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THE ROLE OF EDUCATION AND DIGITALIZATION IN TOURISM DEVELOPMENT: EVIDENCE FOR THE EUROPEAN UNION

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Abstract. The investigation of the relationship between tourism, digitalization, education, and economic growth is increasingly significant in the context of sustainable development and technological transformation. This study examines the long run and short run impacts of digitalization (measured through internet usage and broadband subscriptions), education (reflected in tertiary enrollment and public expenditure), and macroeconomic factors (including GDP per capita, employment in services, and urbanization) on international tourism performance, as indicated by arrivals and receipts across clusters of European Union countries. Methodologically, the study adopts a two-stage approach. Hierarchical cluster analysis is first applied to classify European Union countries according to key tourism characteristics, followed by the estimation of panel ARDL models for each resulting cluster to examine both long-run equilibrium relationships and short-run dynamics. Employing panel ARDL models applied to four distinct groups of countries, the analysis highlights differentiated dynamics, strong long-run effects in high-income tourism economies and more pronounced short-run responsiveness in structurally varied countries. Cointegration tests affirm the existence of long-run relationships in most clusters, reinforcing the validity of an error correction framework. Therefore, the empirical findings indicate that digitalization exerts a consistently positive influence on tourism performance in the long-run, while the effects of education are more heterogeneous across clusters. In the short-run, the impact of macroeconomic variables and digital infrastructure is more pronounced, underscoring the relevance of structural and contextual factors in shaping tourism dynamics. The findings emphasize the importance of aligning digital and educational policies with tourism development strategies while considering the structural differences among regions. This research provides a comparative framework that enhances the understanding of tourism as both an economic and social phenomenon.

Keywords: tourism performance, digitalization, education, economic growth, ARDL, European Union.

JEL Classification: L83, Z32, I25

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1. Introduction

Tourism is one of the most dynamic and significant economic sectors globally, exerting a profound impact on both economic and social development. According to the United Nation World Tourism Organization (UN Tourism, 2025a), tourism significantly contributes to the gross domestic product (GDP) of numerous countries, generating substantial revenues and creating millions of jobs. In 2019, prior to the COVID-19 pandemic, global tourism accounted for approximately 10.4% of global GDP and supported 334 million jobs, representing 10.6%

of total global employment (World Travel & Tourism Council, 2021). Following the devastating outcome of the COVID-19 pandemic and amidst ongoing economic, political, and military crises, the tourism sector witnessed a strong recovery by 2024, generating approximately USD 348 billion – roughly 10.2% of global GDP – and supporting an estimated 348 million jobs worldwide. In real terms, tourism receipts in 2024 exceeded those of 2023 by 4% and surpassed the 2019 levels by 3% (World Tourism Organization [WTO], 2025). In most countries of the world, tourism plays a central role in diversifying the economic structure and stimulating regional development, also having a multiplier effect on the economy. Tourism is a decisive contributor to the promotion of cultural exchanges and the improvement of international relations, to mutual understanding and respect, but also to global peace and stability.

The tourism industry is in a state of continuous evolution, shaped by emerging trends. Anticipating these trends is important, particularly with regard to digitalization and the growing importance of education in tourism development. Digitalization facilitates access to tourism information and services, improving the traveler experience through advanced technologies, such as artificial intelligence and mobile applications (Organisation for Economic Co-operation and Development [OECD], 2024; WTO, 2025). Education, on the other hand, plays a strategic role in training tourism professionals and promoting sustainability and innovation in this field (McGladdery & Lubbe, 2017; Chen et al., 2022; UN Tourism, 2023). Studying these trends is paramount to understanding the dynamics of the industry and to developing effective strategies that respond to the changing needs of travelers and the global market (WTO, 2023), contributing to strengthening knowledge and identifying opportunities for growth and adaptation in tourism.

Nevertheless, a significant research gap exists concerning the integration of digitalization into tourism and hospitality education. While some studies address specific technologies or required digital competencies, few adopt a comprehensive approach (Çinar, 2020; Mandalia, 2023). Longitudinal studies that track the long-run evolution of digital skills at the level of destination population or of tourism professionals (Minor et al., 2024), or the interaction between education and digitalization in the context of sustainability and innovation in tourism are also insufficient (Carlisle et al., 2023). There are also a few studies that develop comparative analyses of the relationship between tourism, education and digitization by groups of countries or regions (for example in the European Union). In this context most of the research focuses on the specific aspects of these themes or on bilateral interactions, without providing an integrated and comparative analysis (Alonso Gallo et al., 2024; EU Tourism Platform, 2024a). In this sense, we propose an integrated study of the relationship between tourism, education and digitalization, on the level of the European Union. This approach would contribute to the understanding of the dynamics and complex interactions in this field, by incorporating both structural and temporal dimensions. It would offer a comparative perspective across distinct groups of countries.

The article is organized as follows: the introduction is followed by a literature review about the role and importance of education and digitalization for tourism development, and by the research hypotheses. It carries on with the data and cluster analysis, followed by unit root and cointegration tests. The methodological framework and the panel ARDL model used for estimation are then outlined, after which the empirical results, discussion, and policy implications are presented. The paper concludes with final remarks and suggestions for future research.

2. Literature review

The educational level of the population in tourist destinations has attracted increasing scholarly attention, with studies suggesting that an educated workforce can offer higher quality services, thereby enhancing tourist satisfaction (Cerdeira Bento et al., 2021; Harazneh et al., 2018; Abubakar et al., 2014). Education also contributes to the development of linguistic and intercultural competencies, facilitating positive interactions between locals and visitors (Martínez-Roget & Rodríguez, 2021; McGladdery & Lubbe, 2017), and supporting the steady inflow of international tourists. Research indicates that investment in tourism-related education can promote local economic growth and sustainable development (Amaro et al., 2024), particularly when linked to practices that conserve natural and cultural heritage (Chen et al., 2022). Higher education institutions (Tomasi et al., 2020), along with international organizations such as UNWTO (Pololikashvili, 2022) or UNESCO (2023), have played key roles in advancing education in this field.

Education in general, and tourism education in particular, can serve as a powerful tool in ensuring the success of tourism destinations, linking and enhancing aspects such as experience, connection with visitors and involvement in current professional activity. Equipping industry professionals, destination partners and local communities with the necessary knowledge is the fundamental strategy for creating exceptional visitor experiences and sustainable economic impact (Tomasi et al., 2020). Because tourism is not only a journey, but also an economic engine, a cultural bridge and a platform for storytelling, without adequate education and training, tourism actors do not have the necessary tools to fully engage with visitors, present their destinations and create lasting impressions (Suciu et al., 2022). With adequate education and training, they can enhance visitor experiences, share specific knowledge and create moments of delight (Tomasi et al., 2020).

