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The synergy between institutionalism and digitalization in the EU27: the road to more effective national governments

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Abstract
Institutionalism ranges from theories in the social sciences to political theories that underscore the pivotal role of institutions in creating regulations, guiding behavior, stabilizing societies, and supporting social development. This research primarily examines the interplay between institutionalism and digitalization in EU member states, demonstrating their interaction. The findings support the research hypothesis, indicating that digitalization is increasing the effectiveness of government. Consequently, EU member states that have strengthened digital capabilities and implemented e-governance have seen notable progress in transparency, accessibility, and institutional effectiveness. Meanwhile, digitalization reshapes the institutional structure, streamlines administration, and supports the advancement of the public sector. These outcomes may inform digitalization-centered public policies. This paper contributes to the relevant literature by revealing the institutionalism-digitalization relationship and confirming a positive link between digitalization and the effectiveness of government.

Keywords: government effectiveness, e-gov, institutionalism, digitalization policy, digital technology

Introduction

The close relationship between digitalization and institutionalization is reshaping modern society. Digital tools not only transform the operations of institutions, organizations, and governments, but they also impact the development of rules and structures within these bodies. Here, digitalization refers to the increasing influence of digital tools in daily life and institutions. Institutionalism influences the behavior of actors within institutions. Digitalization is transforming

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the way institutions operate and interact with society. For instance, governments now utilize online services to enhance transparency, increase efficiency, and reduce corruption. Institutionalism examines the norms that help maintain societal stability. As technology advances quickly, organizations must adapt just as fast. Digitalization and institutions interact in an ongoing, dynamic relationship.

Digitalization shapes the digital economy in areas such as AI and cryptocurrency. At the same time, institutionalism determines how these impacts should be managed to ensure accountability and sustainability. Theories of institutionalism offer valuable insights into understanding and guiding digitalization. This encourages responsible and sustainable adoption. Digitalization also raises challenges. For instance, entrenched bureaucratic structures exist that would be difficult to displace. It could also contribute to some risks like centralization, digital divide, and overdependence on technology, which can cause mental illness, cyber-bullying, and social media misinformation. The publication of this article does not aim to address the same risks in detail; however, they need to be addressed as soon as possible. With the proliferation of digitalization, it is vital to embrace technology at a sustainable pace. Primarily, education is needed, along with clear (ethical) guidelines and substantial investments in infrastructure. Those actions help society realize the benefits of digitalization while reducing its risks.

This research paper aims to conceptualize and empirically examine the interaction between digitalization and institutionalism in the context of public governance within EU member states. Initially, specialized literature will be synthesized to examine diverse perspectives on how digital technologies advance institutionalism and to identify shared elements, such as governance and development, within an institutional framework. We will then test the hypothesis that digitalization enhances governance through empirical analysis. Our methodology progresses from a broad literature review to a systematic quantitative assessment, ultimately advancing understanding of how digitalization streamlines governance and institutions. This process establishes a robust theoretical and empirical foundation for future public policy and digital initiatives.

In the first part, we will review the literature on the subject under analysis. Thus, we will present notions about digitalization and institutionalism, explore the advantages of their duality, and discuss other related topics, such as the EU 2030 digitalization agenda and the Digital Economy and Society Index (DESI). In the second part, we formulate the research hypothesis. Variables subject to empirical analysis will be described in Section 3 of the research methodology.

1. Theoretical foundations

To begin, we will define the terminology and concepts that we use. By definition, digitalization is a complex process that involves integrating digital technologies into various aspects of life and business, transforming the way

organizations operate and interact with their environment. This is not limited to the implementation of technologies, but also includes essential organizational and pedagogical changes. The stages preceding digitalization, which include technologies like computers and the internet, have contributed to the current trend, marking the emergence of a digital society.

This development necessitates that social institutions adapt to the complexity of the new digital reality. Digital platforms are becoming essential pillars, including within public administration, while the challenges generated by the virtual world call for a reevaluation of social structures and traditional governance models (Vasilenko et al., 2022). Digitalization facilitates the optimization of service quality and increases customer satisfaction. However, it is accompanied by significant risks, including cybersecurity vulnerabilities, potential job losses due to automation (Subach, 2024), and psychosocial risks (Moja, 2024). Digital inclusion and access to ICT have a significant impact on the quality of life at the global level (Alhassan and Adam, 2021). Access to ICT, as well as ICT usage by the government, has a significantly positive impact on public sector performance (Dogbe et al., 2024).

On the other hand, institutionalism is an influential theory in political science and organizational studies that examines the role of institutions in shaping social and political outcomes. Modern institutionalism is a complex and diverse field, encompassing multiple versions: sociological, historical, and rational choice institutionalism (Hall and Taylor, 1996). Therefore, modern institutionalism does not represent a unified body of thought, but rather a collection of distinct analytical approaches (Hall and Taylor, 1996; Immergut, 1998).

Sociological institutionalism explores how cultural norms and values shape behaviours and organizational structures, while historical institutionalism focuses on macro-political or macroeconomic determinants, emphasizing the importance of institutions and being valued for its ability to explain complex and path-dependent processes (Kelly, 2019; Hall and Taylor, 1996). Rational choice institutionalism is grounded in rational choice theory and the maximization of individual benefits. It is often used to explain political and economic behaviors through the lens of personal interests and institutional constraints (Hall and Taylor, 1996).

Without pretending to list all types of institutionalism, a few less discussed forms should be mentioned:

- *The new Economic Institutionalism* that focuses on the economic aspects of institutions, analysing the policies of redistribution, regulation, and modernization;
- *Regulatory institutionalism* that focuses on the norms and values that guide institutional behaviors;
- *Institutionalism „billiard ball"* that analyzes interactions between different institutions and their impact on public policies (Reich, 2000).

In the current technological era, we can go even further by defining digital institutionalism. This type of institutionalism refers to the processes by which norms

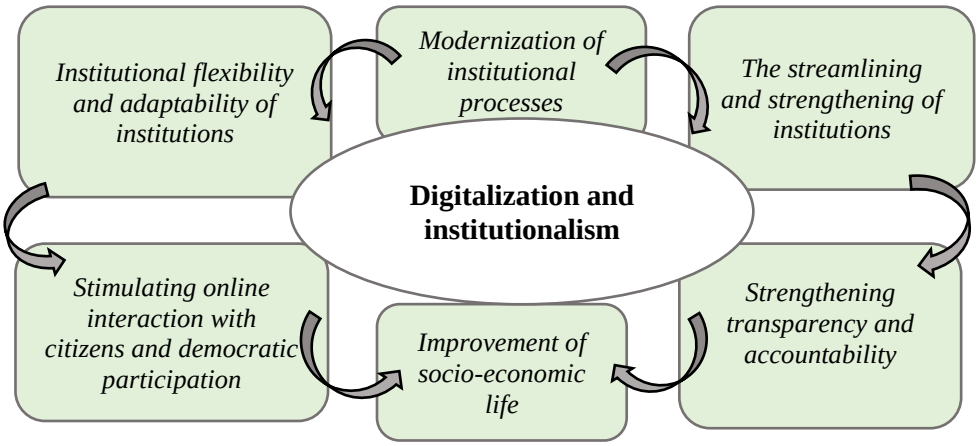
and rules are integrated into digital infrastructures, thereby changing social and organizational practices. The digitalization of institutional entities — such as those in the medical sector (for prescriptions), treasuries (for payments), or the insurance field — exemplifies the process of institutionalization in the digital environment (Eriksson and Ehlund, 2024).

