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DIGITAL DIVIDE IN THE EUROPEAN UNION: ASSESSING SPATIAL DISPARITIES AND NEIGHBORHOOD EFFECTS

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Abstract: This article aims to investigate whether the digital inequality within the European Union (EU) has been reduced in the period 2017–2022. The goal of the study is to measure the dynamics of EU digital inequality and assess the effectiveness of the EU supranational bodies in reducing digital disparities. The author seeks to determine if the dynamics of this divide have been influenced by the EU's supranational policy fostering digital transformation by juxtaposing EU financing of digital transformation and spatial disparities among EU members based on Digital Economy and Society Index (DESI) and its components. The study reveals that, despite the fact that the agenda of digital divide reduction has been in the focus of the European supranational bodies within the last 22 years, the funding of digital transformation was neither adequate in terms of volumes nor consistent. The main beneficiaries were the EU members located in Western and Southern Europe and the least supported area was the members in Eastern Europe. In addition, using spatial econometric analysis, the author proves that the spatial digital divide has decreased in the period 2017–2022 and coincides only partially with the conventional cleavage "developed North & West VS lagging South & East". However, as the correlation analysis shows, the EU financial support of digital transformation had a slight positive impact on countries' DESI score, which implies that the EU supranational policy on curbing digital divide was only partially effective.

Keywords: digital divide; EU digital transformation policy; Next Generation EU; Digital Economy and Society Index (DESI); Moran's *I*

1. Introduction

The digital divide, defined as "the gap between individuals, households, businesses, and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities" (OECD, 2001, p.5), is a pressing issue in the European Union (EU). The problem of the digital divide across the EU is significant because it perpetuates social and economic inequalities, hindering the overall development and cohesion of the Union. A geospatial perspective could be advantageous in investigating this issue, as it allows for the identification of regional disparities and the understanding of how

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geographical factors, for example, the neighborhood effect (Anselin, 2022), contribute to the digital divide.

In addition, besides the conventional digital divide dimensions, such as the internet access divide, the digital skills divide, and the digital outcomes divide, it is necessary to look at the actions taken to reduce digital disparities, especially financial measures. The case of the EU is of particular interest because the EU has supranational policy framework to foster digital development. Still, it remains unclear whether the undertaken measures have a significant impact on the general level of EU members' digital transformation levels and correspond to the existing spatial digital divide. The author intends to investigate the overall digital performance based on Digital Economy and Society Index (DESI), which includes 32 indicators measuring:

- Human capital aspects (e.g., share of ICT specialists in the labor force);
- Connectivity, including next generation access (NGA), very high capacity networks (VHCN), 5G coverage;
- Integration of digital technology (big data, cloud, AI); and
- Digital public services (open data, e-government, etc.).

The goal of this paper is to estimate whether the digital divide in the EU has been reduced within the five years (2017–2022) and whether the dynamics have been influenced or not by the supranational policy of the EU fostering digital transformation. The author's research question is the following: Do digital disparities in the EU coincide with the divide in countries' economic position? There is a certain notion in the academic literature backed up by statistical data about thriving Western and Northern European countries and underperforming Eastern and Southern European states (Bârgăoanu et al., 2019; Farina & Tamborini, 2015; Landesmann, 2015). The author, therefore, tests the hypothesis, whether digital cleavage in the EU coincides with this conventional cleavage "North & West VS South & East". For this purpose, the following tasks were set:

- To examine the amount and distribution of funding for supranational programs to stimulate digital transformation as a tool to reduce digital divide among EU countries; and
- To conduct a spatial analysis of the digital inequality in the EU in 2017 and 2022 based on DESI (European Commission, 2023) to evaluate the effects of the EU's supranational policies on digital transformation.