Effective tourism governance requires collaboration among government bodies, destination management organizations (DMOs), local businesses, and educational institutions. Education plays an important role in ensuring alignment and consistency in how destinations are promoted and experienced (Deyà-Tortella et al., 2021). Scholars such as Liburd (2018) or Weiermair and Peters (2012) examine the role of education in facilitating collaboration between different industry actors and stakeholders for sustainable tourism development. Ertuna et al. (2023) examines the role of higher education institutions as partners in multi-sectoral initiatives for implementing the Sustainable Development Goals (SDGs) in tourism. It also highlights how they facilitate collaboration between various stakeholders for transformative change and sustainable development.

Education also enhances community engagement, empowering residents to serve as ambassadors for their destinations. Education shapes interactions between residents and tourists and influences residents' perceptions of the impact of tourism on their quality of life, promoting memorable tourist experiences (Matatolu, 2019), helping to promote a positive destination image and increase tourist loyalty (Stylidis et al., 2021), and harmonious coexistence between tourists and local communities (Moscardo, 2012; Martínez-Roget & Rodríguez, 2021; McGladdery & Lubbe, 2017).

The global adoption of responsible management education principles and tourism strategies can ensure not only the attractiveness and sustainability of destinations for future

generations (Séraphin et al., 2022), but can also prove beneficial for the economy, well-being and environmental sustainability (Vieira et al., 2022; Chen et al., 2022). A thriving tourism industry is supported by well-educated and informed employees. Ganie and Dar (2018) or Mungai et al. (2021) highlighting the imbalances between tourism education and industry needs, emphasizes the pivotal role of well-educated human resources in promoting tourism and enhancing visitor experience, advocating for collaboration among educators, parents, and governments to improve graduates' skills and knowledge. Bindawas (2025) explores the interdependent relationship between employee skills and sustainable tourism, underscoring the importance of education in developing necessary competencies.

International literature and practice, while recognizing the important role of education in the success of tourism, indicate a series of limits and challenges that temper the optimism of a consistently positive relationship between the level of education and the performance of tourist destinations. For example, investments in quality education are costly, limited financial resources represent a barrier for many destinations, and significant variations in the level of education between different regions can affect the uniformity of the quality of tourist services (WTO, 2023). Challenges such as adapting educational programs to meet the specific needs of the tourism industry, staff retention, which affects the continuity and quality of services (WTO, 2023), or limited access to quality education in certain tourist destinations are hindrances to the development of international tourism. At the same time, the difficulties and hesitations in the practical implementation of educational programs and the uncertainty of their relevance and effectiveness over time emphasize the highly complex role of education in stimulating international tourism. The issue presents the need for integrated and sustainable approaches.

Researchers argue that the level of digitalization can be considered a form of education, as it involves the development of necessary digital skills to navigate and effectively use modern technologies, skills that are increasingly important in the current context, where technology plays an integrated role in almost all aspects of life (OECD, 2023; Timotheou et al., 2023). The level of digitalization of the population, measured by various indicators, such as fixed broadband subscriptions, or the percentage of the population using the internet, has a significant impact on international tourism. Digitalization facilitates access to information, online reservations and communication, improving the tourist experience. Studies show that destinations with an advanced digital infrastructure attract more international tourists due to the ease of planning and booking trips (Lee et al., 2021). The use of the internet for tourism marketing and promotion significantly increases the number of visitors in various regions (Standing et al., 2014).

In the same context, digital technologies contribute to the development of sustainable tourism by optimizing resources and reducing the environmental impact. UNWTO emphasizes the importance of digitalization for the stimulation of international tourism and the promotion of sustainable development (Abouzeid, 2022), that create smart destinations and improve their competitiveness (UN Tourism, 2024; Pencarelli, 2020).

The challenges and limits of digitalization in international tourism come from discrepancies in internet access and technology between different regions that can limit the benefits of digitalization (Dredge et al., 2019), from risks related to cybersecurity and personal data protection affecting tourist confidence (Kindzule-Millere & Zeverte-Rivza, 2022), but also from

the need to adapt existing digital infrastructure to meet the constantly changing demands of the tourism industry (Thomas, 2024).

However, most researchers and practitioners consider the level of education and the degree of digitalization in tourist destinations to be facilitators rather than motivators of international tourism. Destinations with significant investments in education tend to have a better-prepared population, capable of providing higher quality services, with advanced intercultural skills, which facilitates positive interactions between tourists and locals (UN Tourism, 2023). For example, UNWTO emphasizes the importance of education in tourism to promote sustainable practices and improve visitor satisfaction (UN Tourism, 2025b). At the same time digitalization facilitates access to information and online reservations, that improves the tourist experience (EU Tourism Platform, 2024b). Destinations with an advanced digital infrastructure tend to attract more international tourists due to the ease of planning and booking trips (Pololikashvili, 2022).

Drawing from the existing literature and empirical insights, the following hypotheses are proposed to evaluate both the long-run equilibrium relationships and the short-run dynamics between tourism performance – quantified through international arrivals and receipts – and key explanatory variables. The model differentiates between structural factors, including digitalization and education, and macroeconomic control variables, such as GDP per capita, employment in the services sector, and urbanization. The Hypotheses to be tested are formulated as follows:

H1a: *In the long run, a higher level of digitalization positively influences the number of international tourism arrivals.*

H1b: *In the long run, increased digitalization contributes positively to the growth of international tourism receipts.*

H2a: *Greater enrolment in tertiary education and higher public expenditures on education are associated with a significant rise in international tourism arrivals over the long run.*

H2b: *In the long-run, higher levels of education contribute to increased revenue generating capacity within the tourism sector.*

H3: *Key control variables, such as GDP per capita, the proportion of employment in the services sector, and urbanization levels, significantly influence long-run tourism dynamics in terms of both arrivals and receipts across countries.*

H4: *In the short run, digitalization can have negligible or negative effects on international tourism arrivals and receipts.*

H5: *In the short run, variations in education levels do not influence the number of international arrivals or the amount of tourism generated income.*

H6: *Short-run fluctuations in GDP and employment within the services sector positively influence tourism dynamics.*

H7: *In the short run, urbanization has no statistically significant effect on international tourism arrivals or receipts.*

3. Data and cluster analysis

To ensure a comprehensive investigation of the relationship between digitalization, education, and tourism performance across European Union member countries, a set of variables has been employed. Table 1 provides an overview of the variables included in the analysis, detailing their descriptions, classification into dependent, independent, and control categories, the respective data sources, and the time span covered. The dependent variables, international tourism arrivals and tourism receipts, serve to capture both the scale and the economic impact of tourism activities. Independent variables reflect the digitalization level and educational investments at the national level, while control variables account for key macroeconomic and structural characteristics that could influence tourism dynamics.

The data were obtained from international databases, The World Bank (n.d.) and the United Nations World Tourism Organization (UN Tourism, 2025a), spanning the years 2000 to 2022 to ensure the reliability, comparability, and temporal consistency of the panel dataset. The analysis focuses on 25 European Union countries, Spain and Malta were excluded due to the lack of sufficiently complete data over the study period. The countries included are 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, and Sweden.

