12 months)
DS – Individuals who have basic or above basic overall digital skills
Fia – Frequency of Internet access: once a week (including every day)
Ia1 – Internet use: telephoning or video calls
Ia2 – Internet use: finding information about goods and services
IC – Broadband Internet coverage by speed (More than 100 Mbps)
Lia – Last Internet use: in the last 12 months
UC – Used Internet storage space to save documents, pictures, music, video or other files (cloud services)

Within the following section of the paper, the results of the regression estimation will be presented and discussed.

4. RESULTS OF REGRESSION ANALYSIS

To estimate the coefficients of this econometric model, the Method of Least Squares (MCMMP) will be used. This inherently involves testing the following seven hypotheses about the model, independent variables, and errors, further presented in Figure 1.

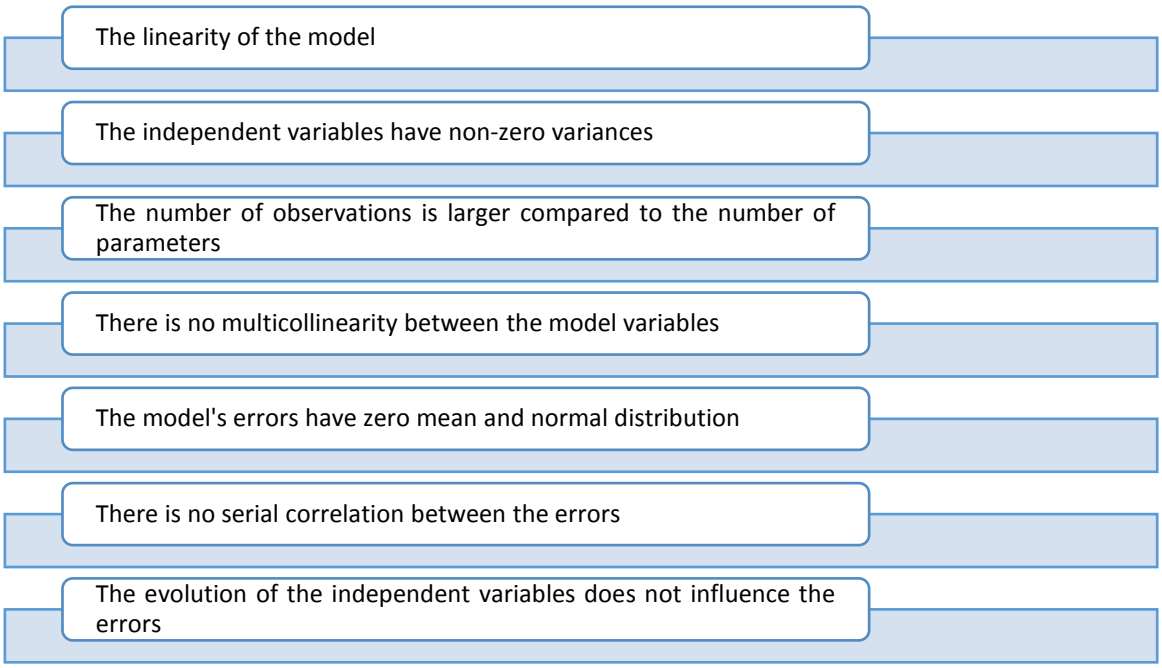

Figure 1. Assumptions intrinsic to the application of Least Squares method
Source: the authors (Cicea et al., 2022)

Considering the fact that the model involves the use of panel data, for the ease of estimating the coefficients, the EViews 13.0 software will be used. Among all assumptions, only the last two could not be validated. However, there are some ways of dealing with correlation, as well as with heteroscedasticity. As the correlation is present, the White Cross Section option (from

EViews when setting all LS application conditions) will be used. Thus, the correlation is allowed between cross-sections, and through the panel data model estimation, it is greatly reduced. As for the last assumption referring to homoscedasticity, the observations do not have the same error variance. In this case, the hypothesis is not validated. It is thus required to assign an equal weight to each cross-sectional unit in the regression (Cross Section Weights option in EViews).

