

Digitalization, Economic Growth and Sustainability: A Comparative Analysis of Romania and EU Countries Using Trading Economics Data and Jasp

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Abstract

This paper investigates the relationship between digitalization, macroeconomic performance, and sustainable development in Romania, in comparison with selected European Union (EU) countries. The main objective is to identify whether digital and economic indicators contribute significantly to economic convergence and sustainability outcomes, with a particular focus on Romania's relative positioning within the EU. The study is based on secondary data extracted from the Trading Economics database, covering key indicators such as GDP per capita (USD), employment rate, inflation, and digitalization proxied by internet users (% of population). A comparative cross-country design is employed, including Romania and a sample of EU member states. Statistical analysis is conducted using JASP, an open-source software for reproducible research, applying descriptive statistics, correlation analysis, independent samples t-tests, and multiple regression models to examine relationships between digitalization and economic performance variables. The results indicate a positive association between digitalization indicators and economic performance, with stronger effects observed in more digitally advanced EU countries. Romania shows a persistent gap in both digital intensity and economic outcomes, although certain indicators suggest gradual convergence. Regression results highlight digitalization as a statistically significant predictor of GDP per capita and employment, while inflation exhibits a weaker and less consistent relationship. The paper contributes to the literature by integrating open-access macroeconomic data with reproducible statistical analysis using JASP, offering a transparent and accessible methodological framework. It also provides updated empirical evidence on the digitalization–sustainability nexus in an emerging EU economy. The findings support the need for targeted public policies that enhance digital infrastructure, digital skills, and e-government services in Romania. Strengthening digital capabilities may accelerate economic convergence and improve sustainable development outcomes within the EU context.

Keywords

Digitalization; economic growth; sustainable development; Romania; European Union; trading economics data; JASP statistical analysis

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Introduction

Digitalization has become a central driver of economic transformation, reshaping production processes, labor markets, and public service delivery across both developed and emerging economies. Within the European Union (EU), the digital transition is closely linked to broader sustainability objectives, including economic resilience, social inclusion, and efficient governance. Recent studies emphasize that digital technologies not only enhance productivity and competitiveness but also contribute to sustainable development by optimizing resource allocation and enabling data-driven decision-making (Verhoef et al.,

2021; George et al., 2021). At the same time, the uneven adoption of digital technologies across EU member states continues to generate structural disparities, particularly between Western economies and countries such as Romania (Mergel et al., 2019).

Although the relationship between digitalization and economic performance has been widely discussed, empirical evidence remains fragmented, especially in the context of emerging EU economies. Existing research often focuses either on macro-level indicators without integrating digital variables, or on digital transformation without linking it systematically to economic outcomes and sustainability dimensions. Furthermore, methodological transparency and reproducibility remain limited, as many studies rely on proprietary datasets or non-replicable analytical frameworks.

In this context, the present study addresses the following research problem: to what extent do digitalization indicators influence economic performance and sustainable development outcomes in Romania, compared to other EU countries? The paper adopts a quantitative, comparative approach, using secondary data from Trading Economics and applying statistical analysis through JASP, an open-source platform that supports reproducible research. By combining macroeconomic and digital indicators within a unified analytical framework, the study aims to provide clearer empirical evidence on the digitalization–economic performance nexus.

The remainder of the paper is structured as follows. The next section reviews the relevant literature on digitalization, economic growth, and sustainability. The methodology section outlines the data sources, variables, and statistical techniques employed. This is followed by the results and discussion section, which presents the main empirical findings. The final section concludes the paper, highlighting key contributions, limitations, and directions for future research.

1. Literature review

Digitalization has increasingly been conceptualized as a structural driver of economic transformation, influencing productivity, competitiveness, and sustainability across national economies. At the European level, empirical evidence confirms that digital transformation is closely associated with improved economic performance and enhanced sustainability outcomes, although the magnitude of these effects varies significantly across countries (Bocean & Vărzaru, 2023; Mura & Donath, 2023). This heterogeneity reflects differences in institutional capacity, technological infrastructure, and the ability to integrate digital technologies into economic and administrative systems.

A substantial body of literature highlights the role of digitalization in fostering innovation and competitiveness. Studies focusing on European economies demonstrate that digital technologies support entrepreneurial activity, facilitate knowledge diffusion, and enhance firms' adaptive capacity in dynamic environments (Galindo-Martín et al., 2023; de Rojas et al., 2024). These mechanisms contribute to long-term economic growth and are particularly relevant in the context of post-pandemic recovery, where digital capabilities have become critical determinants of resilience and performance (Bran et al., 2023). At the macroeconomic level, digitalization is often examined in relation to economic growth indicators such as GDP per capita and employment. Empirical analyses using cross-country data indicate a positive and statistically significant relationship between digitalization and economic growth, although the strength of this relationship depends on the level of economic development and the degree of digital adoption (Kasap, 2025; Lei et al., 2024). Moreover, digital transformation is increasingly linked to sustainable development objectives, as it enables more efficient resource utilization and supports the transition toward low-carbon and knowledge-based economies (Rădulescu et al., 2022; Yang et al., 2025).