Table 1. Description of variables and data sources

Variable	Description	Variable type	Source	Time
TOURARRIV	International tourism, number of arrivals	Dependent	United Nations World Tourism Organization (UN Tourism, 2025a)	2000–2022
TOURREC	International tourism, receipts (current US$)	Dependent	United Nations World Tourism Organization (UN Tourism, 2025a)	2000–2022
BROAD	Fixed broadband subscriptions	Independent	The World Bank (n.d.)	2000–2022
INTERNET	Individuals using the Internet (% of population)	Independent	The World Bank (n.d.)	2000–2022
GOV	Government expenditure on education, total (% of GDP)	Independent	The World Bank (n.d.)	2000–2022
EDU	School enrollment, tertiary (% gross)	Independent	The World Bank (n.d.)	2000–2022
GDP	GDP per capita (current LCU)	Control	The World Bank (n.d.)	2000–2022
EMP	Employment in services (% of total employment)	Control	The World Bank (n.d.)	2000–2022
URBAN	Urban population (% of total population)	Control	The World Bank (n.d.)	2000–2022

Within the framework of European integration and economic convergence, tourism serves as a key driver for advancing sustainable development, fostering regional cohesion, and strengthening the global competitiveness of the European Union (EU). Nevertheless, EU member states exhibit considerable diversity in their tourism profiles, which range from well-established international destinations to emerging markets that have not yet realized their full potential. To better understand these differences, cluster analysis becomes an important element. This method enables the categorization of countries according to their tourism performance levels, thereby providing a solid basis for econometric comparisons and contextually relevant impact assessments.

Two essential tourism indicators were chosen to analyze tourism dynamics across 25 EU countries, the number of international tourist arrivals and international tourism receipts. Utilizing hierarchical clustering techniques and visualizing the findings through dendrograms, two clusters were identified for each of the tourism indicators. The application of Ward's method for hierarchical clustering was beneficial, as it minimizes total within-cluster variance, resulting in more homogeneous clusters. This approach is preferred for its effectiveness in managing squared Euclidean distances and its ability to create compact clusters that accurately reflect statistical variations. In this study, Euclidean distance was employed as a commonly used metric to assess similarity between observations within a multidimensional space. This method computes the shortest distance between points, making it particularly useful for clustering applications that aim to group similar data points (Kaur, 2014; Idrus et al., 2022). While effective, relying solely on Euclidean distance can pose challenges, particularly in high-dimensional datasets or clusters with uneven distributions. This is due to the assumption that all features equally influence the dissimilarity measures (Singh & Saha, 2014; Kapil & Chawla, 2015). As a result, other distance metrics, such as Manhattan distance or Mahalanobis distance, may yield more effective outcomes for clustering tasks (Strauss & Maltitz, 2017).

The existing literature endorses the application of cluster analysis as an effective method for identifying prevalent tourism patterns. The predominant methodologies incorporate Euclidean distance as a similarity measure and hierarchical aggregation methods like Ward. D2, which are acknowledged for producing compact and statistically sound clusters. These methods are particularly recommended for cross-country comparisons, especially when applied to moderate sample sizes, as exemplified by the context of EU member states.

The dendrograms presented in Appendix (Figures A1–A2) effectively illustrate the hierarchical cluster analysis based on international tourism metrics. The first dendrogram (Figure A1), focused on international tourism – number of arrivals, displays two primary clusters: one composed of Italy, France, and Croatia (Cluster 1) – countries characterized by robust tourist volumes and well-developed tourism infrastructure and the other consisting of the other 22 EU countries (Cluster 2), which show more moderate or emerging tourism flows along with substantial structural diversity. The second dendrogram (Figure A2) corroborates this classification using data on international tourism receipts (current US dollars), identifying a distinct group of Italy, France, and Germany (Cluster 3), which generate significantly higher tourism revenues, while the other 22 EU countries (Cluster 4) form a homogeneous cluster with lower revenue levels. Furthermore, both dendrograms reflect clear statistical and visual separations supporting the two-cluster solution. The four clusters can be defined as follows:

- **Cluster 1:** Italy, France, Croatia. Countries with high international tourism arrival volumes and mature tourism infrastructure.
- **Cluster 2:** Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden. Countries with more heterogeneous and evolving tourism profiles.
- **Cluster 3:** Italy, France, Germany. Economies with the highest tourism revenue levels in the EU, indicative of their strong global market position and diversified tourism sectors.
- **Cluster 4:** Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden. Countries with relatively lower tourism receipts, reflecting differences in market positioning, infrastructure development, and tourism sector integration.

Cluster analysis, as a central methodological foundation in this study, enables the application of panel econometric models separately within each cluster. This approach not only enhances the robustness of estimations but also facilitates more valid and context-sensitive comparisons across different country groups. To address issues of heteroskedasticity, improve the linearity of relationships, and facilitate the interpretation of coefficients in terms of elasticities, all continuous variables were transformed into their natural logarithmic form prior to estimation. Logarithmic transformation is widely recommended in empirical research as it stabilizes variance across observations, reduces the impact of extreme values, and allows for the modeling of proportional rather than absolute changes. Furthermore, given the wide variation in scale among the selected variables, such as tourism receipts, broadband subscriptions, and GDP per capita, the use of logarithmic form ensures greater comparability across countries and periods, thereby enhancing the robustness and interpretability of the econometric results.

Table 2 presents the descriptive statistics for the four identified clusters and shows distinct patterns of homogeneity and variability across the analysed variables. Cluster 1 (focused on international tourist arrivals) shows very low variability, particularly for TOURARRIV (CV = 2%), EMP (CV = 3%), and URBAN (CV = 3%), suggesting a high level of internal consistency in tourism flows, service sector employment, and urbanization among Italy, France, and Croatia. In contrast, Cluster 2 exhibits greater dispersion, with higher coefficients of variation for the INTERNET, BROAD, and GDP (from 14% to 15%), reflecting more heterogeneous economic and digital development structures among the remaining 22 EU countries. Regarding tourism receipts, Cluster 3 (Italy, France, and Germany) displays high homogeneity, with a CV of just 1% for TOURREC and equally low dispersion for EMP and URBAN, confirming a shared profile of high-value tourism economies. Meanwhile, Cluster 4 shows moderate variability for TOURREC (CV = 5%) and similarly elevated dispersion in digitalization and economic indicators as observed in Cluster 2. Overall, the analysis highlights that Clusters 1 and 3 are internally cohesive, whereas Clusters 2 and 4 are characterized by greater heterogeneity, reinforcing the need for differentiated econometric estimation across clusters.