2. Literature review

Over the past thirty years, scholars have been expressing their concerns about the digital divide (Melikyan, 2022). The understanding of this divide has evolved from differences in access to the Internet and physical infrastructure (like computers) to variations in digital competencies and the frequency of using digital resources. With the advancement of ICTs the initial excitement generated by these new technologies has given way to a realization that the benefits they provide are not distributed equally. This inequality undermines the principles of territorial justice and exacerbates social and territorial inequalities. Consequently, the digital divide operates according to the so-called Matthew effect (Hargittai, 2003), meaning it perpetuates itself. Individuals with diminished levels of educational attainment and lower income seldom engage in using Internet for educational objectives, and consequently, fail to leverage it for income enhancement, even when granted access. This is how the digital divide feedback loop operates (Volchenko, 2016).

Research on the spatial analysis of digital divides in specific territories has been carried out for over 20 years. The digital divide, a multifaceted phenomenon encompassing disparities in access, skills, and outcomes related to digital technologies, has been a topic of extensive research in recent years. While early studies primarily focused on the binary distinction between those with and without access to technology (Norris, 2001; Warschauer, 2004), subsequent research has highlighted the multidimensional nature of the digital divide, considering factors such as skills, usage patterns, and outcomes (Hargittai, 2002; van Dijk, 2005). Research generally agrees that the global digital divide corresponds to the "Global North – Global South" divide. Castells (2002) attributes global inequality to resource scarcity and an unfavorable environment for foreign direct investment. James (2011) shows that developing countries can address digital inequality, but the progress varies, especially in Latin America and sub-Saharan Africa. He emphasizes the topic by distinguishing between absolute and relative digital divides. While attention often focuses on relative metrics, there are instances where the absolute digital divide widens due to faster ICT diffusion in economically successful countries. In the EU, Cardaica (2020) identifies significant digital gaps using DESI data, with three to five times differences in digital literacy and business digitalization between leading and lagging countries. Cleavages align with North–South and West–East divisions, and an urban-rural divide exists. Concerns arise that pan-European digital transformation policies may exacerbate the divide without adequate measures.

The EU's experiences with digital inequality extend beyond the pan-European level (Cuervo & Menéndez, 2006), with studies being conducted in specific regions such as the Balkans, including non-EU members (Mitrović, 2015) and Eastern Europe (Ragnedda & Kreitem, 2018), as well as individual countries like Greece (Gounopoulos et al., 2018) and Germany (Schleife, 2010). Previous research has highlighted the persistence of the digital divide within the EU, despite efforts by supranational bodies to reduce disparities. Polykalas (2014) examined the evolution of the digital divide across EU countries from 2008 to 2013, finding that while the divide had decreased, significant disparities remained between member states. Similarly, Szeles and Simionescu (2020) analyzed the digital divide in the EU between 2008 and 2018, concluding that the gap between high and low performers had narrowed, but not disappeared. These studies emphasize the role of economic factors in shaping the digital landscape, with more developed countries generally exhibiting higher levels of digital adoption and skills. However, these analyses are limited by their focus on a narrow set of indicators, such as internet access and basic digital skills, which may not fully capture the complexity of the digital divide. Furthermore, they do not explicitly consider the impact of EU policies and funding on reducing disparities, leaving open questions about the effectiveness of supranational efforts to promote digital convergence.

In the context of this paper, the spatial distribution of digital inequality, particularly using spatial econometrics, i.e., local indicators of spatial association (LISA), holds significant interest. The Google Scholar database yields more than 600,000 unique results on the “spatial analysis of digital divide” query. Several countries, including Japan (Nishida et al., 2014), Rwanda (Otioma, 2019), and China (Song et al., 2020), have become geographic targets for spatial analysis. Similarly, the EU was not exempt from this analysis. For instance, Spanish researchers (Lucendo-Monedero et al., 2019) conducted an analysis of the inequality in digital development of households and individuals in 2019 using spatial econometrics. It's worth noting that the application of spatial and regression analysis remains relatively infrequent, with researchers primarily focusing on cluster analysis through the creation of percentile maps. In the studies mentioned, only the experiences of China and the EU were analyzed using a more sophisticated methodological apparatus of spatial econometrics. Nevertheless, the research question regarding the impact of the neighborhood effect (Anselin, 2022), in other words, the extent to which proximity to a more digitally successful neighbor is a factor in the success of a state/region's digital development, and vice versa, remains unanswered.