As for the hypotheses to be validated or disproved by the multiple regression model with panel data, they are formulated as follows:
H1: *there is a positive link between digitisation in the public sector and the level of digital competence of Internet users.*

H2: *there is a positive link between digitisation in the public sector and the frequency of Internet use.*

H3: *there is a positive link between digitisation in the public sector and Internet usage*
H3a: Internet use: telephoning or video calls
H3b: Internet use: finding information about goods and services

H4: *there is a positive link between digitisation in the public sector and the degree of cloud services usage*

H5: *there is a positive link between digitisation in the public sector and Internet use in the last 12 months*

H6: *there is a positive link between digitisation in the public sector and the degree of broadband coverage*

To estimate the coefficients of the panel data multiple regression model, the time series were imported into an Eviews 13.0 worksheet. After applying all conditions and using the available options, the coefficients were estimated using the LS technique. The results presented in Table 1 were obtained.

Table 1. Results obtained after LS estimation

EU - 27
IU = 506.82 - 493.9 - 0.69*DS - 1.39*FIA + 0.06*IA1 + 0.202*IA2 + 0.21*IC + 1.91*LIA - 0.08*UC
Austria
IU = 993.41 - 493.9 + 2.51*DS - 2.09*FIA - 0.18*IA1 - 1.53*IA2 + 2.69*IC - 4.85*LIA - 1.82*UC
Belgium
IU = 621.06 - 493.9 - 2.67*DS - 0.71*FIA + 0.10*IA1 + 2.43*IA2 + 1.87*IC - 2.35*LIA + 0.005*UC
Bulgaria
IU = 567.05 - 493.9 - 0.75*DS - 2.23*FIA + 1.67*IA1 + 0.22*IA2 + 0.26*IC + 0.07*LIA - 0.23*UC
Croatia
IU = 793.51 - 493.9 + 2.66*DS - 12.12*FIA - 0.84*IA1 + 1.13*IA2 + 1.94*IC + 3.42*LIA + 5.34*UC
Cyprus
IU = 630.62 - 493.9 + 1.84*DS + 3.07*FIA + 0.66*IA1 + 1.71*IA2 + 0.04*IC - 7.41*LIA + 0.79*UC
Czech Republic
IU = 120.4 - 493.9 + 2.38*DS + 1.04*FIA + 2.76*IA1 + 0.69*IA2 - 1.65*IC + 0.88*LIA + 2.48*UC
Denmark
IU = 788.89 - 493.9 + 0.81*DS - 4.32*FIA + 0.23*IA1 - 0.66*IA2 + 3.29*IC - 1.07*LIA - 0.17*UC
Estonia