The role of political entrepreneurs and key explanatory factors is essential in influencing the stability and change of digital policies (Torfs et al., 2022), while the success of digital inclusion projects depends on several stages — gaining recognition from the community, encouraging social activities within relevant groups, establishing connections to stable sources of income, and mobilizing institutional support from government authorities (Madon et al., 2009) — all of which contribute to the advancement of governmental digitalization, which in turn shows a significant positive correlation with the effectiveness of public administration, particularly in terms of governmental efficiency, combating corruption, and stimulating economic activity (Dobrolyubova et al., 2019).

1.1. Advantages of duality digitalization-institutionalism

Digitalization brings multiple benefits, optimizing processes and increasing efficiency for public institutions, as well as improving public services for citizens and companies. These advantages are summarized schematically in Figure 1, and we will elaborate on them further, providing references from the literature.

Figure 1. Advantages of binomial digitalization – institutionalism



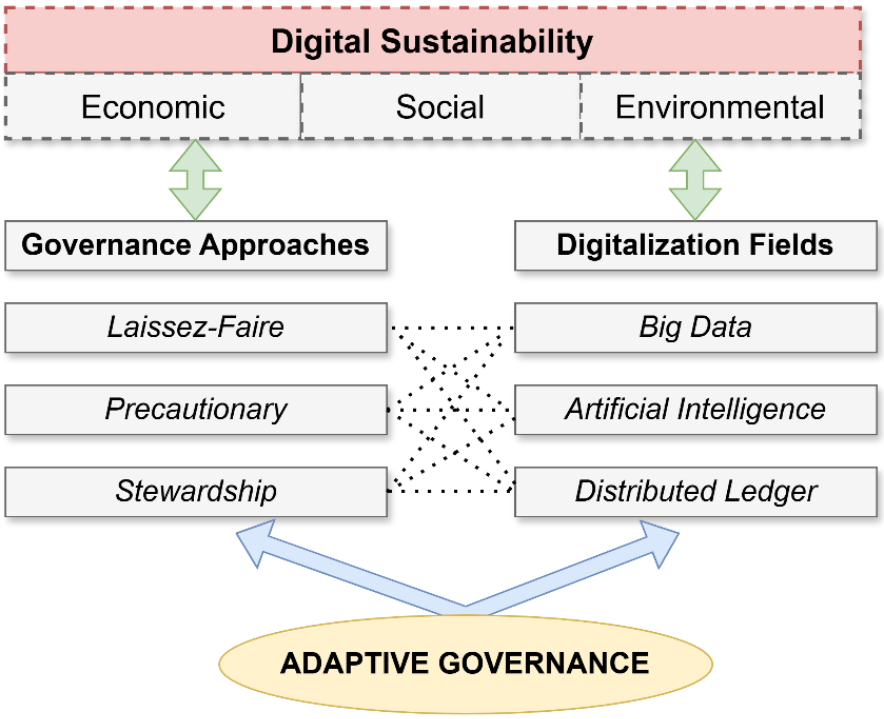
Source: authors' representation

Modernization of institutional processes

Digitalization facilitates the restructuring of traditional bureaucracy, as outlined in classical institutional theory, thereby reducing the influence of traditional institutional structures and allowing for a reevaluation of fundamental theoretical principles (Schildt, 2022). By implementing electronic processes (e-government), government institutions can reduce the time and resources required for administrative functions, including the digital filing of applications, automating public services, and creating an interconnected digital infrastructure among institutions, which simplifies bureaucracy and enhances the government's response to citizens' needs (Zubarev and Ivanov, 2021).

From the perspective of normative institutionalism, digitalization strengthens the principles of transparency and accountability, promoting open governance. On the other hand, while digitalization improves transparency, measures are needed to prevent cyber fraud and protect citizens' data (Mynenko and Lyulyov, 2022). Online platforms for publishing budget data and providing citizens with access to public interest information help build trust in institutions and reduce corruption (Thanh, 2022).

Figure 2. Digital Sustainability



Source: authors' adaptation after Linkov et al. (2018)

Accelerating the flexibility and adaptability of institutions

According to historical institutionalism, institutions evolve slowly, but digitalization is accelerating this process. The technology provides a flexible framework that enables rapid policy adaptation, the deployment of digital solutions in unforeseen crises (e.g., the COVID-19 pandemic), and the development of analytical and predictive capabilities for informed decision-making through data analysis using modern technologies. Thus, digitalization facilitates *adaptive governance*, enabling it to respond effectively to new challenges.

Adaptive governance *can be defined as adjusting regulatory rules and practices to incorporate new data and balance the risks and benefits of a given activity.* A flexible and adaptive government administration can be strengthened through legislative measures, voluntary partnerships among relevant actors, and collaboration between industry, academia, and civil society. The objectives are to monitor digital services, mitigate risks, and develop effective governance strategies. Figure 2 is relevant (after Linkov et al., 2018).

Stimulating online interaction with citizens and democratic participation

Modern institutionalism emphasizes the importance of the interaction between institutions and citizens. Digitalization offers citizens new channels for active involvement in decision-making, such as public consultation platforms and e-voting, thereby contributing to more inclusive and democratic governance.

A sociological study conducted in Russia highlights that government initiatives to develop a digital environment for interacting with citizens can adequately meet societal demands. These measures would help to reduce bureaucracy and administrative formalism, while facilitating a more efficient and accessible process in the delivery of public services (Zubarev & Ivanov, 2021).

