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Original Scientific Article

IMPACT OF DIGITAL TRANSFORMATION ON GREEN GROWTH IN EUROPEAN UNION COUNTRIES

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Abstract: A green economy is an economy that results in improved human well-being and social justice, while significantly reducing environmental risks and damage to the environment. The aim of this paper is to empirically assess the impact of digital transformation on green growth in European Union countries. The article conducts correlation and regression analysis of cross-sectional data on a sample of twenty-six European Union countries in 2022. The measure of green growth is the Green Growth Index (GGI) published by the Global Green Growth Institute. The measure of digital transformation is the Digital Competitiveness Ranking score of the International Institute for Management Development (IMD). The research results show that digital transformation in the observed European Union countries has a positive impact on green growth.

Keywords: *green growth, digital transformation, green economy, European Union, regression analysis.*

INTRODUCTION

Green growth is the new revolutionary development paradigm that sustains long-term economic growth while at the same time ensuring climatic and environmental sustainability. It focuses on addressing the root causes of these challenges while ensuring the creation of the necessary channels for resource distribution and access to basic commodities for the impoverished and vulnerable populations. Green growth is fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. Green growth is growth that is efficient in its use of natural resources, clean in that it minimizes pollution and negative environmental impacts, and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters. It is growth that emphasizes environmentally sustainable economic progress to foster low-carbon, socially inclusive and equitable development (United Nations, 2025).

Digital transformation is the process of using digital technologies to fundamentally change how a business operates, interacts with customers, and delivers value. It involves integrating digital technologies across all areas of a business, economy, society, or institutions. This process refers not only to the introduction of new technologies, but also to changes in organizational culture, structure and strategy. In the case of business and markets, digital transformation aims to enhance customer experiences, improve operational efficiency, and create new revenue streams.

The European Union is actively pursuing a "twin transition" – a simultaneous green and digital transformation. This involves using digital technologies to accelerate the shift to a sustainable, climate-neutral economy, while also ensuring that the digital transformation itself is environmentally friendly and socially inclusive. The European Union is pursuing a Green Economy through the European Green Deal, a comprehensive strategy aiming for climate neutrality by 2050. The European Green Deal is the EU's growth strategy aimed at transitioning to a modern, resource-efficient, and competitive economy, while also tackling climate change and environmental degradation. The EU's digital strategy focuses on strengthening digital sovereignty, setting standards, and investing in digital skills, infrastructure, and technologies. The digital strategy is part of the broader "Decade of Digital Transformation". The Digital Decade Policy Programme is a framework, with specific goals and objectives for 2030, that guides Europe's digital transformation (Peković et al., 2024, p. 248).

The scientific literature in the field of sustabinability emphasizes the connection between green economy and digital transformation. Various studies suggest that digital transformation and green growth are positively related. However, the situation varies according to the characteristics of observed groups of countries and other specificities.

The aim of the paper is to assess the relationship between digital transformation and green economy in European Union. The impact of digital transformation on green growth is especially considered. The research is conducted using regression analysis of cross-sectional data on a sample of twenty-six European Union countries in 2022.

The paper consists of an introduction, three sections, and a conclusion. The second part of the paper provides a review of scientific literature and empirical research. The third part of the paper presents the data and research methodology. The fourth part of the paper presents the research results and discussion. The fifth part of the paper provides a conclusion.

LITERATURE REVIEW

El Awady et al. (2025) analyze the impact of digital transformation on sustainable development using a sample of 63 countries with middle or high incomes for 2017-2023. The research utilized a two-way fixed effects model. The study's findings indicate that digital transformation (DT) has a favorable impact on sustainable development goals (SDGs) and there is a linear relationship between DT and SDGs. The study also finds a positive relationship between DT and SDGs. The results show that there is a positive relationship between DT and the income level of countries. The greater the income level, the greater the DT. The model find that there is a non-dynamic relation between DT and SDGs, which means DT in the previous years does not affect the current SDGs.