In parallel, the literature on public administration emphasizes the importance of digital governance as a key enabler of sustainable development. Digital public administration systems improve transparency, efficiency, and service delivery, thereby strengthening institutional performance and citizen trust (Burlacu et al., 2019; Burlacu et al., 2021). More recent contributions extend this perspective by analyzing integrative digital governance models and the role of technological innovation in modernizing public sector operations (Burlacu et al., 2024; Burlacu et al., 2025). These studies suggest that the digitalization of public administration is not only a technical process but also a strategic transformation with significant socio-economic implications. Furthermore, sector-specific analyses underline the interaction between digitalization and sustainability in domains such as agriculture, energy, and urban development. For instance, sustainable agricultural development and energy transition processes are increasingly dependent on digital tools and data-driven decision-making (Buzoianu et al., 2024; Rădulescu et al., 2023). Similarly, urban sustainability is closely linked to digital infrastructure and smart governance solutions, which

facilitate efficient resource management and improve quality of life (Profiroiu et al., 2020; Yang et al., 2025).

Despite these advances, several gaps remain in the literature. First, there is a lack of integrated empirical studies that simultaneously examine digitalization, macroeconomic performance, and sustainability using comparable cross-country datasets. Second, methodological approaches are often heterogeneous and lack reproducibility, limiting the comparability of results. Although systematic reviews provide important conceptual frameworks for understanding digital transformation (Hanelt et al., 2021), there is still a need for empirical research that applies transparent and replicable statistical methods.

In addition, emerging research points to the growing role of artificial intelligence and advanced digital technologies in shaping economic development trajectories (Rădulescu et al., 2025). However, the empirical validation of these relationships, particularly in the context of emerging EU economies such as Romania, remains limited. This gap is further compounded by the insufficient integration of governance and corporate perspectives, including the role of state-owned enterprises and institutional frameworks in supporting digital transformation (Stănilă et al., 2025). In this context, the present study contributes to the literature by providing a comparative, data-driven analysis of the relationship between digitalization, economic performance, and sustainability in Romania and selected EU countries. By using standardized macroeconomic indicators and applying reproducible statistical analysis through JASP, the paper addresses both empirical and methodological gaps identified in prior research.

2. Research methodology

This study adopts a quantitative, cross-sectional research design to examine the relationship between digitalization, economic performance, and macroeconomic conditions across selected European countries. The empirical analysis is based on secondary data collected from the Trading Economics database, ensuring comparability and consistency across indicators. The sample includes ten European Union countries, selected to reflect a balanced representation of both emerging and advanced economies: Romania, Bulgaria, Hungary, Poland, Germany, France, Italy, Spain, the Netherlands, and Sweden. The analysis relies on the most recent available annual data (2023 or closest available year), following a harmonized approach to avoid temporal inconsistencies.

The variables are operationalized as follows: economic performance is measured through GDP per capita (USD), while digitalization is proxied by the percentage of internet users in the total population. Control variables include the employment rate (%) and inflation rate (%), capturing labor market conditions and macroeconomic stability, respectively. Data analysis was conducted using JASP, an open-source statistical software suitable for reproducible and transparent research. The empirical strategy consists of three main stages. First, descriptive statistics are computed to assess central tendencies and dispersion across variables. Second, Pearson correlation analysis is used to identify associations between digitalization and economic indicators. Third, a multiple linear regression model is estimated, with GDP per capita as the dependent variable and digitalization, employment, and inflation as independent variables.

In addition, a comparative analysis is performed using an independent samples t-test. To ensure statistical validity given the limited sample size, countries are grouped based on the median level of digitalization, resulting in two sub-samples: lower digitalization and higher digitalization economies. Despite the analytical rigor, the study has several limitations. The relatively small sample size restricts the generalizability of the findings, while the use of proxy indicators may not fully capture the multidimensional nature of digital transformation. Therefore, the results should be interpreted as exploratory evidence, offering insights into the relationship between digitalization and economic performance rather than establishing causal effects. Given the small sample size and the imbalance between Romania and the rest of the sample, a median split approach was used to ensure statistical validity of the comparative analysis.

3. Results and Discussion

The empirical results provide a comparative perspective on the relationship between digitalization, economic performance, and macroeconomic conditions across the selected European countries.