Improving socio-economic life

Digitalization presents unique opportunities for enhancing socioeconomic well-being. On the other hand, also through the prism of modern institutionalism, the process of digitalization is guided, regulated, and adapted through state institutions to meet social and economic needs. In this context, digitalization forms the foundation of the modern economy, driving technological innovation and enhancing various aspects of social life, including the labour market, education, and health (Bessonova & Battalov, 2020). The institutionalization of the digital economy, as an emerging economic model, is driven by the interaction of technological, organizational, and humanities innovations (Vasilenko et al., 2020). Evidence from Europe between 2011 and 2019 shows that digital business transformation via e-commerce contributed to economic complexity, which in turn accelerated

digitalization, indicating a bidirectional relationship (Ha, 2022). Key indicators of digital transformation include broadband coverage, software skills, and the share of businesses using big data and online commerce (Olczyk & Kuc-Czarnecka, 2022).

The COVID-19 pandemic has further accelerated digitalization, fostering significant economic growth, with advanced countries reaping greater benefits than those in earlier stages of the process (Parubets, 2022). In Ukraine, digitalization has facilitated virtual socialization and institutionalization, supporting socio-economic development through inclusive institutions and the promotion of political and economic pluralism (Ivashyna et al., 2023).

Enhancing institutions

From the perspective of *rationalist institutionalism*, we will retain only the proper meaning of our construct: digitalization can optimize the costs and resources of government institutions, thereby increasing their ability to implement effective public policies.

1.2. Digital innovation and institutionalism

Digital innovation and institutionalism are two key concepts for understanding how emerging technologies are transforming society and the economy. Digital innovation (artificial intelligence, blockchain, big data) provides significant opportunities for the modernization of institutions. In turn, institutionalism provides the necessary framework for the responsible adoption of digital innovations.

On the other hand, the institutional perspective is a crucial framework for analysing digital innovation and transformation. Digital innovation refers to the development of new products and services, while digital transformation reflects the effects of these innovations. It reconfigures actors, structures, practices, and values, and changes the rules in organizations and various fields. This approach examines how new arrangements gain social legitimacy and interact with existing institutional structures (Hinings et al., 2018). Eriksson and Ohlund (2024) emphasize that digital infrastructures and their design play a crucial role in institutionalization processes. The authors also highlight the need to rethink the processes of institutionalization in the era of digitalization.

In conclusion, from the perspective of institutionalism, digitalization transforms governmental institutions through efficiency, transparency, and adaptability. It not only improves the act of government but also strengthens legitimacy and trust in public institutions, facilitating modern and inclusive governance. Digitalization thus becomes an essential tool in modernizing the state and strengthening institutions in the current context. As a preamble to the practical part of the paper, it is appropriate to discuss the EU's digitalization agenda, specifically the primary measure of a country's degree of digitalization (DESI).

1.3. The EU digitalization agenda

The EU's digitalization agenda reflects various strategic goals and orientations for implementation, aligning with the UN Sustainable Development Goals (SDGs). It explains that a mutually supportive process is designed to realize all 17 SDGs. Digitalization is seen as a horizontal enabler and accelerator of development in many fields, including poverty eradication, e-government, innovation, and sustainability. Digitalization presents risks and challenges in achieving its goals, including digital divides between developed and developing countries, privacy concerns, cybersecurity threats, uneven access to digital infrastructure in the periphery, and the need for a certain level of digital literacy to prevent technological exclusion (Tan & Taeihagh, 2020). Jovanović et al. (2018) emphasize the key role of digitalization in sustainable development, highlighting a strong positive correlation between economic and social levels. Advanced digitalization also facilitates competitiveness, innovation, and entrepreneurial activities, thus promoting economic growth.

Cultural patterns also play a significant role in the digitalization process (Rubino et al., 2020). Antikainen et al. (2018) propose that digitalization can support the shift to a more sustainable circular economy. However, in the European Union, digitalization was associated with positive changes in labor market indicators in 2018, increasing employment levels and income (Basol & Yalcin 2021).

According to Xu et al. (2022), digitalization is fundamental for the sustainable development of a country or region, allowing the realization of purposes in sustainable development objectives such as the elimination of poverty and hunger, better health and education services access, an increase in industrial innovation, and the enhancement of infrastructure, reinforcement of governance structures, or managing environmental hazards.

1.4. About DESI

According to the European Commission, the DESI (Digital Economy and Society Index) is used to assess the progress of European Union member states in digitalizing their economies and societies. The digital performance of countries is measured based on indicators such as connectivity, digital skills, Internet use, the integration of digital technologies in business, and digital public services.

Despite progress, digital skills and technology integration are lagging (see the work - *Digital Economy and Society Index 2022: global progress but digital skills, SMEs and 5G networks leave behind*, 2022).

DESI score for a country „C" is calculated by the formula:

DESI(C) = *Human capital* (C) * 0.25 + *Connectivity* (C) * 0.25 + *Integration of Digital Technologies* (C) * 0.25 + *Digital public services* (C) * 0.25 (1)

Following Russo (2020), the European Union monitors the degree of digitalization through the Digital Economy and Society Index (DESI), developed by the European Commission to assess technological progress and maintain competitiveness compared to the US, Japan, and South Korea. DESI is positively correlated with GDP per capita, depending on the extent to which citizens utilize online services and companies adopt digital technologies (Parra et al., 2021). Additionally, DESI enhances occupancy rates and personal earnings (Başol & Yalçın, 2020). In 2021, DESI sub-indicators were adapted to align with the goals of the Digital Agenda 2030, which comprises four fundamental dimensions: human capital, connectivity, digital technology integration, and digital public services.

According to Kovacs et al. (2022), the analysis of digital skills among member states did not reveal significant convergence, emphasizing the need to develop digital skills to achieve the goals of the 2030 Agenda. Socioeconomic factors, including GDP, education, and research and development spending, positively impact the DESI score, whereas the number of hours worked has an adverse effect (Masoura and Malefaki, 2023).

Almeida de Figueiredo (2024) highlights, through a panel analysis, the positive influence of digitalization factors on economic development, demonstrating a significant impact on GDP growth. Moreover, Asoy (2024) states that a 1% increase in the Digital Economic and Societal Index (I-DESI) generates a 1% increase in GDP. Török (2024) builds on the same idea that I-DESI generally has a positive influence on GDP/capita, but registers a slight slowdown in the 2015-2020 EU period.

2. Methodology

The research methods used: systematization of the relevant literature (described in the second section) and a quantitative method based on data, strategies, and statistical techniques, to test the hypothesis of dependence H1: „Digitalization improves the act of government". Null hypothesis: H0: „Digitalization does NOT improve the act of government".

The appreciation of government actions can be expressed through the quality of government. This reflects the efficiency and performance of the governance act. How digitalization can be effectively operated through the variable Governmental Effectiveness, which we propose as the dependent variable (Y): „Government Effectiveness Index - Percentile Rank" (source: World Bank).