3. Methodology

The first phase of the research entailed an analysis of digital transformation funding and its efficiency. Public data on EU budgeting revealed specific digital transformation funding programs. Three programs were identified due to their consistent implementation and funding from 2007 to 2026. These are: the Information and Communication Technologies Policy Support Program (ICT-PSP), 2007–2013 (EUroalert.net, 2023); Connecting Europe Facility, CEF-Telecom, 2014–2020 (INEA, 2023); and Next Generaton EU (NGEU), 2021–2026 (European Commission, 2022a; NextGenerationEU, 2023). These programs offered comprehensive information on funding, broken down by countries (European Commission, 2022b). Maps of funds distribution were created using the software and hardware complex GeoDA (Version 1.20.0.20 of 15 July 2022). This step further enhanced our understanding of the distribution of resources and the potential impact on the digital gaps.

The second phase of the analysis involved spatial econometrics analysis of analyzing DESI and its components in 2017 and 2022 (European Commission, 2023). The author used the matrix of spatial neighborhood weights based on the intersection of two matrices—by the queen rule and the k-nearest neighbors' method, where k = 3 to avoid isolated cases, such as Malta, Cyprus, and Ireland, i.e., they remain in the analysis and have three neighbors each. The following instruments included:

- The percentile method to create a cartogram with rigid interval boundaries, but unequal scales, e.g., 0–1%, 1–10%, 10–50%, 50–90%, 90–99% which can be successfully used to identify observations with extremely high or extremely low values (outliers);
- Global Moran's *I* (Moran, 1950) to measure the overall spatial autocorrelation across all EU members in the dataset and to identify whether there is a tendency towards clustering or dispersed distributions;
- LISA based on Local Moran's *I* statistic (Anselin, 1995) to identify local clusters and spatial outliers and provide more detailed information about the digital divide localization in the EU by classifying locations into different types of clusters based on statistical significance:
  - High–High—cluster of spatial autocorrelation of high indicators of the phenomenon (red color),
  - Low–Low—cluster of spatial autocorrelation of low indicators of the phenomenon (blue color),
  - High–Low—cells with high indicators of the phenomenon surrounded by a cluster of spatial autocorrelation of low indicators of the phenomenon (pink color), and

– Low–High—cells with low indicators of the phenomenon surrounded by a cluster of spatial autocorrelation of high indicators of the phenomenon (purple color); and

- Bivariate Moran's I (Wartenberg, 1985) to measure the spatial correlation between DESI values and supranational funding of the EU members, identifying whether the spatial patterns of digital divide are related and statistically significant to the spatial patterns of EU funding of digital transformation.

Finally, Pearson's correlation was used to identify the relation between EU digital transformation funding for the previous (2007–2014, ICT-PSP and CEF Telecom programs) and contemporary periods (2021–2026, NGEU program). This statistics is used to measure the strength and direction of a linear relationship between two variables, providing a numerical value, known as the correlation coefficient, which ranges from −1 to 1. To characterize the results of Pearson's correlation as well as Global Moran's *I*, the author used the degrees of determination as shown in Table 1 (Okunev, 2020).

Table 1. Degrees of determination of correlations (Pearson's coefficient) and spatial autocorrelations (Moran's *I*)

Degree	Interval
Absolute positive	1
Strong positive	0.6–1
Medium positive	0.4–0.6
Moderate positive	0.2–0.4
Weak positive	0–0.2
No association	0
Weak negative	from –0.2 to 0
Moderate negative	from –0.4 to –0.2
Medium negative	from –0.6 to –0.4
Strong negative	from –1 to –0.6
Absolute negative	–1

Note. Adapted from *"Osnovy prostranstvennogo analysa* [Fundamentals of spatial analysis]", by I. Yu. Okunev, 2020, Aspekt-Press, pp. 161–162. CC BY-NC-ND.