First, the descriptive statistics reveal substantial cross-country disparities, particularly in terms of GDP per capita and digitalization levels. GDP per capita shows the highest variability, indicating a marked divide between more advanced Western and Northern European economies and the less economically developed countries in the sample. Digitalization levels are relatively high overall, but Romania and Bulgaria remain

below the sample average, which suggests persistent structural gaps in digital adoption. Employment rates display more moderate variation, while inflation appears comparatively less dispersed.

Table no. 1. Descriptive statistics of key variables

Variable	N	Mean	Std. Deviation	Minimum	Maximum
GDP per capita (USD)	10	38923.30	17873.54	17412	68219
Employment rate (%)	10	71.10	4.60	65	78
Digitalization (%)	10	88.10	7.10	75	96
Inflation (%)	10	5.10	0.87	3.50	6.00

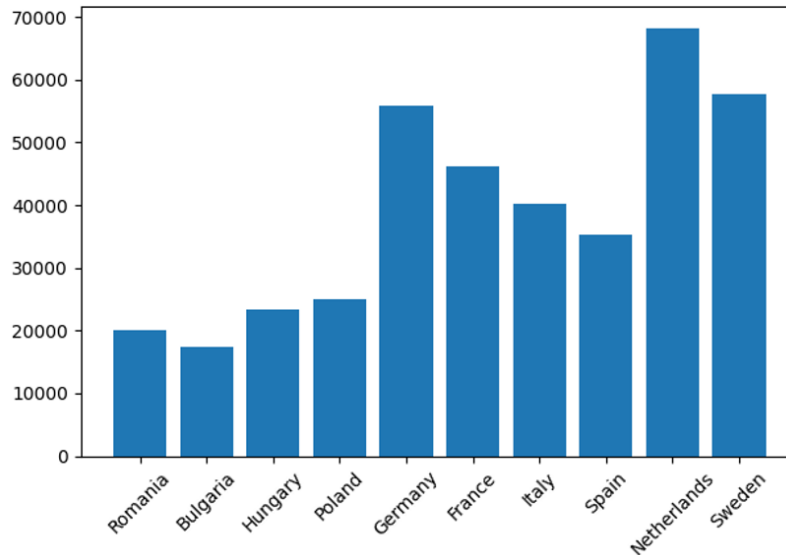


Figure no. 1. GDP per capita comparison across countries

The correlation analysis further supports the existence of a positive relationship between digitalization and economic performance. Countries with higher digitalization scores also tend to record higher GDP per capita and better employment outcomes. By contrast, inflation presents weak and less consistent associations with the other variables, indicating that price dynamics are influenced by broader macroeconomic mechanisms that are not fully captured by the present model.

Table no. 2. Correlation matrix

Variable	GDP_pc	Employment	Digitalization	Inflation
GDP_pc	1.000	0.749	0.889	-0.367
Employment	0.749	1.000	0.660	-0.221
Digitalization	0.889	0.660	1.000	-0.320
Inflation	-0.367	-0.221	-0.320	1.000

To strengthen the comparative interpretation, the sample was divided into two groups according to the median level of digitalization: lower digitalization and higher digitalization countries. The independent samples t-test shows statistically significant differences between the two groups for GDP per capita, employment rate, and digitalization. Countries in the higher digitalization group report substantially higher GDP per capita and better labor market outcomes than those in the lower digitalization group. Inflation differences are not statistically significant at conventional thresholds, which suggests that digital advancement is more strongly associated with productivity and labor market performance than with price stability.

Table no. 3. Independent samples t-test by digitalization group

Variable	Lower digitalization Mean	Lower digitalization SD	Higher digitalization Mean	Higher digitalization SD	t	p
GDP per capita (USD)	25208.80	8892.82	52637.80	12464.22	-4.006	0.005
Employment rate (%)	68.20	3.42	77.00	4.36	-2.341	0.049
Digitalization (%)	82.80	6.22	93.40	2.07	-3.615	0.016
Inflation (%)	5.60	0.39	4.60	1.02	2.041	0.095

These findings indicate that digitalization operates as a structural determinant of economic performance rather than a purely technological attribute, but also a marker of broader economic development. The results are consistent with the literature emphasizing the role of digital transformation in improving competitiveness, strengthening innovation capacity, and supporting economic resilience (Bocean & Vărzaru, 2023; Galindo-Martín et al., 2023; Lei et al., 2024).

The regression analysis provides additional evidence regarding the explanatory role of digitalization. The overall model is statistically significant and explains a substantial share of the variation in GDP per capita. Among the predictors, digitalization emerges as the only statistically significant variable, with a positive coefficient. This suggests that a one-unit increase in the digitalization indicator is associated with a sizable increase in GDP per capita, holding the other variables constant. Employment has a positive but statistically non-significant coefficient, while inflation has a negative and non-significant effect.