By definition, Government effectiveness *captures perceptions of the quality of public services, the degree of independence of public services from political pressures, the quality of policy formulation and implementation, and the credibility of government commitment to such policies*. The percentage level indicates the country's rank among all countries covered by the aggregated indicator, with 0

corresponding to the lowest rank and 100 corresponding to the highest rank (Spătaru and Popescu, 2025).

As independent variables (Xi), we propose a set of indicators that directly or indirectly relate to the process of digitalization, as follows:

(**X1**): „E-government activities of individuals via websites" (source: EUROSTAT) - Internet usage: obtaining information from websites of public authorities (last 12 months), % of individuals, out of total individuals;

(**X2**): „Transparency", all life events, score: 0 to 100 (source: e-Gov. Benchmark, European Commission);

In short, this indicator assesses the extent to which governments are transparent about:

- the process of providing public services,
- responsibilities and own performance,
- personal data involved in the provision of services and citizens' access to them.

In a more detailed explanation, „Transparency" is a composite indicator representing the average of three sub-dimensions: *the transparency of online public services* (availability and clarity of information about digital public services), *the transparency of administrative processes* (the extent to which users can track and understand the stages of online administrative procedures), and *the accessibility of personal data* (the users' ability to access and manage their data stored by public authorities). Essentially, this indicator reflects the accessibility, clarity, security, and comprehensibility of information and processes for citizens. *Life events* are defined as sets of government services designed for citizens and/or entrepreneurs.

(**X3**): „Individuals using the Internet", % of the population, (source: EUROSTAT) - The percentage of the population with internet access is an indicator that measures the percentage of the total population using the internet. Internet users are individuals who have accessed the Internet (from any location) within the last three months. Internet access can be obtained through various devices, including computers, mobile phones, personal digital assistants, game consoles, digital televisions, and others;

(**X4**): „Employ ICT specialists" - total, % of total employment (source: EUROSTAT);

(**X5**): „Secure Internet servers per 1 million people" (source: WB) - Refers to the number of distinct, publicly trusted TLS/SSL certificates found in the Netcraft Secure Server survey;

(**X6**): „Fixed broadband subscriptions (per 100 people)", (source: WB) - Fixed broadband internet subscriptions for individuals and organizations refer to fixed subscriptions for fast access to the public internet (a TCP/IP connection) with download speeds equal to or greater than 256 kbit/s.

The descriptions of the predictors (X) are derived from the statistical metadata of the indicators. *The basic model proposed in this study can be expressed through the following multiple regression equation:*

$$\boldsymbol{Y} = \beta 1\boldsymbol{X1} + \beta 2\boldsymbol{X2} + \beta 3\boldsymbol{X3} + \beta 4\boldsymbol{X4} + \beta 5\boldsymbol{X5} + \beta 6\boldsymbol{X6} + \boldsymbol{\mathcal{E}} \quad (2)$$

We validate the research hypothesis by analyzing the collected data for the relevant variables. This analysis spans 10 years from 2013 to 2022, encompassing all 27 EU member states and the EU average, resulting in 28 observations per year.

To complete the missing data in the data series, where appropriate, we used the average value (compared to the values in the immediate vicinity) and/or employed the linear regression technique for prediction. More specifically, linear regression was used to estimate the missing values of the following indicators: E-government activities of individuals via websites for 2013 and 2022, Transparency for 2016, and Employed ICT specialists for 2013. EU values were calculated as weighted averages using the total population as a weighting factor.

The study encompasses a range of specific analyses, including correlation and regression analyses, analysis of variance (ANOVA), factor analysis (utilizing the KMO test), and cluster analysis. Additionally, scatterplots are an integral part of the analysis.

As for the regression and correlation coefficients, the theoretical rules are as follows:

- In the range (0 – 0.20), there is no connection between the variables;
- In the range (0.20 – 0.50), there is a weak link between the variables;
- In the range (0.50 – 0.75), there is a medium intensity link between the variables;
- In the range (0.75 – 0.95), there is a strong connection between the variables;
- In the range (0.95 – 1), there is a deterministic link between the variables (the independent variable determines almost entirely the dependent one).

We have used the Pearson correlation coefficient in this analysis. They illustrate the intensity of the relationships between the variables, examined in pairs (this is a bi-variable analysis). Correlation coefficients take values between 0 and 1. The closer it is to 1 (100%), the stronger the link between the variables. The most important results of the regression analysis are the coefficients R and R^2, as well as the level of significance (p-value, or Sig.). The coefficient „R-square" (R^2) indicates the percentage of variation in the dependent variable explained by the independent variables. In theory, the level of statistical significance Sig. has an ideal value of < 0.05 (i.e., statistical significance > 95%). It is accepted in current practice and Sig. < 0.1 (statistical significance > 90%).

To assess the degree of internal coherence among the chosen and analyzed factors (variables), we conduct a factorial analysis using the Kaiser-Meyer-Olkin (KMO) statistical test. In theory, the KMO should be in the range (0.5 - 1); if the KMO < 0.5, the values are unacceptable.

Scatterplots provide a visual representation of how the EU member states are grouped relative to the linear regression trend line (R^2), which is marked on the graph with a red dashed line. Countries positioned in the upper part of the diagram tend to

occupy better rankings. For the first and last year of the analysis (2013 and 2022), we also present a *dendrogram*, a type of cluster analysis that shows how the member states (MS) are grouped based on the dependent variable, Government Effectiveness (*Gov_Ef*).

3. Results and discussion

In Tables 1–4, we present the results of the quantitative analysis for 2013, 2017, 2020, and 2022, including correlation and regression analyses, variance analysis (ANOVA), and factorial analysis (KMO). For comparison, we also included parts of the crisis years in the analysis: 2020 (pandemic crisis) and 2022 (energy crisis). The corresponding *dispersion diagrams* (*Scatterplots)* are found in Figures 3–6.