Table 2. Clustered descriptive statistics for tourism and structural variables

Variable	Cluster	Mean	Std.dev.	CV	Cluster	Mean	Std.dev	CV
TOURARRIV	Cluster 1	18.04	0.427	2%	Cluster 2	15.84	0.949	6%
EDU		4.085	0.176	4%		4.110	0.420	10%
GOV		1.551	0.147	9%		1.589	0.207	13%
INTERNET		3.926	0.528	13%		4.057	0.593	15%
BROAD		14.86	2.418	16%		13.55	2.031	15%
GDP		9.923	0.536	5%		10.63	1.489	14%
EMP		4.203	0.107	3%		4.189	0.166	4%
URBAN		4.204	0.143	3%		4.254	0.174	4%
TOURREC	Cluster 3	24.52	0.318	1%	Cluster 4	22.25	1.018	5%
EDU		4.096	0.138	3%		4.108	0.422	10%
GOV		1.562	0.172	11%		1.588	0.208	13%
INTERNET		4.083	0.422	10%		4.036	0.605	15%
BROAD		16.24	1.332	8%		13.36	1.971	15%
GDP		10.32	0.165	2%		10.58	1.518	14%
EMP		4.253	0.057	1%		4.183	0.168	4%
URBAN		4.312	0.060	1%		4.240	0.167	4%

Note: Std.dev – standard deviation, CV – Coefficient of variation.

4. Unit root and cointegration

Unit root tests are fundamental tools in econometric analysis for determining the stationarity of time series, and their correct application in panel data, where multiple cross-sectional units are observed over time, is fundamental for ensuring reliable empirical results.

In this study, three unit root tests are utilized: the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1979), which enhances the basic Dickey-Fuller approach by including lagged differences; the Phillips-Perron (PP) test (Phillips & Perron, 1988), which adjusts for serial correlation and heteroskedasticity without additional lags; and the Cross-sectionally Augmented Im-Pesaran-Shin (CIPS) test (Im et al., 2003), which accounts for cross-sectional dependence by incorporating panel averages. While ADF and PP serve to assess individual series, the CIPS test strengthens the robustness of stationarity results, especially in the presence of common shocks across units. Establishing the stationarity properties of tourism-related variables across the four EU clusters is a prerequisite for subsequent cointegration and dynamic panel analyses.

The unit root tests applied to the four clusters using ADF, PP, and CIPS methodologies, as presented in Table 3, reveal mixed stationarity properties among the analyzed variables. In Cluster 1 (Italy, France, Croatia), the dependent variable TOURARRIV is non-stationary at level according to ADF and PP tests but becomes stationary at first difference (I (1)), as confirmed by the significant CIPS statistic (–2.58, p = 0.00). Similarly, the independent variables such as EDU, GDP, EMP, and URBAN are non-stationary at levels and become stationary after differencing, confirming integration of order one (I (1)). On the other hand, variables like GOV,

Table 3. Unit root tests results by cluster for tourism and structural variables

Cluster	Variable	ADF	PP	CIPS	I	Cluster	ADF	PP	CIPS	I
Cluster 1	TOURARRIV	20.55 (0.00)	10.29 (0.11)	–2.58 (0.00)	I (1)	Cluster 2	130.75 (0.00)	86.75 (0.00)	-7.02 (0.00)	I (0)
	ΔTOURARRIV	60.85 (0.00)	42.13 (0.00)	–8.82 (0.00)			–	–	–	
	EDU	6.20 (0.40)	12.50 (0.05)	0.26 (0.60)	I (1)		69.36 (0.00)	127.84 (0.00)	–1.39 (0.08)	I (0)
	ΔEDU	9.85 (0.10)	17.84 (0.00)	–1.20 (0.10)			–	–	–	
	GOV	19.07 (0.00)	20.14 (0.00)	–2.71 (0.00)	I (0)		63.56 (0.02)	67.29 (0.01)	–2.23 (0.01)	I (0)
	ΔGOV	–	–	–			–	–	–	
	INTERNET	20.13 (0.00)	80.59 (0.00)	–2.71 (0.00)	I (0)		946.34 (0.00)	2234.1 (0.00)	–32.66 (0.00)	I (0)
	ΔINTERNET	–	–	–			–	–	–	
	BROAD	32.72 (0.00)	414.96 (0.00)	–4.79 (0.00)	I (0)		1547 (0.00)	1510 (0.00)	–36.92 (0.00)	I (0)
	ΔBROAD	–	–	–			–	–	–	
	GDP	0.88 (0.98)	1.74 (0.94)	1.77 (0.96)	I (1)		41.25 (0.59)	30.28 (0.94)	0.16 (0.56)	I (1)
	ΔGDP	18.63 (0.00)	29.86 (0.00)	–2.75 (0.00)			80.27 (0.00)	95.99 (0.00)	–2.89 (0.00)	
	EMP	11.61 (0.07)	18.10 (0.00)	–1.15 (0.12)	I (1)		53.08 (0.16)	110.56 (0.00)	–0.47 (0.31)	I (1)
	ΔEMP	10.87 (0.05)	33.06 (0.00)	–1.39 (0.00)			190.93 (0.00)	280.53 (0.00)	–10.41 (0.00)	
	URBAN	4.99 (0.54)	0.33 (0.99)	2.01 (0.97)	I (1)		552.25 (0.00)	826.17 (0.00)	–54.35 (0.00)	I (0)
	ΔURBAN	5.05 (0.05)	11.59 (0.00)	0.19 (0.05)			–	–	–	
Cluster 3	TOURREC	19.95 (0.00)	10.56 (0.10)	–2.98 (0.00)	I (1)	Cluster 4	101.03 (0.00)	81.50 (0.00)	–5.28 (0.00)	I (0)
	ΔTOURREC	38.06 (0.00)	29.25 (0.00)	–5.62 (0.00)			–	–	–	
	EDU	2.69 (0.84)	15.12 (0.01)	1.02 (0.84)	I (1)		72.87 (0.00)	125.21 (0.00)	–1.67 (0.04)	I (0)
	ΔEDU	16.09 (0.00)	28.06 (0.00)	–2.13 (0.00)			–	–	–	
	GOV	7.79 (0.25)	12.30 (0.05)	–0.82 (0.20)	I (1)		74.84 (0.00)	75.13 (0.00)	–2.92 (0.00)	I (0)
	ΔGOV	28.14 (0.00)	71.53 (0.00)	–4.14 (0.00)			–	–	–	
	INTERNET	184.21 (0.00)	60.99 (0.00)	–10.27 (0.00)	I (0)		782.26 (0.00)	2253 (0.00)	–29.86 (0.00)	I (0)
	ΔINTERNET	–	–	–			–	–	–	
	BROAD	53.20 (0.00)	446.79 (0.00)	–7.67 (0.00)	I (0)		1526 (0.00)	1478 (0.00)	–35.86 (0.00)	I (0)
	ΔBROAD	–	–	–			–	–	–	
	GDP	0.64 (0.99)	0.82 (0.99)	2.48 (0.99)	I (1)		12.49 (0.99)	33.59 (0.87)	5.77 (0.99)	I (1)
	ΔGDP	31.81 (0.00)	38.89 (0.00)	–4.72 (0.00)			115.65 (0.00)	134.38 (0.00)	–5.97 (0.00)	
	EMP	20.36 (0.00)	59.63 (0.00)	–3.05 (0.00)	I (0)		44.32 (0.45)	69.04 (0.00)	0.22 (0.58)	I (1)
	ΔEMP	–	–	–			191.62 (0.00)	278.06 (0.00)	–10.45 (0.00)	
	URBAN	1.90 (0.92)	8.96 (0.17)	3.97 (0.99)	I (1)		550.38 (0.00)	817.24 (0.00)	–52.38 (0.00)	I (0)
	ΔURBAN	5.12 (0.05)	5.28 (0.05)	0.02 (0.05)			–	–	–	

Note: I – integration.