Bai et al. (2025) examine the impact of digital economy on carbon efficiency across 287 Chinese cities from 2000 to 2021, using benchmarks regression, threshold effect model, spatial effect regression, mechanism analysis, heterogeneity analysis, and difference-in-difference analysis. Results show that a 1% increase in the Digital Economy Index leads to a 0.148% improvement in carbon emission efficiency. In high-GDP regions, this effect rises sharply to 3.624%. A mediation analysis reveals that the digital economy also indirectly boosts carbon efficiency through economic growth, contributing an additional 0.47% improvement. These findings underscore the digital economy's dual potential to foster both economic growth and reduce carbon emissions.

Liao (2023) analyzes the impact of the digital economy on development of urban green economy using panel data from 280 cities across China from 2010-2019. Using a fixed-effects model and the Spatial Durbin model, the digital economy is found to have a significant positive impact on urban green economy development. Moreover, there is a significant positive spatial effect of the digital economy on the green economic development of cities. While enhancing the green economic development of cities, the digital economy also promotes the green economic development of neighboring cities through the knowledge spillover effect, which contributes to synergistic development among cities.

Majeed and Sharif (2024) analyze the effects of digitalization on green growth (GG) using panel data from 164 countries covering the period from 1990 to 2023. The study uses four measures of digitalization: internet users, broadband, mobile cellular, and fixed telephone subscriptions. Empirical results are estimated using pooled ordinary least squares (OLS), fixed effects, random effects, system generalized method of moments (GMM), and panel quantile regression estimation approaches. Findings suggest that the proliferation of digitalization measures tends to boost GG. The results based on principal component analysis also confirm the positive impact of digitalization on GG.

Nguyen et al. (2024) examine five critical factors affecting the digital economy and its impact on green growth in the case of Vietnam. The researchers employed the structural equation model (SEM) with a sample of 250 respondents. They analyze the following factors of the digital economy: (1) quality of digital human resources, (2) perfect digital policies, (3) investment in digital infrastructure, (4) raising awareness of the society about digital transformation, and (5) technological innovation. The study finds that all five factors have a statically significant and positive impact on both the digital economy and green growth.

Zhang (2024) analyzes the impact of digitalisation on green development using a sample of provincial panel data and enterprise panel data from 2011 to 2021. The empirical results are estimated employing benchmark regression. The research shows that the digitalization level has a significant positive promoting effect on the green development of regions and enterprises. Entrepreneurship acts as an intermediary bridge through which digitalization promotes green development. Furthermore, the results indicate that the environmental regulations serve as accelerators, enhancing the positive effect of entrepreneurship on green development.

Yu et al. (2025) examine the relationship among digital transformation, green investment and green transformation by analyzing a sample of 1,098 manufacturing companies from 2013 to 2022. The empirical results are estimated employing benchmark regression, heterogeneity analysis, and mechanism analysis. This study demonstrates that digital transformation significantly promotes green transformation in manufacturing enterprises, confirming the positive impact of digital technology on environmental sustainability. This finding emphasizes the crucial role of digital transformation in enhancing resource utilization efficiency and fostering green innovation in manufacturing companies.

DATA AND METHODOLOGY

The paper explores the relationship between green growth and digital transformation in the European Union countries. Green growth is measured by the Green Growth Index (GGI), based on the Green Growth Index Report published by the Global Green Growth Institute (GGGI). The GGI values range from 0 to 100, with a value of 100 representing the highest level of green growth. Digital transformation is measured by the score from of the Digital Competitiveness Ranking (DCR), sourced from the IMD

World Digital Competitiveness Ranking Report of the International Institute for Management Development (IMD). The DCR scores range from 1 to 100. This index evaluates a country's ability to adopt and utilize digital technologies for economic and social development. The environmental protection is assessed using three indicators: 1) EI - Energy intensity of GDP in purchasing power standards (PPS), 2) RE - Renewable energy share of total final energy consumption (TFEC) (%), and 3) CO_2 - Carbon dioxide emissions per capita (tonnes per person). The research also includes two additional variables important for sustainable and green growth: 1) TE - Tertiary education (% of the population aged 15–64), and 2) Urban population (% of total population).