Table no. 4. Multiple linear regression results (dependent variable: GDP per capita)

Predictor	B	Std. Error	t	p
Constant	-175048.690	52403.959	-3.340	0.016
Digitalization	1678.333	549.416	3.055	0.022
Employment rate	1054.458	789.707	1.335	0.230
Inflation	-1738.128	3335.493	-0.521	0.621

Notes: Model summary: N = 10; R = 0.919; R² = 0.845; Adjusted R² = 0.767; F = 10.888; p = 0.008

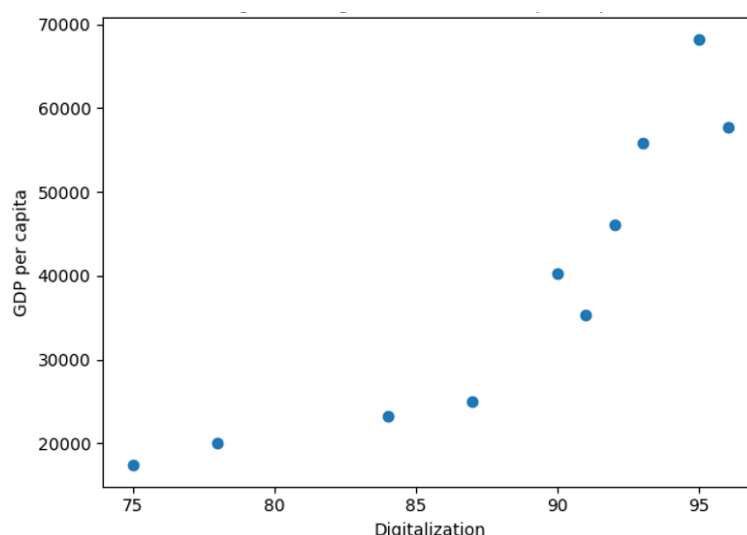


Figure no. 2: Scatter plot with Digitalization vs GDP per capita

The scatter plot visually confirms the upward relationship between digitalization and GDP per capita. At the same time, the dispersion of observations shows that digitalization alone does not fully explain differences in economic performance. This is an expected result, since economic development is also shaped by institutional quality, education, sectoral structure, governance capacity, and investment patterns.

From a substantive perspective, Romania's position remains consistent with a pattern of partial convergence. Although the country has made progress in digital adoption, it still remains below the level observed in the more advanced EU economies included in the sample. This supports the argument that digital transformation can contribute to economic development, but only when accompanied by broader structural reforms and sustained investment in administrative capacity, human capital, and innovation ecosystems (Burlacu et al., 2021; Burlacu et al., 2025; Rădulescu et al., 2025).

Conclusions

This study examined the relationship between digitalization, economic performance, and sustainability across Romania and selected European Union countries using a comparative, data-driven approach based on Trading Economics data and JASP statistical analysis.

The results provide consistent empirical evidence that digitalization represents a significant determinant of economic performance. Both correlation and regression analyses indicate a strong positive association between digitalization and GDP per capita, confirming that more digitally advanced economies tend to

achieve higher levels of economic development. The comparative analysis further highlights that countries with higher levels of digitalization significantly outperform less digitalized economies in terms of both income and employment indicators.

In this context, Romania's position reflects a pattern of partial convergence. Although progress in digital adoption is evident, the country continues to lag behind more advanced EU economies, particularly in terms of digital intensity and economic outcomes. This finding reinforces the argument that digital transformation alone is insufficient; its impact depends on complementary factors such as institutional capacity, human capital, and governance quality.

The main contribution of this paper lies in integrating open-access macroeconomic data with a transparent and reproducible analytical framework, demonstrating how accessible tools such as JASP can support empirical research in the field of digitalization and sustainability. Moreover, the study contributes updated empirical evidence on the digitalization–economic performance nexus in the context of an emerging EU economy.

From a practical perspective, the findings suggest that public policies in Romania should prioritize investments in digital infrastructure, digital skills development, and the modernization of public administration systems. Strengthening digital governance mechanisms may accelerate economic convergence and support sustainable development objectives within the European context.

However, studying has several limitations. The relatively small sample size restricts the generalizability of the results, while the use of proxy indicators may not fully capture the multidimensional nature of digital transformation. In addition, the cross-sectional design limits the ability to draw causal inferences.

Future research should extend the analysis by incorporating larger samples, longitudinal data, and more complex indicators of digitalization, including artificial intelligence adoption and e-government performance. Furthermore, integrating institutional and governance variables could provide a more comprehensive understanding of the mechanisms through which digitalization influences economic and sustainability outcomes.

The study also highlights the importance of combining digital transformation policies with broader structural reforms to ensure sustainable and inclusive economic growth.

Generative Artificial Intelligence (GenAI) usage statement:

ChatGPT (version 5.0) was responsibly used for language improvement. After this process, the authors reviewed and edited the content as needed and take full responsibility for the content of the present article.

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