INTERNET, and BROAD are already stationary at levels (I (0)), suggesting mixed integration orders in Cluster 1. In contrast, Cluster 2 (other 22 EU countries) displays stronger stationarity, with TOURARRIV being stationary at level (I (0)) according to all tests (ADF = 130.75, p = 0.00; CIPS = –7.02, p = 0.00), along with INTERNET, BROAD, and URBAN, while variables like GDP and EMP still require differencing to achieve stationarity. These results indicate a more stable dynamic structure for tourism arrivals in Cluster 2 compared to Cluster 1, facilitating more straightforward econometric estimation for the broader group of EU countries. Regarding the tourism receipts variable (TOURREC), the patterns are similar. In Cluster 3 (Italy, France, Germany), TOURREC is non-stationary at level but becomes stationary after first differencing (I (1)), as shown by the significant CIPS statistic (–2.98, p = 0.00). In Cluster 4 (other 22 EU countries), TOURREC is stationary at level (I (0)). Variables such as INTERNET and BROAD are stationary at level across all clusters, whereas GDP and URBAN remain non-stationary and require differencing (I (1)). These findings highlight the importance of correctly specifying econometric models depending on the degree of integration. Overall, the stationarity analysis supports a mixed-panel framework, where both I (0) and I (1) variables coexist, justifying the use of models like ARDL that accommodate variables of different integration orders.

Pedroni cointegration is an econometric technique designed to identify long-run equilibrium relationships among variables in a panel data framework, accommodating both cross-sectional heterogeneity and common time trends. Introduced by Pedroni (1999), this method extends traditional cointegration analysis to allow for more robust testing across heterogeneous groups, making it particularly suitable for studies involving economic indicators such as trade, investment, or tourism across countries or regions. In this article, Pedroni's test is employed to investigate the existence of long-run relationships among tourism indicators across four clusters of EU countries, enabling a better understanding of how education and digitalization impact tourism performance over time. By segmenting countries into clusters, the study accounts for differentiated tourism dynamics and external influences, illustrating the importance of panel cointegration approaches in comparative economic research.

Table 4. Pedroni panel cointegration test results by Cluster

Cointegration		Cluster 1	Cluster 2	Cluster 3	Cluster 4
		Statistics (Prob.)			
Within dimension	Panel v-statistic	2.0125 (0.022)	1.0776 (0.140)	0.3746 (0.354)	0.4853 (0.313)
	Panel rho-statistic	1.1243 (0.869)	2.3053 (0.989)	0.8667 (0.807)	4.1878 (0.999)
	Panel PP-statistic	–2.7349 (0.003)	–7.246 (0.000)	–1.631 (0.050)	–1.9606 (0.028)
	Panel ADF-statistic	–1.6814 (0.046)	–10.342 (0.000)	–1.811 (0.035)	–3.0956 (0.001)
Between dimension	Group rho-statistic	1.4948 (0.932)	3.4107 (0.999)	1.5866 (0.943)	7.2366 (0.999)
	Group PP-statistic	–2.6510 (0.004)	–9.2928 (0.000)	–2.5878 (0.004)	–0.8547 (0.096)
	Group ADF-statistic	–2.2074 (0.013)	–9.4294 (0.000)	–3.4107 (0.000)	–1.4619 (0.071)

The panel cointegration results in Table 4 confirm the existence of long-run equilibrium relationships among the analyzed variables across the four clusters, albeit with varying levels of robustness. For Cluster 1 (Italy, France, Croatia), within-dimension tests show mixed results: the Panel v-statistic is significant (2.0125, p = 0.022), indicating some evidence of cointegration, while the Panel rho-statistic is not significant (1.1243, p = 0.869). However, both the Panel PP-statistic (–2.7349, p = 0.003) and the Panel ADF-statistic (–1.6814, p = 0.046) are statistically significant, suggesting the presence of a stable long-run relationship among the variables. The between-dimension results reinforce this finding, as the Group PP-statistic (–2.6510, p = 0.004) and Group ADF-statistic (–2.2074, p = 0.013) are both significant, even though the Group rho-statistic is not (1.4948, p = 0.932). Overall, the majority of significant results indicate that Cluster 1 demonstrates cointegration among the analyzed economic, digitalization, and tourism variables. In contrast, Cluster 2 (the other 22 EU countries) presents much stronger evidence of cointegration. All within-dimension and between-dimension statistics are significant: the Panel PP-statistic (–7.246, p = 0.000), Panel ADF-statistic (–10.342, p = 0.000), Group PP-statistic (–9.2928, p = 0.000), and Group ADF-statistic (–9.4294, p = 0.000) confirm a strong and stable long-run relationship. Similar patterns are observed for Cluster 3 (Italy, France, Germany), where the Panel PP-statistic (–1.631, p = 0.050), Panel ADF-statistic (–1.811, p = 0.035), and Group ADF-statistic (–3.4107, p = 0.000) provide clear evidence of cointegration, despite the Group rho-statistic remaining non-significant. Finally, for Cluster 4 (the other 22 EU countries in the TOURREC model), evidence is slightly weaker: while the Panel PP-statistic (–1.9606, p = 0.028) and Panel ADF-statistic (–3.0956, p = 0.001) confirm cointegration, the Group PP-statistic (–0.8547, p = 0.096) and Group ADF-statistic (–1.4619, p = 0.071) are marginally significant or just above conventional thresholds. These results suggest that although long-run relationships are present across all clusters, they are considerably stronger and more robust in Clusters 2 and 3, while Clusters 1 and 4 show weaker but still acceptable levels of cointegration. Overall, the presence of cointegration validates the application of error correction models (ECM) and supports the reliability of long-run and short-run estimations.

5. Panel ARDL model results

Considering the stationarity characteristics revealed through unit root tests and the long-run relationships validated by panel cointegration tests, the Auto Regressive Distributed Lag (ARDL) model for panel data is selected as the principal econometric methodology for this study (Pesaran et al., 1999). The panel ARDL framework is adept at handling variables that are integrated of different orders (I (0) and I (1)), and it allows for heterogeneity among countries. This makes it particularly well-suited for analyzing the relationships between digitalization, education, and tourism performance across clusters of European Union member states.

The general form of the panel ARDL (p, q) model is specified as:

$$y_{it} = \mu_i + \sum_{j=1}^{p} \delta_{ij} y_{i,t-j} + \sum_{k=0}^{q} \beta_{ik} X_{i,t-k} + \varepsilon_{it}, \quad (1)$$

where: y_{it} – is the dependent variable for country i at time t; $X_{i,t-k}$ – represents a vector of

explanatory variables (BROAD, INTERNET, GOV, EDU, GDP, EMP, URBAN); μ_i – capture the individual fixed effects; δ_{ij} and β_{1k} – are coefficients to be estimated; ε_{it} – error term.