4. Results and discussion

4.1. Funding digital transformation in the EU: directions and distribution per EU members

For the quantitative assessment, considering the mentioned difficulties, the author has chosen three consecutive ICT stimulus and digital transformation programs implemented in 2007–2026, for which the most complete information on funding by countries is available: ICT-PSP, CEF-Telecom and NGEU. The following assumption was taken as a basic premise: since the EU has proclaimed as one of its goals to increase digital competitiveness for building an information/digital society, the funding of such programs works to improve the position of each of the EU countries and to reduce the digital inequality in the EU in general. The geographic distribution of funding in 2007–2026 is presented in Figure 1.

The ICT-PSP and CEF programs shared similarities and differences in funding distribution, favoring Western, Northern, and Southern Europe over Eastern Europe. The NGEU program, with an 800-billion-euro budget over eight years, prioritizes digital transformation. At least 20% of the national plan's funding for economic recovery and resilience is allocated to it (European Commission, 2021). Italy, Spain, and Germany lead in absolute funding, while Germany, Spain, and Austria allocate the highest percentage. Western and Southern European countries benefit most from the NGEU program, with Eastern European countries receiving funding above the average. Nordic countries allocate below-average budgets for digital transformation.

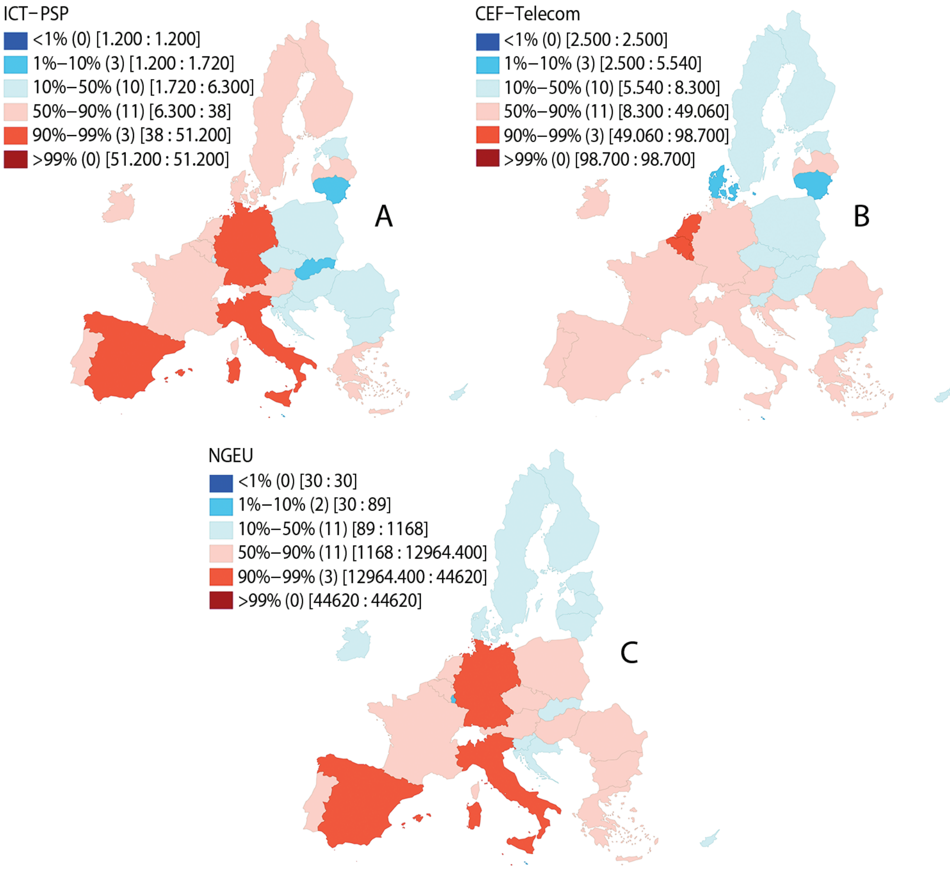

Figure 1. Percentile cartograms of EU digital transformation funding in 2007–2026 under ICT-PSP (A), CEF-Telecom (B), and NGEU (C) by countries, mln EUR.
Note. Blue color corresponds to below-average funding values; orange color corresponds to above-average values. Value in the parentheses is the number of countries in the percentile group; value in square brackets is the range of funding values corresponding to the percentile group.