Table 1. Methods/statistical techniques applied in variable analysis, year 2013

Correlations 2013		Gov_Ef_ 2013	E_gov_ web_ 2013	Transp_ 2013	us_int_ 2013	ICT_spec_ 2013	secure_ servers_ 2013	Fixed_ broadband_ subscriptions 2013
Gov_Ef_2013	Pearson Correlation	1	,744**	,452*	,856**	,775**	,754**	,791**
	Sig. (2-tailed)		<,001	,016	<,001	<,001	<,001	<,001
	N	28	28	28	28	28	28	28

Model Summary (Dependent Variable)	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,912predictors	,831	,783	5,73990

ANOVA[a] Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3406,294	6	567,716	17,231	<,001[b]
	Residual	691,875	21	32,946		
	Total	4098,169	27			

a. Dependent Variable: Gov_Effectiveness_Percentile Rank_2013

b. Predictors: (Constant), Fixed_ broadband_ subscriptions _per 100 people_2013, Transparency_score_ 2013, ICT_specialists_%_2013, E_gov_web_access_%_2013, secure_servers_per 1 mill people_2013, using_internet_% 2013

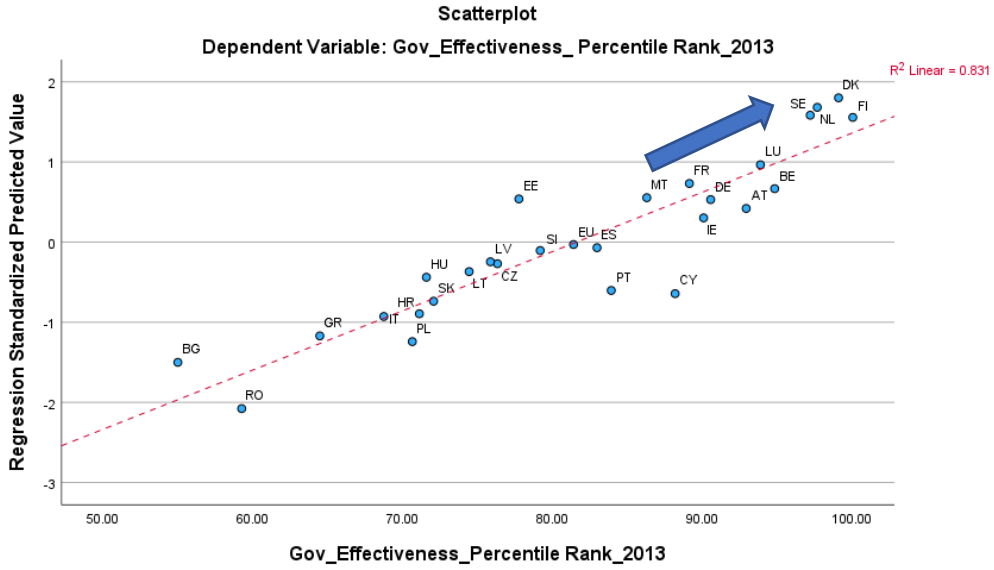
KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,870
Bartlett's Test of Sphericity	Approx. Chi-Square	151,721
	df	21
	Sig.	<,001

Source: authors' representation

According to the results presented in Table 1, the year 2013 is characterized by moderate to strong and statistically significant correlations among the examined pairs of variables, ranging from 45.2% to 85.6%. Regarding the regression results, we note that $R^2 = 0.831$, which means that the model explains 83.1% of the variation in the *Gov_Ef* dependent variable.

Multifactorial ANOVA certifies the statistical significance of the model, Sig. < 0.001. The KMO test value of 87% indicates that the sampling adequacy is very good, suggesting that the obtained solution is appropriate for factor analysis.

Figure 3. Diagram of dispersion. Government effectiveness *vs*. Predictors_2013



Source: authors' representation

Figure 3 illustrates the 2013 scatterplot, highlighting a top cluster of countries – Nordic states, the Netherlands, Belgium, and Luxembourg – with outstanding performance on the analysed dimension. In contrast, at the bottom of the ranking are Romania, Bulgaria, and Greece.

According to the results presented in Table 2, the year 2017 is characterized by moderate to strong and statistically significant correlations among the examined pairs of variables, ranging from 44.8% to 85.8%. Regarding the regression results, we note that $R^2 = 0.812$, which means that the model explains 81.2% of the variation in the *Gov_Ef* dependent variable.

Multifactorial ANOVA certifies the statistical significance of the model, Sig. < 0.001. The KMO test value of 89.3% indicates that the sampling adequacy is excellent, suggesting that the obtained solution is appropriate for factor analysis.

Table 2. Methods /statistical techniques applied in variable analysis, year 2017

Correlations 2017		Gov_Ef_ 2017	E_gov_ web_ 2017	Transp_ 2017	us_int_ 2017	ICT_spec_2017	secure_ servers_ 2017	Fixed_ broadband_ subscriptions_ 2017
Gov_Ef_2017	Pearson Correlation	1	,800**	,501**	,858**	,752**	,448*	,630**
	Sig. (2-tailed)		<,001	,007	<,001	<,001	,017	<,001
	N	28	28	28	28	28	28	28

Model Summary (Dependent variable)	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,901[predictors]	,812	,759	5,93121

ANOVA[a] Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3196,135	6	532,689	15,142	<,001[b]
	Residual	738,763	21	35,179		
	Total	3934,898	27			

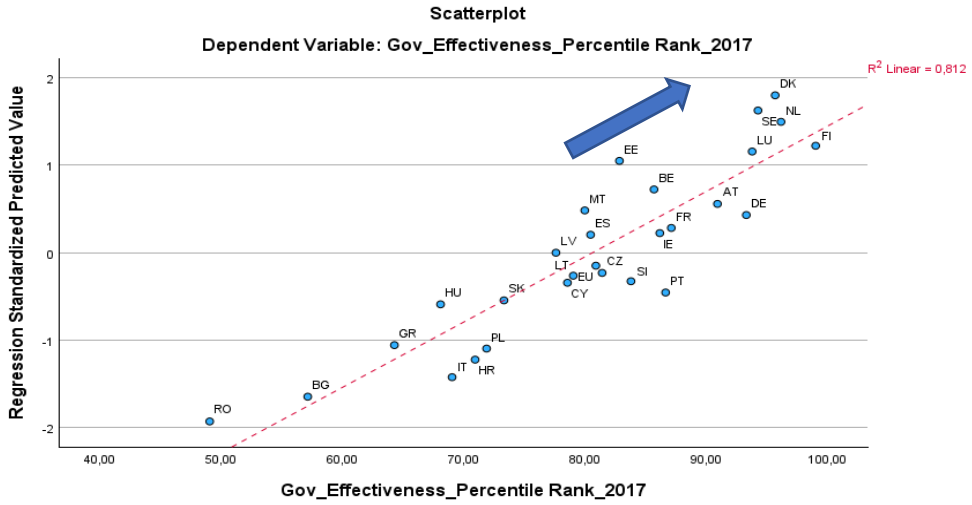
a. Dependent Variable: Gov_Effectiveness_Percentile Rank_2017

b. Predictors: (Constant), Fixed_ broadband_ subscriptions _per 100 people_2017, Transparency_score_ 2017, secure_servers_per 1 mill people_2017, ICT_specialists_%_2017, E_gov_web_ access_%_ 2017, using internet % 2017

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,893
Bartlett's Test of Sphericity	Approx. Chi-Square	112,261
	df	21
	Sig.	<,001

Source: authors' representation

Figure 4. Diagram of dispersion. Government effectiveness *vs*. Predictors_2017



Source: authors' representation

Figure 4 illustrates the 2017 scatterplot, highlighting a top cluster of countries - Nordic states, the Netherlands, Luxembourg, and Germany – with outstanding performance on the analyzed dimension. In contrast, at the bottom of the ranking are Romania, Bulgaria, and Greece.