To distinguish between short-run dynamics and long-run equilibrium relationships, the model is reparametrized into an error correction form:

$$\Delta y_{it} = \lambda_i \left(y_{i,t-1} - \theta_i' X_{i,t-1} \right) + \sum_{j=1}^{p-1} \psi_{ij} \Delta y_{i,t-j} + \sum_{k=0}^{q-1} \gamma_{ik} \Delta X_{i,t-k} + v_{it}, \quad (2)$$

where: λ_i – the error correction term, indicated the speed at which the dependent variable returns to equilibrium after a shock; θ_i' – represents the long-run coefficients; ψ_{ij} and γ_{ik} – denote the short-run dynamic coefficient; Δ – represents first differences.

In alignment with the panel ARDL model's general specification, separate estimations were conducted for each identified cluster based on preliminary clustering analysis. Four distinct models were developed to account for structural differences among the clusters. Cluster 1 comprises Italy, France, and Croatia, with international tourism arrivals (TOURARRIV) serving as the dependent variable. Cluster 2 includes the remaining 22 EU countries, also employing TOURARRIV as the dependent variable. For Cluster 3, which consists of Italy, France, and Germany, international tourism receipts (TOURREC) were utilized as the dependent variable, while Cluster 4 includes the other 22 EU countries analyzed in relation to TOURREC. This cluster-specific estimation facilitates a nuanced understanding of both long-run and short-run relationships, tailored to the unique economic and tourism characteristics of each group.

Table 5. Comparative ARDL estimation results for international tourism – number of arrivals: Cluster 1 vs. Cluster 2

Dependent variable: International tourism, number of arrivals (TOURARRIV)				
Variables	Cluster 1 (Italy, France, Croatia)		Cluster 2 (Other 22 EU Countries)	
	Coefficient	Prob.	Coefficient	Prob.
Long-run coefficients				
EDU	2.727	0.0030	0.455	0.0755
GOV	1.555	0.0103	–0.138	0.6900
INTERNET	1.446	0.0100	–0.245	0.3791
BROAD	0.269	0.0066	0.071	0.3274
GDP	4.273	0.0004	–0.051	0.8177
EMP	4.318	0.0542	3.412	0.0031
URBAN	14.410	0.1812	–4.641	0.0808
COINTEQ	–0.6300	0.1085	–0.388	0.0000
Short-run coefficients				
D(EDU)	–2.378	0.5934	–1.481	0.2091
D(GOV)	2.012	0.4516	–0.832	0.0587
D(INTERNET)	0.893	0.1944	0.407	0.0901
D(BROAD)	0.210	0.2532	–0.142	0.0725
D(GDP)	7.592	0.0183	4.166	0.0000
D(EMP)	–4.296	0.4497	6.683	0.0084
D(URBAN)	–336.194	0.4487	–78.598	0.2066

The long-run and short-run findings, as presented in Table 5, for the dependent variable TOURARRIV indicate significant differences between the two clusters under analysis. In Cluster 1 (Italy, France, and Croatia), long-run estimates show that most independent variables exert a positive and statistically significant influence on tourism arrivals. Education (EDU) has a strong positive effect (coefficient = 2.727, p = 0.0030), suggesting that higher tertiary enrollment substantially enhances tourism flows, in line with H2a. Similar, government expenditure on education (GOV) (coefficient = 1.555, p = 0.0103), internet usage (INTERNET) (coefficient = 1.446, p = 0.0100), broadband access (BROAD) (coefficient = 0.269, p = 0.0066), and GDP per capita (GDP) (coefficient = 4.273, p = 0.0004) all display significant positive effects. These findings provide strong support for hypotheses H1a, H2a, and H3 in Cluster 1. Employment in services (EMP) is significant at 5% level (coefficient = 4.318, p = 0.0542), and urbanization (URBAN) shows a positive but non-significant coefficient. In Cluster 2 (the other 22 EU countries), long-run results are less robust, only employment in services (EMP) maintains a significant and positive impact on tourism arrivals (coefficient = 3.412, p = 0.0031), partially validating H3, while education (coefficient = 0.455, p = 0.0755) is significant only at 10% level, partially validating H2a. Government expenditure (GOV), internet usage (INTERNET), and GDP per capita (GDP) exhibit non-significant effects, and urbanization (URBAN) is negatively associated with tourism arrivals (coefficient = –4.641, p = 0.0808), partially validating H1a and H3. These findings suggest that in the leading tourism economies, factors such as education, digitalization, and economic development have an important role in sustaining tourist inflows, whereas in the broader EU group, tourism arrivals are primarily driven by service sector dynamics and are less sensitive to structural macroeconomic improvements.

Short-run dynamics further differentiate the clusters. In Cluster 1, only GDP per capita is statistically significant (coefficient = 7.592, p = 0.0183), validating H6 in this context. The other short-run variables are non-significant, supporting hypotheses H4 and H5. In contrast, Cluster 2 exhibits a more dynamic short-run response, GDP has a strong positive effect (coefficient = 4.166, p < 0.0001), employment in services significantly boosts arrivals (coefficient = 6.683, p = 0.0084), and improvements in internet usage and broadband access also exert moderate but statistically significant influences. These results further validate H1a, H3, H4, and H6 in Cluster 2. Moreover, the error correction term (COINTEQ) is significant in Cluster 2 (coefficient = –0.388, p = 0.0000), indicating that approximately 38.8% of short-run disequilibria are corrected each year, compared to Cluster 1 where the error correction coefficient is larger in magnitude (–0.6300) but not statistically significant (p = 0.1085). These results imply that the broader group of EU countries exhibit greater short-run sensitivity to economic and digital changes, while leading tourism economies to rely more heavily on their established long-run structural advantages to maintain steady tourist inflows.

The examination of long-run relationships concerning the dependent variable TOURREC highlights significant differences between Cluster 3 (Italy, France, and Germany) and Cluster 4 (other 22 EU countries). According to the results presented in Table 6, in Cluster 3, none of the macroeconomic and structural variables are significant, suggesting that H1b, H2b, and H3 are not supported for mature tourism economies. Although coefficients for education (EDU = 67.2388, p = 0.7836), government expenditure on education (GOV = 76.9644, p = 0.7868), internet usage (INTERNET = 6.4347, p = 0.8092), and GDP per capita (GDP =

Table 6. Comparative ARDL estimation results for tourism receipts: Cluster 3 vs. Cluster 4