Summarizing the results of the funding analysis, the three EU funding programs have similarities and differences in terms of funding distribution and priorities. The NGEU program is the most comprehensive and has an unprecedented budget compared to the previous programs reviewed. It can be stated that the allocated resources were moderate in sums. Main beneficiaries of the programs to support digital transformation and ICT implementation in 2007–2022 in the EU were the countries of Western and Southern

Europe, especially Germany, France, Spain, Italy, and the Benelux countries. EU members located in Eastern Europe (Bulgaria, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia) were allocated substantial amounts for digitalization only in 2021 within the implementation of the Recovery and Resilience Plans until 2027. Thus, the hypothesis of spatial disparities in EU digital transformation funding for Western and Eastern Europe is only partially confirmed. Digital transformation budgeting in Northern European countries was below average, while EU members in Southern Europe received sufficient funding from the ICT-PSP, CEF Telecom, and NGEU programs to gradually reduce the ICT gap. EU funds allocated to digital transformation benefit EU members with an initial average or above-average digitalization position, while less competitive EU members, especially in Eastern Europe, receive less than average funds and spend them less efficiently, with no significant increase in competitiveness.

4.2. The geography of the EU digital divide and its dynamics

The next step of this manuscript is to look the digital divide in the EU through the prism of spatial analysis. This will provide an answer to the main question of the paper: Does the digital inequality in the EU coincide with the divide in countries’ economic position and was the EU supranational bodies financial support to reduce digital disparities effective? For this purpose, statistical data at the national (DESI) level are processed.

4.2.1. Spatial autocorrelation of digital transformation indicators in the EU

At the first stage, Global Moran's *I* (spatial autocorrelation coefficients) was calculated for countries according to the DESI and its components (Table 1a in the Appendix; European Commission, 2023). This metric determines the degree of spatial clustering of countries and NUTS-1 regions with similar values of the selected indicators. The analysis of spatial autocorrelation by Moran coefficients indicates a positive relation between the indicators and spatial distribution. i.e., the grouping in space of objects (countries and regions) with high and, separately, with low values of indicators of digital transformation is mathematically fixed.

The distribution of Global Moran's I values for the DESI and its indicators in 2017 shows different levels of spatial association. Some indicators are strongly clustered, while others have weaker or no spatial association. The indicators with medium positive values, like the share of ICT specialists in the labor force, mobile broadband usage, and DESI total index itself, are more spatially associated because they exhibit a pattern of clustering, where high values tend to be near other high values and low values near other low values.

Additionally, economic and demographic factors could also play a role in the spatial distribution of indicators. Regions with higher levels of economic development and larger populations may have higher usage of e-commerce or e-government services, leading to a moderate positive spatial association for these indicators.

The list of indicators not showing spatial association remains consistent, including Fiber to the Premises coverage, Total number of fixed broadband users, Fast broadband coverage, etc. Overall, there is a notable shift towards stronger positive correlations for several indicators, indicating an increased spatial association in the context of the DESI in 2022 compared to 2017.

A key finding from the trend analysis is that spatial linkages weaken over the five years considered: while the spatial autocorrelation of the DESI was greater than 0.5 in 2017, it decreased by 15% in 2022. This means that spatial clustering of countries and regions with high and low levels of digital transformation weakened in 2021–2022 compared to 2017. Consequently, spatial factors have become less influential in the distribution of digital goods (internet access, ICT competences, and digital services) over the five years; hence, digital inequality in the EU has decreased over the period considered. A similar decrease is observed in the Moran's I values for the components of the index: six out of eight indicators showed a decrease in spatial autocorrelation, except for data on cross-border online sales of SMEs and electronic information exchange (share of enterprises using ERP systems). This provides tentative evidence that digital inequality has decreased.