Table 3. Methods /statistical techniques applied in variable analysis, year 2020

Correlations 2020		Gov_Ef_ 2020	E_gov_ web_ 2020	Transp_ 2020	us_int_ 2020	ICT_spec_2020	secure_ servers_ 2020	Fixed_ broadband_ subscriptions_ 2020
Gov_Ef_2020	Pearson Correlation	1	,734**	,638**	,764**	,775**	,476*	,476*
	Sig. (2-tailed)		<,001	<,001	<,001	<,001	,010	,011
	N	28	28	28	28	27	28	28

Model Summary (Dependent variable)	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,912predictors	,831	,781	6,87087

ANOVA[a] Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4650,229	6	775,038	16,417	<,001[b]
	Residual	944,178	20	47,209		
	Total	5594,407	26			

a. Dependent Variable: Gov_Effectiveness_Percentile Rank_2020

b. Predictors: (Constant), Fixed_ broadband_ subscriptions _per 100 people_2020, Transparency_score_ 2020, secure_servers_per 1 mill people_2020, using_internet_%_2020, ICT_specialists_%_2020, E_gov_web_ access_%_2020

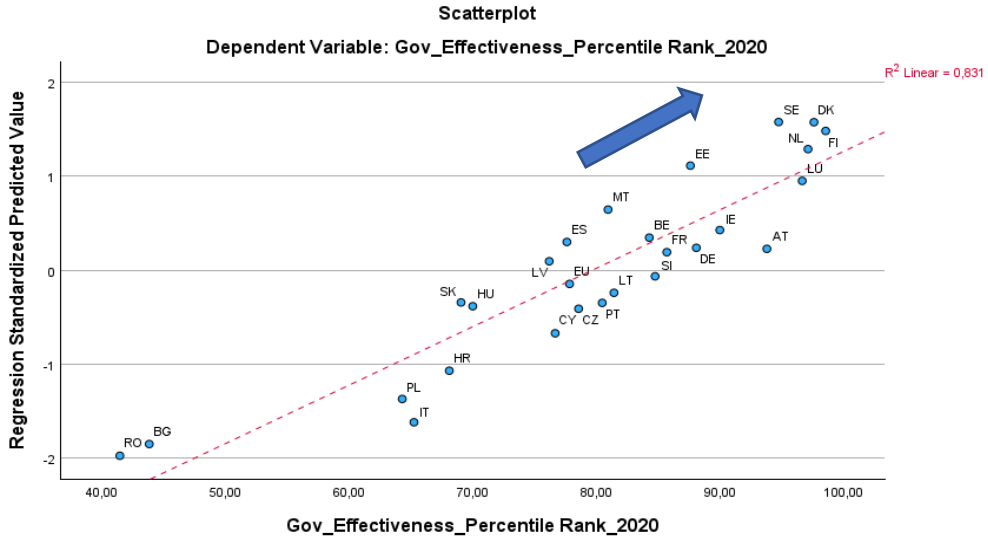
KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,847
Bartlett's Test of Sphericity	Approx. Chi-Square	89,100
	df	21
	Sig.	<,001

Source: authors' representation

According to the results presented in Table 3, the year 2020 is characterized by moderate to strong and statistically significant correlations among the examined pairs of variables, ranging from 47.6% to 77.5%. Regarding the regression results, we note that $R^2 = 0.831$, which means that the model explains 83.1% of the variation in the *Gov_Ef* dependent variable.

Multifactorial ANOVA certifies the statistical significance of the model, Sig. < 0.001. With a KMO test value of 84.7%, the sampling adequacy can be considered good, confirming the suitability of the data for the proposed solution.

Figure 5. Diagram of dispersion. Government effectiveness *vs*. Predictors_2020



Source: authors' representation

Table 4. Methods /statistical techniques applied in variable analysis, year 2022

Correlations 2022		Gov_Ef_2022	E_gov_web_2022	Trans_2022	us_int_2022	ICT_spec_2022	secure_servers_2022	Fixed_broadband_subscriptions_2022
Gov_Ef_2022	Pearson Correlation	1	,772**	,601**	,780**	,798**	,573**	,349
	Sig. (2-tailed)		<,001	<,001	<,001	<,001	,001	,069
	N	28	28	28	28	28	28	28

Model Summary (Dependent variable)	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,899[predictors]	,809	,754	6,87165

ANOVA[a] Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4196,823	6	699,471	14,813	<,001[b]
	Residual	991,610	21	47,220		
	Total	5188,433	27			

a. Dependent Variable: Gov_Effectiveness_Percentile Rank_2022

b. Predictors: (Constant), Fixed_broadband_subscriptions_per 100 people_2022, using_internet_%_2022, secure_servers_per 1 mill people_2022, Transparency_score_2022, E_gov_web_access_%_2022, ICT_specialists_%_2022

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,886
Bartlett's Test of Sphericity	Approx. Chi-Square	98,283
	df	21
	Sig.	<,001

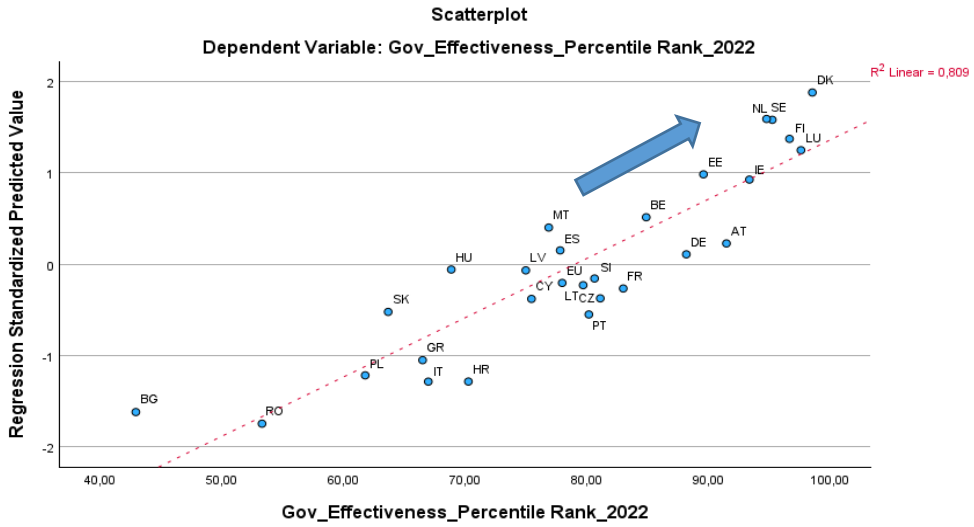
Source: authors' representation

As illustrated in Figure 5, the 2020 scatterplot reveals a distinct upper cluster composed of the Nordic states, the Netherlands, Luxembourg, Austria, and Ireland, characterized by superior performance on the examined dimension. In contrast, Romania and Bulgaria occupy the lowest positions in the ranking.