Dependent variable: International tourism, receipts (current US$) (TOURREC)				
Variables	Cluster 3 (Italy, France, Germany)		Cluster 4 (Other 22 EU Countries)	
	Coefficient	Prob.	Coefficient	Prob.
Long-run coefficients				
EDU	67.2388	0.7836	0.9177	0.0000
GOV	76.9644	0.7868	–0.5302	0.0124
INTERNET	6.4347	0.8092	1.0224	0.0000
BROAD	–1.1790	0.8846	0.0042	0.9175
GDP	33.7899	0.7892	0.0286	0.8294
EMP	–248.2360	0.7781	0.3377	0.6184
URBAN	75.5676	0.7695	–23.986	0.0000
COINTEQ	0.0259	0.2048	–0.3720	0.0000
Short-run coefficients				
D(EDU)	2.2479	0.4598	–1.0769	0.0811
D(GOV)	0.7824	0.2910	–0.6295	0.1633
D(INTERNET)	0.0474	0.8628	0.0541	0.8216
D(BROAD)	0.5216	0.3644	–0.1346	0.0576
D(GDP)	6.2099	0.0000	3.4414	0.0000
D(EMP)	7.1862	0.2238	5.1495	0.0016
D(URBAN)	–728.5931	0.3265	61.4622	0.0000

33.7899, p = 0.7892) are positive, their very high p-values indicate that changes in these factors do not meaningfully explain variations in tourism receipts among the leading tourism economies. This suggests a saturation or inertia effect, where mature tourism markets such as Italy, France, and Germany rely more on entrenched destination appeal and historical reputation rather than ongoing improvements in education or digital infrastructure. In Cluster 4, several variables display significant and robust effects. Thus, education (EDU) positively impacts tourism receipts (coefficient = 0.9177, p < 0.0001), internet usage (INTERNET) is also positively significant (coefficient = 1.0224, p < 0.0001), while government expenditure on education (GOV) exerts a negative influence (coefficient = –0.5302, p = 0.0124). Urbanization (URBAN) shows a strong negative long-run impact on receipts (coefficient = –23.986, p = 0.0000), suggesting that excessive urbanization may diminish the attractiveness of destinations. Furthermore, the error correction term (COINTEQ) is negative and significant in Cluster 4 (coefficient = –0.3720, p = 0.0000), confirming a stable and systematic adjustment toward long-run equilibrium, whereas in Cluster 3, the COINTEQ coefficient is small and non-significant (coefficient = 0.0259, p = 0.2048), reflecting a lack of convergence.

Short-run dynamics further underscore the differences between the two clusters. In Cluster 3, only short-run changes in GDP significantly and positively influence tourism receipts (coefficient = 6.2099, p < 0.0000), indicating that immediate economic growth positively affects revenues even in mature tourism markets. Other short-run variables, such as changes in education (D(EDU)), internet usage (D(INTERNET)), broadband subscriptions (D(BROAD)),

and employment in services (D(EMP)), remain non-significant, though their coefficients generally suggest modest positive or neutral effects. Thus, in Cluster 3, only short-run changes in GDP (D(GDP)) are significant, validating H6, while the other variables remain non-significant, supporting H4 and H5. Cluster 4 displays a more complex short-run dynamic profile, GDP continues to have a highly significant positive impact (coefficient = 3.4414, $p < 0.0000$), and employment in services (D(EMP)) also significantly boosts tourism receipts (coefficient = 5.1495, $p = 0.0016$), validating H6. Broadband subscriptions (D(BROAD)) have a negative and significant short-run effect (coefficient = –0.1346, $p = 0.0576$), suggesting that while digital infrastructure expansion is critical, it may initially displace traditional tourism revenue streams or require adaptation time for effective integration. Urbanization (D(URBAN)) plays a particularly important role in Cluster 4, with a positive and highly significant short-run effect (coefficient = 61.4622, $p = 0.0000$), indicating that well-managed urban environments can stimulate immediate tourism revenue gains. Thus, hypothesis H7 is rejected in this case, as urbanization exhibits a statistically significant short-run impact on tourism receipts.

Table 7. Validation of research hypotheses in Cluster-based ARDL analysis

Hypothesis	Cluster 1	Cluster 2	Cluster 3	Cluster 4
H1a	Confirmed (BROAD and INTERNET)	Not confirmed	–	–
H1b	–	–	Not confirmed	Partially confirmed (only for INTERNET)
H2a	Confirmed (EDU and GOV)	Partially confirmed (only for EDU)	–	–
H2b	–	–	Not confirmed	Confirmed (EDU and GOV)
H3	Partially confirmed (GDP and EMP)	Partially confirmed (EMP and URBAN)	Not confirmed	Partially confirmed (only for URBAN)
H4	Confirmed	Confirmed	Confirmed	Confirmed
H5	Confirmed	Confirmed	Confirmed	Confirmed
H6	Partially confirmed (only for GDP)	Confirmed (GDP and EMP)	Partially confirmed (only for GDP)	Confirmed (GDP and EMP)
H7	Confirmed	Confirmed	Confirmed	Not confirmed

Overall, these findings (Table 7) suggest that while mature economies are less sensitive to structural variables and rely primarily on economic cycles, emerging tourism economies benefit more immediately and significantly from improvements in education, digital infrastructure, and service sector employment.

6. Discussion

The analysis of the dependent variable TOURARRIV indicates marked disparities between the two identified clusters. In Cluster 1, comprising Italy, France, and Croatia, most independent variables exert a positive and statistically significant impact on tourism arrivals. Notably, the education (EDU) exhibits a strong and significant effect (coef. = 2.727, $p = 0.003$), supporting

the findings of Cerdeira Bento et al. (2021) and Harazneh et al. (2018), who argue that an educated population enhances service quality and thus improves tourist satisfaction. In addition, government expenditure on education (GOV) and internet usage (INTERNET) show significant positive correlations with tourist arrivals. These results align with the broader literature that highlights the role of educational investment in promoting economic growth and sustainable tourism development (Amaro et al., 2024). By contrast, Cluster 2, which includes the remaining 22 EU member states, presents weaker relationships. While education continues to exhibit a positive association with tourism arrivals, its impact is less robust than in Cluster 1. The findings align with Martínez-Roget and Rodríguez (2021) and McGladdery and Lubbe (2017), who highlight the importance of education in fostering positive interactions between locals and tourists. However, in this cluster, government expenditure on education and internet usage yield non-significant or negative coefficients, signaling potential challenges in attracting tourists. Short-run estimates for International Tourism Arrivals (TOURARRIV) indicate differing dynamics between the two clusters. In Cluster 1 (Italy, France, and Croatia), most short-run coefficients are non-significant, implying limited immediate effects from changes in education, internet usage, or employment in the service sector. Economic indicators, such as GDP per capita (D(GDP)), show positive and statistically significant effects, echoing Ganie and Dar (2018) and Mungai et al. (2021), who note that well-educated employees enhance visitor experiences. In contrast, Cluster 2 shows stronger and more coherent short-run effects. The robustness of GDP per capita (D(GDP)) in attracting international tourists supports the conclusions of several studies that highlight the importance of economic growth in driving tourism demand (Deyà-Tortella et al., 2021).