The most spatially correlated indicators in 2022 include: the share of hired ICT specialists among employed 15–74-year-olds, the share of administrative actions that can be performed online for major life events (birth of a child, new place of residence, etc.) for citizens and the share of enterprises analyzing big data from any data sources. Thus, the indicator related to human capital is characterized by the greatest spatial clustering. Aspects of clustering of digital public service provision and businesses' use of big data can be interpreted through the prism of the Matthew effect (Hargittai, 2003), where more economically developed countries and their thriving, sustainable businesses can afford to introduce expensive digital services; however, this assumption is not confirmed in a sample of other indicators, such as the use of electronic invoices and the introduction of AI in the activities of firms, whose Moran's I is low, but statistically significant. Consequently, the role of space is limited when interpreting non-human capital dimensions of digital transformation.

However, the indices themselves do not tell us where these clusters are located. This question can be answered by percentile mapping and calculations of local indicators of spatial autocorrelation.

4.2.2. Mapping of digital inequality clusters using local indicators of spatial autocorrelation

This methodology is suitable for identifying spatial clustering of one or two indicators by calculating Local Moran’s *I* statistics and was used in the context of this study only to compare the integral values of the DESI across countries. Clusters with at least two countries were analyzed (i.e., stand-alone states were not considered). The results of the LISA calculation and mapping along with the percentile mappings are summarized in Figure 2.

LISA reveals significant spatial clustering, contradicting a purely North–South and West–East digital divide. LISA identifies a stable cluster in the southeastern EU (Slovakia–Hungary–Romania–Bulgaria–Greece–Cyprus) with consistently low DESI values. Two additional clusters (Belgium–Netherlands and Sweden–Estonia) have emerged over five years, challenging the notion of a static divide. Belgium's dynamics on the percentile map shift, yet it remains in a high-value cluster, suggesting its neighbors outpace it in DESI improvement. LISA moderately supports inequality along southeast EU lines, while Northern and Western Europe show no significant high-value clusters, challenging the idea of these regions as “advanced” in digital transformation. Thus, the results obtained from LISA moderately support the hypothesis of a partitioning of numerical inequality along marked lines of demarcation with respect to the south-eastern members of the EU. At the same time, Northern and Western Europe did not show significant clusters of high DESI values, which refutes the thesis of "advanced" countries in these regions in terms of digital transformation.

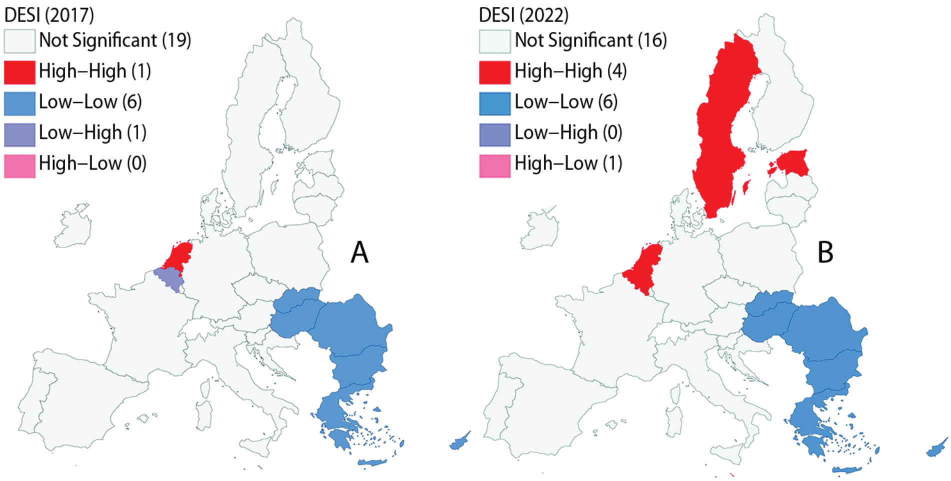

Figure 2. Cartograms of local indicators of spatial autocorrelation for the DESI, 2017 (A) and 2022 (B).