The analysis is conducted on a sample of twenty six European Union countries in 2022. The following European Union countries are included in the research: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden. Malta was excluded from the research because of the lack of data on the digital competitiveness ranking from the IMD.

The paper applies regression analysis of cross-sectional data. The dependent variable is the Green Growth Index (GGI). The following independent variables are considered: energy intensity of GDP (EI), renewable energy share of TFEC (RE), tertiary education (TE), carbon dioxide emissions per capita (CO_2), Digital Competitiveness Ranking score (DCR), and urban population (UP).

The regresion model used in the research:

$$GGI = \alpha_0 + \beta_1 EI + \beta_2 RE + \beta_3 TE + \beta_4 CO_2 + \beta_5 DCR + \beta_6 UP + \sigma(Y)$$

Legend: α_0 - intercept, β_1, β_2, β_3, β_4 - coefficients of variables, $\sigma(Y)$ - error

The basic hypothesis of the research is that digital transformation has a positive impact on green growth in European Union countries.

The values of indicators of the green growth, environmental protection and digital transformation in EU countries are shown in Table 1.

Table 1. Indicators of Green Growth and Digital Transformation in European Union Countries, 2022.

Country	GGI	EI	RE	TE	CO_2	DCR	UP
Austria	75.43	81.74	34.07	33.1	6.75	85.35	59.26
Belgium	63.92	119.07	13.82	36.9	7.77	81.34	98.15
Bulgaria	61.50	137.52	19.04	44.0	7.34	58.51	76.36
Cyprus	58.68	88.63	19.43	42.3	5.60	63.67	66.91
Czechia	72.11	117.65	18.12	33.0	9.51	75.54	74.38
Germany	75.29	80.32	20.91	25.1	8.01	85.17	77.65
Denmark	73.94	58.95	42.38	37.3	4.94	100.00	88.37
Estonia	65.71	127.14	38.54	50.1	8.03	85.06	69.61

Greece	59.26	93.88	22.67	19.6	5.45	56.93	80.36
Spain	64.65	87.07	21.90	25.5	5.32	77.40	81.30
Finland	70.64	153.00	47.74	29.6	6.70	96.60	85.68
France	68.36	90.57	20.45	34.6	4.76	81.42	81.51
Croatia	63.04	84.98	28.09	21.8	4.41	64.58	58.22
Hungary	67.39	98.54	15.19	36.8	4.88	65.25	72.55
Ireland	56.31	33.74	13.07	58.0	7.39	79.56	64.18
Italy	68.28	72.35	19.13	12.2	5.42	68.33	71.66
Lithuania	64.89	81.29	29.60	41.7	4.71	79.32	68.47
Luxembourg	64.22	64.32	14.43	56.2	11.61	76.47	91.88
Latvia	63.73	99.36	43.72	40.6	3.56	74.24	68.54
Netherlands	67.29	92.84	14.90	38.4	7.52	97.85	92.89
Poland	64.49	97.46	16.85	52.2	8.39	63.09	60.13
Portugal	66.32	80.51	34.68	35.8	3.96	70.84	67.38
Romania	63.20	62.88	24.23	40.3	4.03	58.32	54.49
Sweden	73.11	110.10	66.29	40.8	3.61	99.81	88.49
Slovenia	67.35	95.11	25.00	19.1	6.59	71.45	55.75
Slovakia	68.17	119.78	17.48	32.1	6.44	59.64	53.91