According to the results presented in Table 4, the year 2022 is characterized by moderate to strong and statistically significant correlations among the examined pairs of variables, ranging from 34.9% to 79.8%. Regarding the regression results, we note that $R^2 = 0.809$, which means that the model explains 80.9% of the variation in the Gov_Ef dependent variable.

Multifactorial ANOVA certifies the statistical significance of the model, Sig. < 0.001. With a KMO test value of 88.6%, the sampling adequacy can be considered very good, confirming the suitability of the data for the proposed solution.

Figure 6. **Diagram of dispersion. Government effectiveness *vs*. Predictors_2022**



Source: authors' representation

In 2022, the countries with the best performance and those at the bottom of the ranking remain the same as in previous years (Fig. 6). From the consideration of data of 2013, 2017, 2020, and 2022 (Tables 1–4, Figures 3–6, A1, A2), we conclude:

Correlation analysis results

The statistically significant correlation results, established through Sig. < 0.01** or < 0.05*), and suggest moderate to strong relationships among the chosen pairs of variables. More precisely, in 2013, they varied from a minimum of 45.2% to a maximum of 85.6%. In 2017, the correlation ranges between 44.8% and 85.8%,

and so on in the subsequent samples (see Tables 1–4). The bivariate associations between the dependent variable (Government Effectiveness) and the explanatory variables of interest show a mix of disparate degrees of association. However, in all cases, they are statistically significant, demonstrating the validity of the observed relationships.

Regression and factor analysis results

Regression results for all four observed years show that the dependent variable (Government Effectiveness) has a significant relationship with digitalization-related independent variables. Namely, the R value runs from 89.9 to 91.2%. The R^2 figures show that the model explains more than 80% of the variance of government effectiveness: 83.1% in 2013, 81.2% in 2017, 83.1% in 2020, and 80.9% in 2022 (Model Summary, Tables 1–4). The linear regression models are confirmed as significant by the ANOVA, with large F values (Sig. < 0.01) for the years examined, indicating that the obtained relationships had a high degree of reliability (ANOVA Model Tables 1–4). The value of the KMO test coefficient: 87% (2013), 89,3% (2017), 84,7% (2020), and 88,6% (2022), which indicate an excellent level of sampling suitability for analysis tools, testify to a reasonable degree of stability of the factorial structure adopted in measurement instruments used during research (Tables 1–4).

Visualization and country-level insights

Scatterplots depict country positions in relation to the linear regression trend line (R^2). High-scoring countries are mostly Nordic and are located in the top portion of the figure. Estonia recorded the most significant improvement in governance effectiveness between 2013 and 2022, narrowing the gap with top performers. Conversely, Bulgaria and Romania consistently rank at their lowest, highlighting long-standing differences within the EU, both in terms of digitalization and institutional development (Figures 3–6). This finding is reinforced by the European Commission's report (2022) on the DESI index, which places Romania and Bulgaria at the bottom of the ranking on digitalization.

The cluster analysis, illustrated through dendrogram charts, presents the grouping of countries based on similarity criteria for the years 2013 and 2022, as shown in APPENDIX (A1, A2).

Conclusions

This research examines the interconnection between digitalization and institutionalism, two complementary notions that relate to rethinking governance through mutual reflections. In addition, the paper highlights that digitalization is

crucial for improving processes of public administrations and institutions, providing not only a sound theoretical background but also relevant practical evidence.

Consequently, the literature review emphasized that digitalization has much to offer in terms of institutionalism, highlighting synergies between digital transformation and governance efficiency and effectiveness. On the other hand, it also emphasized that institutions play a crucial role in advancing digitalization.

The empirical analysis conducted supports the research hypothesis that digitalization significantly contributes to improving government operations. Firstly, the correlation analysis revealed moderate to strong and statistically significant bivariate relationships between government effectiveness and each predictor, which reflects the level of digitalization. The results demonstrate that higher levels of digitalization are systematically associated with increased government effectiveness. Secondly, the regression and factor analyses further validate this relationship. The regression models exhibit high explanatory power, with R^2 values exceeding 80% across all analysed years. This indicates that digitalization-related factors explain a substantial proportion of the variance in government effectiveness. ANOVA tests confirm the robustness and statistical significance of the models as a whole. Additionally, the KMO coefficients reflect an excellent level of sampling adequacy and prove the stability of the factor structure employed in the analysis. Thirdly, the graphical representations (scatterplots) provide a clear view of countries' positions relative to the overall regression trend. The Nordic countries, along with the Netherlands, Luxembourg, Belgium, Austria, and Germany, consistently occupy the upper part of the distribution, reflecting both a high degree of digitalization and strong institutional effectiveness. Estonia stands out for its significant progress between 2013 and 2022, narrowing the gap with top-performing countries and potentially serving as a model of good practice for other Central and Eastern European countries that joined the EU more recently. Conversely, Romania and Bulgaria consistently rank at the lower end, highlighting persistent disparities within the European Union in terms of both digitalization and institutional development.

In conclusion, digitalization exerts a positive and substantial influence on government effectiveness, contributing to improved institutional performance, enhanced administrative capacity, and overall better governance quality in EU member states. Therefore, the promotion of rapid adoption and deployment of digital technologies in public administration is well justified. Digitalization enables facilities to become more flexible and sustainable as they navigate current challenges. This approach also aligns with the EU's 2030 Digital Compass. The Compass sets ambitious goals for digitalizing public administration in member states.

This research helps us better understand how digitalization affects administration and governance. It also highlights the importance of involving decision-makers in promoting digital public services. The study's findings could serve as a reference point for developing public policies based on the EU Digital

Agenda and launching effective digitalization strategies that support the sustainable development and modernization of public management.

About the study's limitations, it would be interesting for future research to address one or more of them—for example, by analyzing a larger number of indicators and, in particular, countries, exploring the risks associated with the digitalization process and how they have been managed, as well as formulating new questions or hypotheses, such as those concerning the quality of government effectiveness or the impact of digitalization on economic development, etc.