IU = -1460.91 - 493.9 + 1.97*DS + 25.97*FIA + 5.53*IA1 + 8.93*IA2 - 9.65*IC - 7.73*LIA + 1.09*UC
Finland IU = 894.05 - 493.9 - 1.58*DS + 6.07*FIA + 0.51*IA1 + 1.71*IA2 - 0.38*IC - 9.64*LIA + 0.1*UC
France IU = 479 - 493.9 + 1.33*DS + 3.72*FIA - 0.21*IA1 - 0.66*IA2 – 0.00*IC - 2.84*LIA + 0.005*UC
Germany IU = 315.75 - 493.9 - 0.98*DS- 5.18*FIA - 0.49*IA1 + 0.95*IA2 + 0.11*IC + 6.97*LIA + 1.93*UC
Greece IU = 326.24 - 493.9 + 0.13*DS - 1.39*FIA - 0.73*IA1 + 0.38*IA2 + 0.016*IC + 4.75*LIA - 1.51*UC
Ireland IU = 748.2 - 493.9 - 1.44*DS + 16.54*FIA - 0.17*IA1 + 2.56*IA2 + 1.01*IC - 18.95*LIA - 2.31*UC
Italy IU = 419.04 - 493.9 + 2.41*DS + 0.34*FIA - 0.16*IA1 + 0.21*IA2 + 0.16*IC - 0.64*LIA + 0.47*UC
Latvia IU = 159.62 - 493.9 - 2.18*DS + 4.92*FIA - 1.9*IA1 + 0.96*IA2 + 2.65*IC - 0.18*LIA - 2.79*UC
Lithuania IU = 435.47 - 493.9 + 1.86*DS + 1.46*FIA - 1.62*IA1 + 0.63*IA2 + 1.97*IC - 1.86*LIA - 0.64*UC
Luxembourg IU = -14260.6 - 493.9 - 2.54*DS - 119.16*FIA + 0.56*IA1 - 1.91*IA2 - 34.19*IC + 312.1*LIA- 16.97*UC
Malta IU = 1847.86 - 493.9 + 0.2*DS - 0.52*FIA + 0.42*IA1 + 0.42*IA2 - 14.05*IC + 0.97*LIA - 0.05*UC
Great Britain IU = 783.54 - 493.9 + 0.74*DS - 1.02*FIA + 0.67*IA1 + 2.21*IA2 – 0.00009*IC - 4.33*LIA + 0.28*UC
Norway IU = 877 - 493.9 - 0.69*DS + 6.24*FIA + 0.29*IA1 + 0.15*IA2 - 0.05*IC - 9.0*LIA + 0.24*UC
Poland IU = 1040.92 - 493.9 + 3.41*DS + 7.54*FIA + 0.17*IA1 + 2.31*IA2 + 2.78*IC - 18.56*LIA - 0.98*UC
Portugal IU = 361.44 - 493.9 - 0.25*DS- 9.18*FIA + 1.39*IA1 + 0.96*IA2 - 1.81*IC + 10.24*LIA + 3.24*UC
Romania IU = 494.24 - 493.9 + 0.72*DS + 0.75*FIA + 0.01*IA1 + 0.32*IA2 + 0.95*IC - 2.003*LIA + 0.35*UC
Slovakia IU = 335.06 - 493.9 - 1.48*DS - 3.86*FIA + 0.07*IA1 - 1.36*IA2 - 0.35*IC + 7.95*LIA + 1.27*UC
Slovenia IU = 642.39 - 493.9 - 4.17*DS - 6.73*FIA - 0.06*IA1 + 2.07*IA2 + 2.7*IC + 3.23*LIA + 1.58*UC
Spain IU = 219.01 - 493.9 - 1.08*DS - 1.23*FIA - 0.34*IA1 + 0.39*IA2 - 1.83*IC + 8.14*LIA - 2.02*UC
Sweden IU = 484.16 - 493.9 - 0.77*DS + 6.63*FIA - 0.34*IA1 + 0.14*IA2 + 0.68*IC - 5.09*LIA - 0.48*UC
The Netherlands IU = 639.6 - 493.9 - 0.53*DS - 7.53*FIA - 0.02*IA1 + 1.81*IA2 + 1.02*IC + 3.94*LIA + 1.08*UC
Hungary IU = -802.89 - 493.9 + 117.97*DS + 230.35*FIA - 4.51*IA1 - 37.54*IA2 + 57.98*IC - 294.2*LI - 5.32*UC

Source: authors with EViews

Observing the regression equations obtained and presented in Table 1, there are some comments to be made and ideas that can be highlighted. The value of 493.9 appears each time, as it represents the average of the constant value for the 30 studied entities (cross-sections).

The first value (negative or positive) within each equation represents the deviation from the average value for the 30 cross-sections.

The constant of a regression equation, in the present situation is calculated as the sum of the constant average value and the deviation from that value. For example, in the case of Romania, the constant of the equation is 0.34.

If we observe the constant of the equations, we can find both larger and smaller values, as well as positive and negative values. Thus, it is appreciated that there are certainly other factors that were not included in the analysis and that can influence digitisation to a great extent (when the values of the constant are high, for example in the case of Poland) or to a lesser extent (when the values of the constant are small, for example in the case of Romania). Also, these factors as a whole can have a negative effect on the development of digitisation (for example, in the case of Hungary) or they can have a positive effect (for example, in the case of Poland).