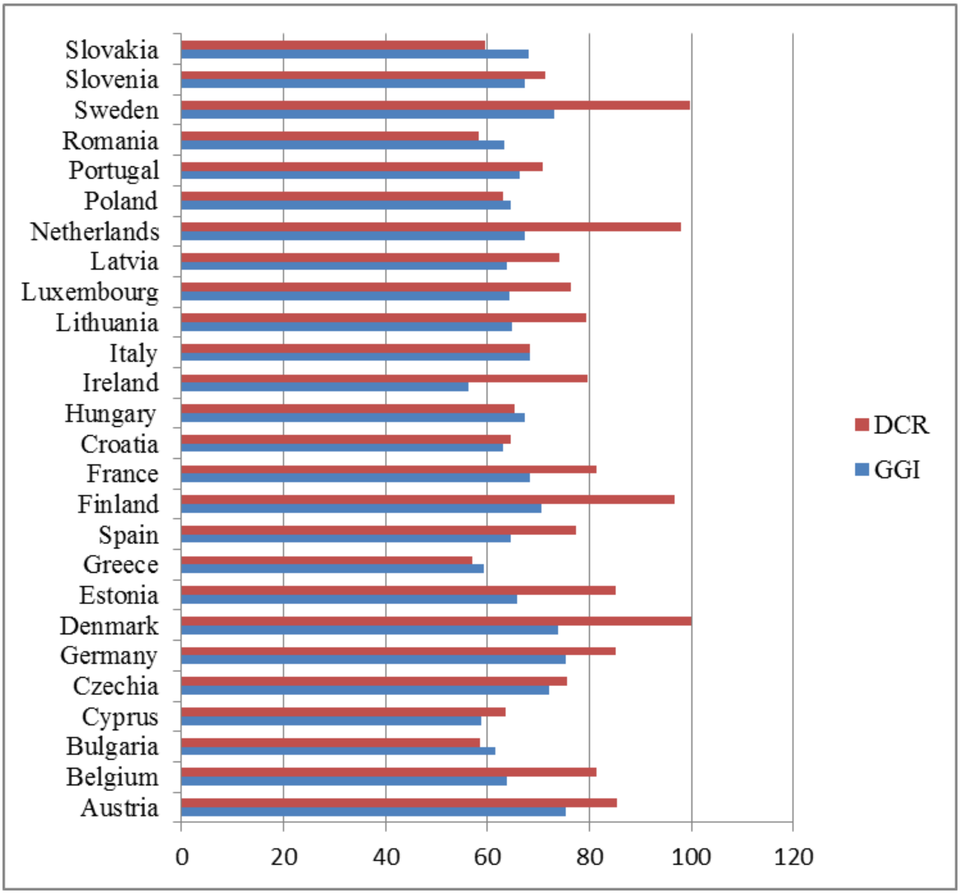
Legend: GGI - Green Growth Index, EI - Energy intensity of GDP in purchasing power standards (PPS), RE - Renewable energy share of TFEC (%), TE - Tertiary education (%), CO_2 - carbon dioxide emissions per capita (tonnes per person), DCR - Digital Competitiveness Ranking score, UP - Urban population (% of total population)

Source: Global Green Growth Institute, 2023; IMD World Competitiveness Centre, 2022; OECD, 2025; Eurostat, 2025; World Bank, 2025.

The highest green growth is recoreded by Austria (75.4), Germany (75.3), Denmark (73.9), and Sweden (73.1), and the lowest is in Greece (59.2), Cyprus (58.7), and Ireland (56.3). Digital transformationa (DCR) scores are highest in Denmark (100.0), Sweden (99.8), the Netherlands (97.8), and Finland (96.6) and lowest in Bulgaria (58.5), Romania (58.3), and Greece (56.9). Energy intensity of GDP is highest in Bulgaria (137.5), Slovakia (119.7), and Belgium (119.1), and lowest in Denmark (58.9) and Ireland (33.7). The renewable energy share is highest in Sweden (66.3) and Finland (47.7), and lowest in Hungary (15.2), Luxembourg (14.9), and Ireland (13.1). CO_2 emissions are highest in Luxembourg (11.6), Poland (8.4), Estonia (8.0), and Germany (8.0), and lowest in Romania (3.6), Portugal (3.9), and Sweden (3.6). Urban population is highest in Belgium (98.1) and the Netherlands (92.9), and lowest in Romania (54.5) and Slovakia (53.9). Tertiary education levels are highest in Ireland (58.0) and Luxembourg (56.2), and lowest in Slovenia (19.1) and Italy (12.2).