4.3. Measuring the effectiveness of the EU funding to foster digital transformation and bridging digital gaps.

The final step is to estimate the effectiveness and spatial effects of the considered three EU financial support programs. For this purpose, the author calculates the Local Moran's *I* and Pearson's correlation between DESI scores and three programs. The findings indicate a complex relationship between EU funding for digital transformation and the digital readiness of member states, as measured by the DESI scores. The correlation coefficients between each funding program and the DESI 2022 scores are relatively weak. For ICT-PSP and CEF Telecom, there is a slight positive correlation (0.170 and 0.181, respectively), indicating that higher funding from these programs is somewhat associated with higher DESI scores. However, for the NGEU funding, there is a weak negative correlation (–0.337), suggesting that countries receiving more funding from this program tend to have slightly lower DESI scores. This is a positive result in the sense that large amounts of funding for the future period will not statistically work to perpetuate the current state of digital inequality in the EU, i.e., underfunded Eastern European EU members have received a chance to actually improve their digital competitiveness and position in terms of spatial digital inequality.

The Moran's I values indicate the spatial autocorrelation of the funding across countries. The values for ICT-PSP (–0.072) and NGEU (–0.068) are close to zero, indicating a nearly random spatial distribution of the funding. However, the Moran's I for CEF Telecom (0.341) suggests a moderate positive spatial autocorrelation, meaning that countries with high funding tend to cluster together geographically.

The bivariate Moran's I values show the spatial correlation between funding and DESI scores. The values for ICT-PSP (0.332) and CEF Telecom (0.357) indicate a moderate positive spatial correlation, suggesting that countries with high funding and high DESI scores tend to cluster together. The value for NGEU (0.066) is close to zero, indicating a weak spatial correlation between this funding and DESI scores.

In summary, the correlation analysis reveals a complex relationship between EU funding for digital transformation and countries' DESI scores. While ICT-PSP and CEF Telecom funding show weak positive correlations and moderate positive spatial correlations with DESI scores, the NGEU funding exhibits a weak negative correlation and a weak spatial correlation. These findings suggest that the impact of EU funding on digital transformation may vary depending on the specific program and the geographical context.

The findings of this study align with previous research highlighting the persistence of the digital divide within the European Union, despite efforts by supranational bodies to reduce disparities (Polykalas, 2014; Szeles & Simionescu, 2020). The spatial analysis conducted in this paper reveals that while the digital divide decreased between 2017 and 2022, it only partially coincides with the conventional cleavage between developed North and West versus lagging South and East EU members. This suggests that factors beyond economic position, such as targeted digital transformation policies and funding allocation, play a role in shaping the digital landscape across the EU. However, the correlation analysis indicates that EU financial support for digital transformation had only a slight positive impact on countries' DESI scores, implying that supranational policies were only partially effective in curbing the digital divide. These findings diverge from studies that emphasize the critical role of EU policies in promoting digital convergence (Katz & Koutroumpis 2013; Szeles & Simionescu, 2020), highlighting the need for more targeted and comprehensive approaches to address the multifaceted nature of the digital divide.

5. Conclusion

The analysis of measures introduced by the EU to reduce the digital divide yielded several key conclusions. First, the analysis of digital transformation funding from 2007 to 2020 revealed that the volume of budget funds allocated for digital transformation was insufficient to accelerate digitalization and, even less so, to bridge digital divides. Furthermore, the funding was inconsistent in terms of geographical resource allocation: the program's primary beneficiaries were Western and Southern European countries, with less funding allocated to Eastern and Northern European countries (likely due to their initially high starting digitalization positions, as demonstrated by their DESI positions).

Secondly, despite insufficient and inconsistent funding, the digital divide has decreased at the national level in EU countries, but neighborhood effects remain at a significant level. Human capital indicators demonstrate the higher degree in comparison to others. Further research is required to measure the potential impact of COVID-19 on the accelerated digital transformation within the observed period.

The limited effectiveness of EU supranational policies in reducing the digital divide has significant policy implications. First, it underscores the need for a more equitable distribution of funding for digital transformation initiatives, with a focus on supporting Eastern European member states that have been historically underserved. Second, policymakers should consider adopting a more holistic approach to digital transformation, addressing not only infrastructure and connectivity issues, but also digital skills development and the integration of digital technologies across various sectors. This aligns with the recommendations of Szeles and Simionescu (2020), who emphasize the importance of investing in human capital and digital literacy to bridge the digital divide. Finally, the EU should establish clear benchmarks and monitoring mechanisms to assess the impact of digital transformation policies on reducing disparities, allowing for timely adjustments and improvements to existing programs.