Table 2. Hypotheses' validation

No. crt.	State	H1	H2	H3a	H3b	H4	H5	H6
1	European Union -27			✓	✓	✓	✓	
2	Austria	✓				✓		
3	Belgium			✓	✓	✓		✓
4	Bulgaria			✓	✓	✓	✓	
5	Croatia	✓			✓	✓	✓	✓
6	Cyprus	✓	✓	✓	✓	✓		✓
7	Czech Republic	✓	✓	✓	✓	✓		✓
8	Denmark	✓		✓		✓		
9	Estonia	✓	✓	✓	✓			✓
10	Finland		✓	✓	✓			✓
11	France	✓	✓					✓
12	Germany				✓	✓	✓	✓
13	Great Britain	✓		✓	✓			✓
14	Greece	✓			✓	✓	✓	
15	Hungary	✓	✓			✓		
16	Ireland		✓		✓	✓		
17	Italy	✓	✓		✓	✓		✓
18	Latvia		✓		✓	✓		
19	Lithuania	✓	✓		✓	✓		
20	Luxembourg				✓		✓	
21	Malta	✓		✓	✓		✓	
22	Norway		✓	✓	✓			✓
23	Poland	✓		✓	✓	✓		
24	Portugal			✓	✓		✓	✓
25	Romania	✓	✓	✓	✓	✓		✓
26	Slovakia				✓		✓	✓
27	Slovenia				✓	✓	✓	✓
28	Spain				✓		✓	
29	Sweden		✓		✓	✓		
30	The Netherlands				✓	✓	✓	✓

Source: the authors

The subunit values (either positive or negative) of the coefficients associated to some of the variables, indicate a reduced influence of them on digitisation in the public domain. At the same time, the above-unit values that were obtained for the coefficients associated with some of the independent variables, show a high influence of the respective independent variable on digitisation. For example, in the case of Romania, the greatest influence on digitisation is recorded for the use of the Internet in the last 12 months. For this, a 1% increase in those who use the Internet in a year means a decrease of approximately 2% in those who interact online with public institutions.

Table 2 is useful in observing the influences exerted by each of the three variables on the level of digitisation in the public domain. According to Table 2, there is no situation for which all six hypotheses could have been validated.

5. CONCLUSIONS

We believe that the purpose of this work has been achieved, since the regression analysis was able to highlight specific aspects: (1) it does support the idea that digitisation in the public system is in a continuous process of improvement in the European Union states; (2) they can capitalise on the fact that, most of the time, strong associations have resulted between the digitisation process in the public system and its opportunities; (3) the results can lead to the understanding of the relationships between the digitisation process and opportunities, in the sense that they can bring added value if properly exploited.

From the statistical analysis of the data, respectively, from their time series analysis, the Nordic countries on the continent are distinguished on every occasion, with very good levels for the use of the Internet in the interaction with public authorities, for a high frequency of access on the Internet, above the EU-27 average, and with a very high level of Internet users' digital skills. At the opposite pole are countries such as Greece, Lithuania, Poland, Portugal, Croatia, Italy, Bulgaria, and Romania.

Moving on to the regression analysis, it reveals how changes in the level of opportunities can influence changes in the digitisation process at the level of each country included in the analysis. In the case of Romania, six out of seven tested hypotheses were validated. Thus, there is a positive link between digitisation in the public sector and the level of digital competence of Internet users, the frequency of Internet use, the mode of Internet use, the degree of cloud service use, and the degree of broadband coverage. These links, although positive, are indirect, indicating a reduced influence of the variables considered as opportunities on digitisation. A direct but negative relationship was established between the dependent variable and Internet use in the past 12 months.

There was no situation in any country for which all six hypotheses could have been validated. However, for Romania, Cyprus, and Czech Republic, there is only one rejected hypothesis, H5, the one testing *a positive link between digitisation in the public sector and Internet use in the last 12 months.* H2 and H5 are the two tested assumptions which were least validated, while H3b (*there is a positive link between digitisation in the public sector and Internet usage: finding information about goods and services*) is the one most validated among all.

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