An overview of the Digiral Competitivness Ranking (DCR) and Green Growth Index (GGI) of Europena Union countires is shown in Graph 1.

Graph 1. Green Growth and Digital Transformation in European Union Countries, 2022.



Source: Global Green Growth Institute, 2023; IMD World Competitiveness Centre, 2022

Graph 1 shows that countries with higher level of digital develomepment (DCR) simultaneously record higher levels of green growth (GGI), with the following exceptions: Slovakia, Romania, Poland, Hungary, Greece, and Bulgaria. They have a higher green growth score than their level of digital transformation.

The results of the descriptive statistics of green growth, digital transformation, and environmental indicators are presented in Table 2.

Table 2. Descriptive Statistics

	GGI	EI	RE	TE	CO_2	DCR	UP
Mean	66.43	93.42	26.22	36.04	6.26	75.99	73.39
Median	66.01	91.70	21.40	36.85	6.02	76.00	72.10
Min	56.31	33.74	13.07	12.20	3.56	56.93	53.91
Max	75.43	153.00	66.29	58.00	11.61	100.00	98.15
Sd.	4.95	25.82	12.85	11.29	1.96	13.12	12.69
Skew	0.09	0.15	-0.04	1.35	0.69	0.34	0.17
Kurtosis	0.62	0.03	1.40	-0.49	0.06	-0.97	-1.11

Source: Authors' calculations

The data in Table 2 indicate that this is a heterogeneous group of countries. Green Growth Index ranges from 56.3 (Ireland) to 75.4 (Austria). The Digital Competiveness Ranking of countries ranges from 56.9 (Greece) to 100.0 (Denmark). The heterogeneity of the data is pronounced in terms of environmental indicators among this countres. For example, energy intensity ranges from 33.7 (Ireland) to 153.0 (Finland).

The mean value of Green Growth Index (66.4) of the European Union countries indicates relatively modest results. The mean value of the Digital Competitiveness Ranking score (76.0) is higher than the mean value of the GGI for the observed group of countries. This suggests that these countries are at a higher level in terms of digital transformation and development than in terms of green growth. These countries perform poorly in environmental terms, as shown by the high mean value of energy intensity of GDP (93.4 kgoe/1000 EUR PPS), low mean value of renewable energy share of total final energy consumption (26.2%), and high mean value of carbon dioxide emissions (6.2 t/per capita).

Skewness indicates that most variables exhibit mild or moderate right (positive) asymmetry, while the variable tertiary education (1.35) shows a strong right asymmetry. Kurtosis values suggest that most distributions are generally close to normal. Some variables have slightly flatter distributions (negative kurtosis), while the variable renewable energy shows a tendency towards more extreme values, with kurtosis of 1.40.

RESULTS AND DISCUSSION

The results of the correlation analysis between the dependent and independent varibales are presented in the form of correlation matrix in Table 3. Pearson's correlation coefficient is used to measure the strength and direction of the linear relationship between the variables.

Table 3. Correlation Matrix

	GGI	EI	RE	TE	CO_2	DCR	UP
GGI	1.000						
EI	0.1747	1.000					
RE	0.4178	0.2395	1.000				
TE	-0.3158	-0.1194	-0.0330	1.000			
CO_2	0.0279	0.1215	-0.4744	0.3393	1.000		
DCR	0.5798	0.0333	0.5199	0.1179	0.0750	1.000	
UP	0.1806	0.1770	0.1006	0.0699	0.2337	0.5888	1.000