It is important to acknowledge the limitations of this study and identify avenues for future research. The analysis relies on DESI scores and EU funding data, which may not capture all aspects of the digital divide, or the full range of policies and initiatives implemented at the national and regional levels. Future studies could incorporate additional indicators, such as measures of digital literacy, e-government services, and the adoption of emerging technologies, to provide a more comprehensive assessment of digital inequality. Moreover, qualitative research, including case studies and interviews with policymakers and stakeholders, could offer valuable insights into the challenges and best practices associated with reducing the digital divide in specific contexts. Finally, as the digital landscape continues to evolve rapidly, ongoing research is necessary to monitor the long-term effects of EU policies and identify new strategies for promoting digital inclusion and cohesion across the union.

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Appendix

Table 1a. Moran's spatial autocorrelation coefficients for the DESI and its indicators

Indicator	Moran's coefficient and *p*-value 2022[a]	Moran's coefficient and *p*-value 2017
ICT specialists	0.478 (0.002)[b]	0.407 (0.002)
Digital public services for citizens	0.461 (0.001)	
Big Data	0.442 (0.003)	0.074 (0.195)
DESI General Index	0.436 (0.002)	0.514 (0.001)
Amount of data transmitted through pre-filled forms	0.343 (0.005)	
Above average digital skills	0.327 (0.005)	
Cloud technologies	0.319 (0.006)	
Minimum basic digital content creation skills	0.31 (0.004)	
Minimum basic digital skills	0.296 (0.004)	
Artificial intelligence	0.285 (0.006)	
Electronic invoices	0.28 (0.09)	
Mobile broadband usage	0.269 (0.017)	0.441 (0.002)
SMEs with at least a basic level of digital intensity	0.239 (0.018)	
Cross-border online sales	0.238 (0.023)	0.186 (0.044)
Users of e-government	0.229 (0.024)	0.35 (0.003)
Digital government services for business	0.222 (0.026)	
Electronic exchange of information	0.214 (0.02)	0.189 (0.047)
Enterprises providing ICT training	0.203	0.276
Women ICT professionals	0.194 (0.035)	0.356 (0.005)
Social Media	0.192 (0.05)	0.119 (0.115)
Fiber to the Premises (FTTP) coverage	0.115 (0.119)*	0.132 (0.106)
Total number of fixed broadband users	0.085 (0.17)	0.313 (0.011)
Fast broadband coverage (NGA)	0.079 (0.156)	0.132 (0.106)
Broadband price index	0.07 (0.169)	
Very High-Capacity Fixed Network (VHCN) coverage	0.036 (0.236)	0.132 (0.106)
Use of fixed broadband at a speed of at least 100 Mbps	0.035 (0.237)	0.123 (0.99)
5G coverage	−0.027 (0.456)	
ICTs for environmental sustainability	−0.034 (0.411)	
5G spectrum	−0.054 (0.497)	
ICT graduates	−0.071 (0.44)	−0.181 (0.159)
E-commerce turnover	−0.095 (0.321)	0.264 (0.019)
Use of fixed broadband at a speed of at least 1 Gbps	−0.096 (0.299)	−0.02 (0.439)
Open data	−0.128 (0.223)	
SMEs selling online	−0.28 (0.422)	0.186 (0.044)

Note. Compiled by the author based on: European Commission. (2023). DESI by components. Digital Agenda Data. Retrieved November 8, 2023, from https://digital-decade-desi.digital-strategy.ec.europa.eu/datasets/desi-2022/charts/desi-components?indicator=desi&breakdownGroup=desi&period=2022&unit=pc_desi
[a]Values are ranked according to Moran's I 2022;
[b]*p*-values are given in parentheses;
*Values $p > .05$, i.e., statistically not significant, are highlighted in red.