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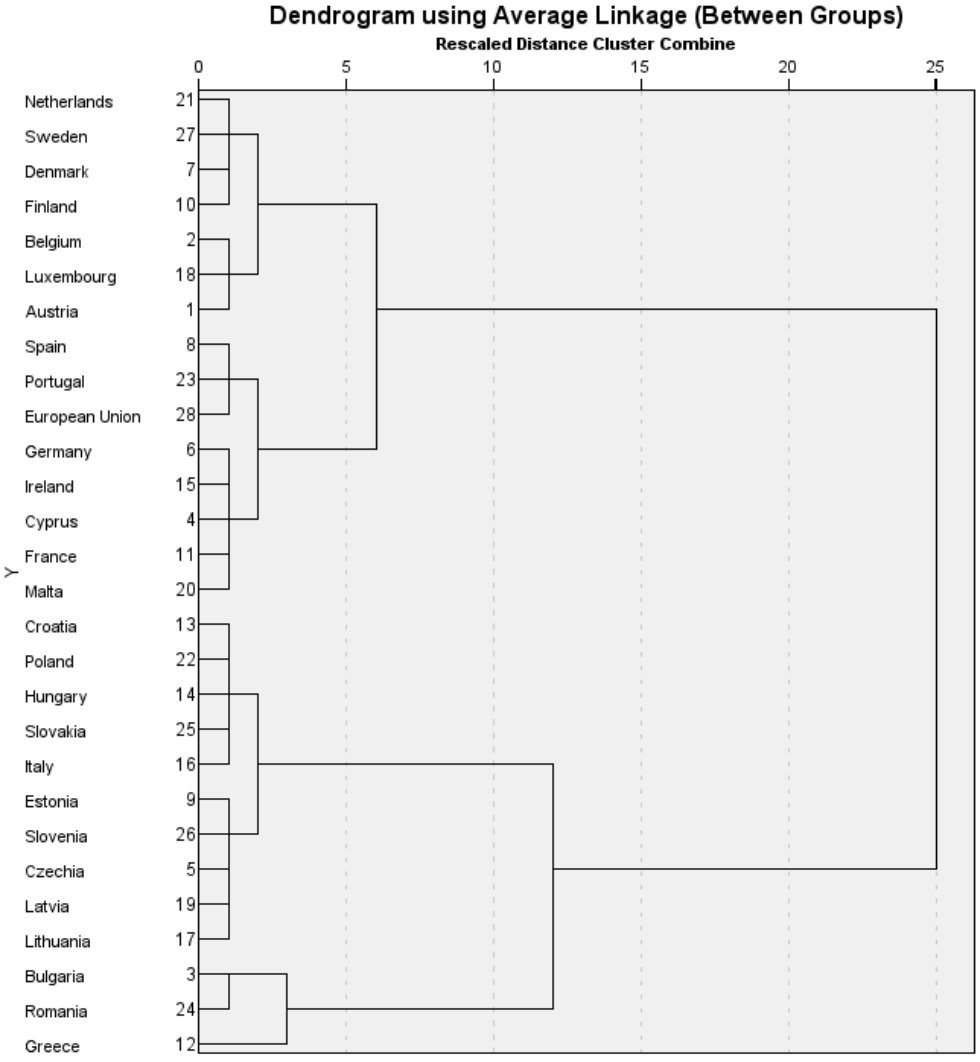
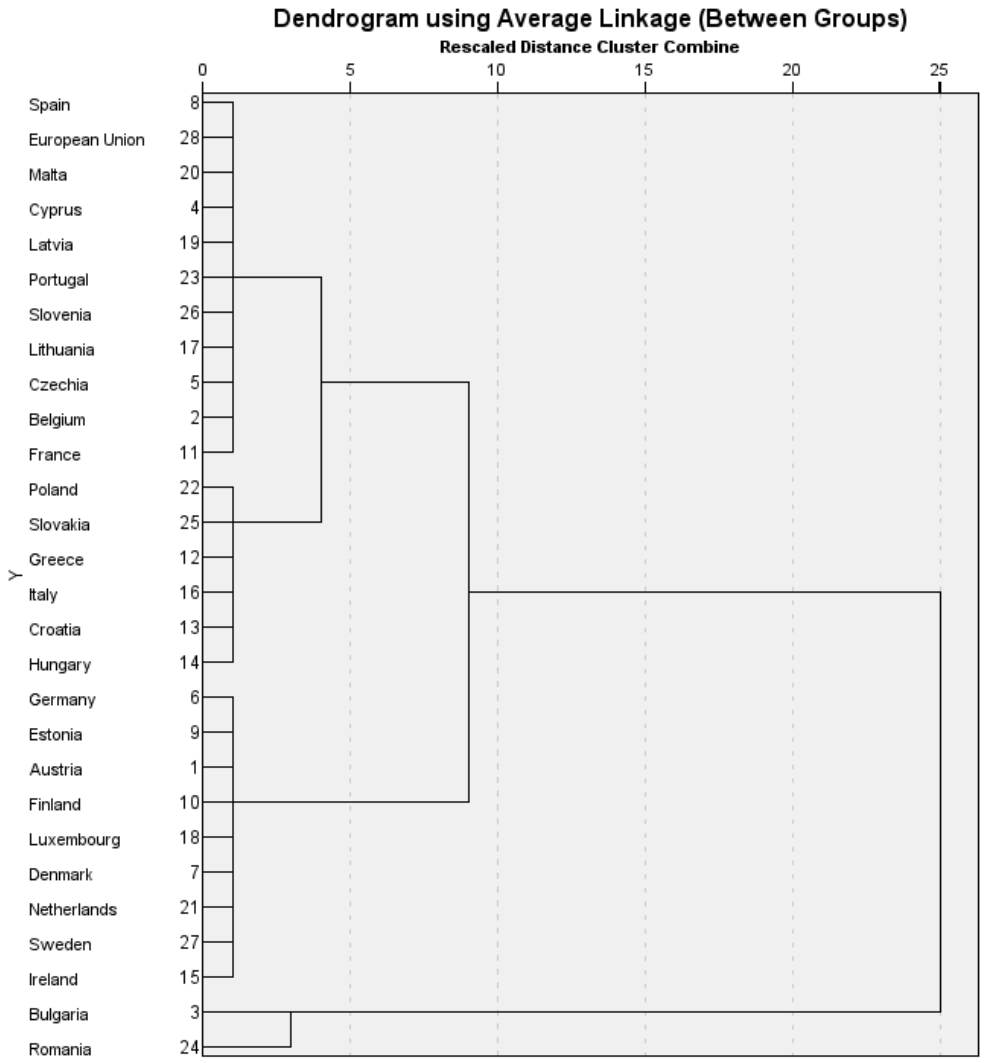
APPENDIX

A1. Dendogram_Government Effectiveness_2013



Source: authors' representation

A2. Dendogram_Government Effectiveness_2022



Source: authors' representation