Source: Authors' calculations

The correlation coefficient between the Green Growth Index and the Digital Competitiveness Ranking (0.5798), the renewable energy share of TFEC (0.4178), and tertiary education (-0.3158), indicates a satisfactory level of correlation for further analysis. The correlation is especially weak between the Green Growth Index and carbon dioxide (CO_2) emissions per capita (0.0279), indicating the absence of correlation. Furthermore, the correlation coefficient between the Green Growth Index and the Digital Competitiveness Ranking score is positive. The correlation coefficient of 0.5798 reflects a moderately strong positive correlation, implying that countries with higher levels of digital competitiveness tend to exhibit better performance in green growth. This supports the assumption that digital transformation contributes to enhanced environmental outcomes through increased efficiency, innovation, and sustainable practices.

On the other hand, the correlation coefficient between the Green Growth Index and tertiary education of -0.3158 indicates a weak to moderate negative correlation. This suggests that a higher share of highly educated individuals does not automatically mean higher green growth. This unexpected result may be due to labor market mismatches. Finally, the correlation coefficient between all independent variables remain below the critical threshold of 0.8, indicating no signs of multicollinearity. The highest value are found between the Digital Competitiveness Ranking score and urban population (0.5888), and between the Ranking and renewable energy (0.5199).

Both values are within acceptable limits, confirming the appropriateness of including these variables in the model.

The results of the Variance Inflation Factor (VIF) test are presented in Table 4 in order to assess the possibility of multicollinearity in the model.

Table 4. Results of the Variance Inflation Factor (VIF) Test

Variables	Model
Energy intensity of GDP in purchasing power standards (PPS)	1.4291
Renewable energy share of TFEC (%)	3.0142
Tertiary education (%)	1.2352
Carbon dioxide emissions per capita (tonnes per person)	2.1622
Digital Competitiveness Ranking score	2.9394
Urban population (% of total population)	1.8430

Source: Authors' calculations

The VIF values for all variables are below the critical threshold 5, indicating that the model does not suffer from multicollinearity.

The results of the regression analysis of the cross-sectional data for the model estimation are presented in Table 5.

Table 5. Results of the Regression Analysis

	Coefficients	Standard Error	t-value	p-value
Intercept	54.78197***	5.71686	9.583	1.04e-08
EI	0.01209	0.03377	0.358	0.7244
RE	0.07888	0.09857	0.800	0.4334
TE	-0.20091*	0.07180	-2.798	0.0115
CO_2	0.72893	0.54804	1.330	0.1992
DCR	0.25200*	0.09530	2.644	0.0160
UP	-0.10921	0.07804	-1.399	0.1778
R^2	0.5867			
Adjusted R^2	0.4562			
Res. std. error	3.648			
F-statistic	4.495			
p-value	0.005371			
DF	19			

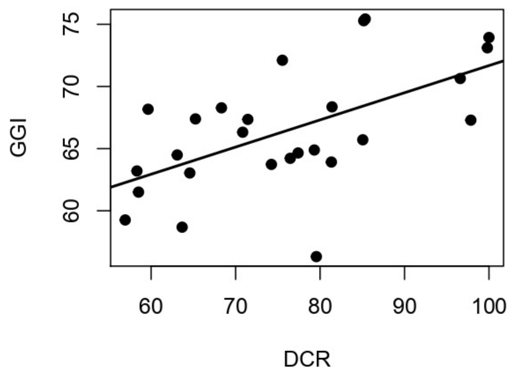
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Source: Authors' calculations

The adjusted coefficient of determination (R^2 adjusted) for the model amounts to 0.4562 (or 45.62%). This means that 45.62% of the variation in the Green Growth Index across the observed countries can be explained by the combined effect of six factors: energy intensity of GDP, renewable energy share of TFEC, tertiary education, carbon dioxide emissions per capita, Digital Competitiveness Ranking score, and urban population. The F-test value of 0.005371 is less than 0.05, indicating that the model is statistically significant. Focusing on individual predictors, the relationship of the Green Growth Index and the Digital Competitiveness Ranking score, measured by the β coefficient, is 0.25200. The relationship between the Green Growth Index and the Digital Competitiveness Ranking score is positive according to this β coefficient. The result is statistically significant, as the p-value in this case is less than 0.05, and specifically 0.0160. The relationship between the Green Growth Index and tertiary education, measured by the β coefficient, amounts to -0.20091. The result is statistically significant, as the p-value is 0.0115. The negative relationship between green growth and tertiary education is specific to this case. The other four considered variables (energy intensity of GDP, renewable energy share of TFEC, carbon dioxide emissions, and urban population) are not statistically significant in this model.

The following Graph 2 provides an overview of the Green Growth Index regression lines of the considered European Union countries as a function of the the Digital Competitiveness Ranking score.

Graph 2. Linear Regression between Green Growth and Digital Tranformation



Source: Green Growth Institute, 2023; IMD World Competitiveness Centre, 2022 Authors' drawing

Looking at Graph 2, we can see an increasing regression line between GGI and DCR. This means that the growth of the Green Growth Index corresponds to an increase in the Digital Competitiveness Ranking score.

The results of the tests for the model evaluation are presented in Table 6. Here, we present tests for model heteroskedasticity and the normality of residuals.

Table 6. Test Results for Model Evaluation

Conducted test	t-statistic value	DF	p-value
Studentized Breusch-Pagan test	BP = 5.2232	6	0.5155
Shapiro-Wilk normality test	W = 0.95786	-	0.3511
Jarque Bera Test	X^2 = 1.2308	2	0.5404

Source: Authors' calculations

The Studentized Breusch-Pagan test is used to assess the presence of heteroskedasticity in a regression model. If the p-value of the test is less than the significance level of 0.05, this indicates the presence of heteroskedasticity. In this case, the p-value is 0.5155, which is greater that 0.05, so we fail to reject the null hypothesis of homoskedasticity. This suggests that there is no evidence of heteroskedasticity in the model.

The Shapiro-Wilk test is used to assess the normality of residuals in regression analysis. If the p-value of the test is less than 0.05, the null hypothesis of normality is rejected, indicating that the residuals are not normally distributed. In this case, the p-value is 0.3511, which is greater than 0.05, so we fail to reject the null hypothesis. This suggests that the residuals are approximately normally distributed, supporting the assumption of normality in the regression model.

The Jarque-Bera test is used to assess the normality of residuals in a regression model. If the p-value of the test is less than 0.05, this indicates that the residuals are not normally distributed. In this case, the p-value is 0.3511, which is greater than 0.05, so we fail to reject the null hypothesis. This suggests that the residuals are approximately normally distributed.

CONCLUSION

In the study, the authors assess the impact of digital transformation on green growth in twenty-six European Union countries. The paper uses the Green Growth Index of the Global Green Growth Institute as a measure of green economy, and the Digital Competitiveness Ranking score of the International Institute for Management Development as a measure of digital transformation. Regression analysis was conducted on cross-sectional data. The R programming language was used for data analyses.

The results of the correlation analysis indicate that there is a moderately strong positive correlation between the Green Growth Index and the Digital Competitiveness Ranking score of European Union countries. The positive correlation value (0.5798) indicates that green growth is accompanied by a higher level of digital transformation and development.

The results of the regression analysis confirm the research hypothesis that digital transformation has a positive impact on green growth in the European Union countries. The adjusted R-squared of the model with six observed variables (energy intensity of GDP, renewable energy share of TFEC, tertiary education, carbon dioxide emissions, Digital Competitiveness Ranking score, and urban population), amounts to 0.4562. The β coefficient for digital transformation (Digital Competitiveness Ranking score) is 0.2520, indicating a positive impact of this indicator on green growth in the European Union countries.

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REFERENCES

1. Bai, C., Du, X., & Chua, S.Y. (2025). The green potential of the digital economy in balancing economic growth and carbon emissions. *Scientific reports*, 15(1), 19365, 1-18, https://doi.org/10.1038/s41598-025-04616-x
2. El Awady, S. M. S., Salman, W. M. M., & Eltayb, A. T. (2025). Digital transformation and its impact on sustainable development. *SDGs Review*, 5, 04576, 1-42, https://doi.org/10.47172/2965-730X.SDGsReview.v5.n01.pe04576
3. Eurostat. (2025). *Energy intensity* [Dataset]. Eurostat. Retrieved July 16, 2025, from https://ec.europa.eu/eurostat/web/energy/database
4. Eurostat. (2025). *Population by educational attainment level, sex, age and country of birth (%)* [Dataset]. Eurostat. Retrieved July 15, 2025, from https://ec.europa.eu/eurostat/databrowser/view/edat_lfs_9911/default/table?lang =en
5. Eurostat. (2025). *Renewable energy share of TFEC (%)*. In *Renewable energy statistics*. Eurostat. Retrieved July 15, 2025, from https://ec.europa. eu/eurostat/statistics-explained/index.php?title=Renew able_energy_statistics
6. Global Green Growth Institute. (2023, December). *Green Growth Index 2023: Technical report* (No. 32). Global Green Growth Institute. Retrieved from https://greengrowthindex.gggi.org
7. IMD World Competitiveness Center. (2022). *IMD World Digital Competitiveness Ranking 2022*. IMD. Retrieved from https://www.imd.org/ centers/world-competitiveness-center/rankings/world-digital-competi tiveness/
8. Liao, W. (2023). How does the digital economy affect the development of the green economy? Evidence from Chinese cities. *PLOS ONE*, 18(8), e0289826, 1-24. https://doi.org/10.1371/journal.pone. 0289826
9. Majeed, M. T., & Sharif, F. (2024). The role of digitalisation in driving green growth: A global panel data persepective, *Pakistan Journal of Commerce and Social Sciences (PJCSS)*, 18(2). 435-467.

10. Nguyen, Q. M., Hang, N. P. T., & Dao, L. T. (2024). Exploring the nexus between digital economy and green growth: Insights from emerging economies. *Emerging Science Journal*, 8(4), 1622-1641. http://dx.doi.org/ 10.28991/ESJ-2024-08-04-022
11. OECD. (2025). *Environmentally Related Tax Revenue (ERTR) database* [Dataset]. Organisation for Economic Co-operation and Development. Retrieved July 15, 2025, from https://data-explorer.oecd.org/
12. Peković, D., Joksimović, M., & Madžar, L. (2024). The impact of digitalization on employment and labour skills in European Union. In *Proceedings of the Second International Scientific Conference "Challenges of Digitalization in the Business World"* (pp. 244–257). Alfa BK University, Belgrade.
13. United Nations. (n.d.). *Green growth*. Sustainable Development Goals Knowledge Platform. Retrieved July 28, 2025, from https://sustainable development.un.org/index.php?menu=1447
14. World Bank. (2025). *GDP per capita, PPP (constant 2021 international $)* [Dataset]. World Bank. Retrieved July 15, 2025, from https://data.worldbank. org/indicator/NY.GDP.PCAP.PP.KD
15. World Bank. (2025). *Urban population (% of total population)* [Dataset]. World Bank. Retrieved July 15, 2025, from https://data.worldbank. org/indicator/SP.URB.TOTL.IN.ZS
16. Yu, H., Su, X., Yang, Y., & Yao, S. (2025). Digital transformation, green investment, and green transformationa: The moderating effects of industrial policy. *Polish Journal of Environmental Studies,* 20(10), 1-16. https://doi.org/10.15244/pjoes/192579
17. Zhang, J. (2024). Research on the impact of digitalization on green development: An empirical analysis from the low-carbon strategy perspective. *PLOS ONE*, 19(3), e0300288, 1-23. https://doi.org/10.1371/journal.pone.0300 288