The examination of TOURREC reveals significant differences, especially when comparing Cluster 3 (comprising Italy, France, and Germany) with Cluster 4 (which includes the remaining 22 EU countries). Within Cluster 3, none of the independent variables attain statistical significance, indicating a possible saturation effect in these well-established tourism markets. This finding is consistent with the insights provided by Chen et al. (2022), who discuss the complex interplay of education, digitalization, and economic factors in mature tourism industries. Alternatively, Cluster 4 exhibits statistically significant relationships between key predictors and tourism receipts. Education (EDU) has a positive effect, reinforcing the argument that investments in higher education contribute to increased tourism revenues. This is consistent with the findings of Tomasi et al. (2020), who emphasize how education equips industry professionals to create exceptional visitor experiences. For Cluster 3, GDP per capita (D(GDP)) remains the only variable exerting a strong and statistically significant influence, underscoring the critical role of short-run economic growth in enhancing tourism income. These findings validate earlier discussions on the importance of economic factors in tourism's performance. Cluster 4 demonstrates more dynamic short-run relationships, with GDP per capita and employment in services (D(EMP)) showing significant positive impacts. This observation reflects the work of Ertuna et al. (2023), which highlights how higher education institutions can foster multi-sectoral collaboration for sustainable tourism development.

The negative or non-significant impact of urbanization on tourism performance may be assigned to the consequences of over-urbanization, which can reduce the attractiveness of destinations and strain local infrastructure. In some cases, rapid urban growth can lead to

overcrowding, loss of local charm, and environmental degradation, all of which may reduce the appeal of a destination. Therefore, unregulated urbanization can negatively affect the overall tourist experience. In mature economies, urbanization is often already well developed, and its additional impact on tourism becomes limited. In such contexts, the qualitative aspects of urban life, such as cultural heritage, the quality of public spaces, or the diversity of events, may weigh more heavily than population growth alone. Moreover, the direction of urban development also plays a role. If it focuses primarily on residential or industrial infrastructure without a clear tourism dimension, the positive effects on tourism may be absent, regardless of urban expansion. On the other hand, in the short term, urbanization can generate immediate positive effects, especially when local authorities invest in events, public infrastructure, or city center renewal. This contrast between long-term and short-term impacts illustrates the complexity of the relationship between urbanization and tourism and highlights the need for context-specific policies.

7. Conclusions and implications

The analysis of international tourism arrivals (TOURARRIV) and international tourism receipts (TOURREC) reveals significant differences between the clusters examined, offering insights into the complex interplay among education, economic variables, and tourism dynamics in European Union member states. In Cluster 1 – comprising of Italy, France, and Croatia – education exhibits a notably positive effect on tourism arrivals, underscoring the pivotal importance of a well-educated workforce in enhancing service quality and elevating the overall tourist experience. Additionally, government spending on education and digital infrastructure positively correlates with tourism metrics, reinforcing the argument that investments in these areas are essential for fostering sustainable economic growth in the tourism sector. In this context, national and local governments should develop integrated tourism-education strategies by strengthening vocational programs in hospitality and digital literacy. Co-financing training centers with tourism associations, and subsidizing digital upgrades for tourism businesses in high-demand destinations, would give added value. In contrast, Cluster 2 displays a weak correlation between educational levels and tourism demand. This suggests that while education remains relevant, other factors may exert a more immediate influence on tourism dynamics in these less mature markets. Policymakers in these countries should focus on improving basic infrastructure, enhancing service delivery, and strengthening links between local educational institutions and tourism businesses.

Regarding tourism receipts, the results indicate that more established destinations, particularly in Cluster 3, may experience a saturation effect, where deeper structural strengths outweigh the impact of educational advancements and digitalization. This observation suggests that mature tourism markets like Italy, France, and Germany rely more on their longstanding appeal rather than on improvements in education or technology to drive revenues. In these markets, authorities should shift focus toward value-added strategies, such as developing experiential tourism, improving visitor management systems, and adopting sustainability certifications to maximize returns without increasing tourist volume. In contrast, Cluster 4 demonstrates significant relationships between key predictors, such as education

and internet usage, and tourism receipts. This emphasizes the necessity for continued investment in education as it has the potential to significantly enhance tourism revenues. Countries in this cluster should expand access to tertiary education with tourism relevance and accelerating digital infrastructure rollout in smaller towns and heritage sites. Co-designed programs with local tech startups could also enable innovative visitor experiences and real-time data monitoring for tourism authorities. Overall, these findings point to the importance of tailored policies that support educational initiatives and technological advancements across the EU, thereby improving tourism performance and ensuring sustainable growth in the sector. Integrated strategies that foster educational development and promote technological enhancements will be essential for advancing the tourism economy in regions that lag in these areas.

The findings give rise to several policy implications for enhancing tourism performance across EU member states. For Cluster 1, where education and digital infrastructure have demonstrated substantial positive effects on tourism arrivals, policymakers should prioritize investments in higher education and digital access. Programs aimed at boosting tertiary enrollment, especially within tourism-related fields, could further attract international tourists and improve competitive positioning. Governments should collaborate with universities to establish dedicated tourism innovation hubs and incubators for digital tourism services in cities with high visitor density. This aligns with the recommendations from Liburd (2018) and Weiermair and Peters (2012), who highlight the importance of educational collaboration among industry actors.

For Cluster 2, tailored strategies should focus on stimulating service sector growth, as evidenced by its positive contributions. Targeted interventions to improve quality of service and education may help create a more favorable environment for tourism development, emphasizing the necessity for collaboration between educational institutions and tourism stakeholders as outlined by Tomasi et al. (2020).

The evident variation in tourism receipts across clusters indicates that governments in Cluster 4 should reevaluate their resource allocations in education and tourism promotion to ensure that expenditures yield measurable impacts, as noted by the WTO (2023). Thus, authorities should adopt performance-based budgeting in tourism and education programs, linking funding to measurable indicators such as increases in tourism receipts, digital service availability, and graduate employability in the tourism sector.

This study acknowledges several limitations that may influence the scope and interpretation of the results. First, Spain and Malta were excluded from the analysis due to the unavailability of consistent time series data for the selected indicators, despite their significant roles in the European tourism landscape. Their omission may affect the representativeness of the findings, particularly in clusters where high-volume tourism economies are central. Second, the analysis focuses exclusively on quantitative macroeconomic indicators, which limits the inclusion of qualitative factors such as visitor satisfaction, policy frameworks, or institutional quality, elements that could meaningfully shape tourism dynamics. Third, the operationalization of digitalization and education is constrained by data availability, which restricted the study to a narrow set of measurable indicators.

Future research could provide a clearer perspective on how digitalization influences professional development and adaptability in industry or how sustainable and innovative

practices can be integrated into educational programs, using digital technologies to enhance learning experience and prepare students for the challenges of the future. Also, future research could examine the impact of emerging technologies, such as artificial intelligence, augmented reality, or blockchain on tourism education and service innovation.

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Authors contribution

The paper is a result of a collaborative work. SD, DB, RS, CS and AB conceived the study, DB, CS and AB reviewed the literature, SD and RS did the data analysis. SD, DB, RS, CS and AB wrote the first draft. All authors revised the paper and prepared the final article.

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Authors declare they have no competing financial, professional, or personal interests from other parties.

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APPENDIX

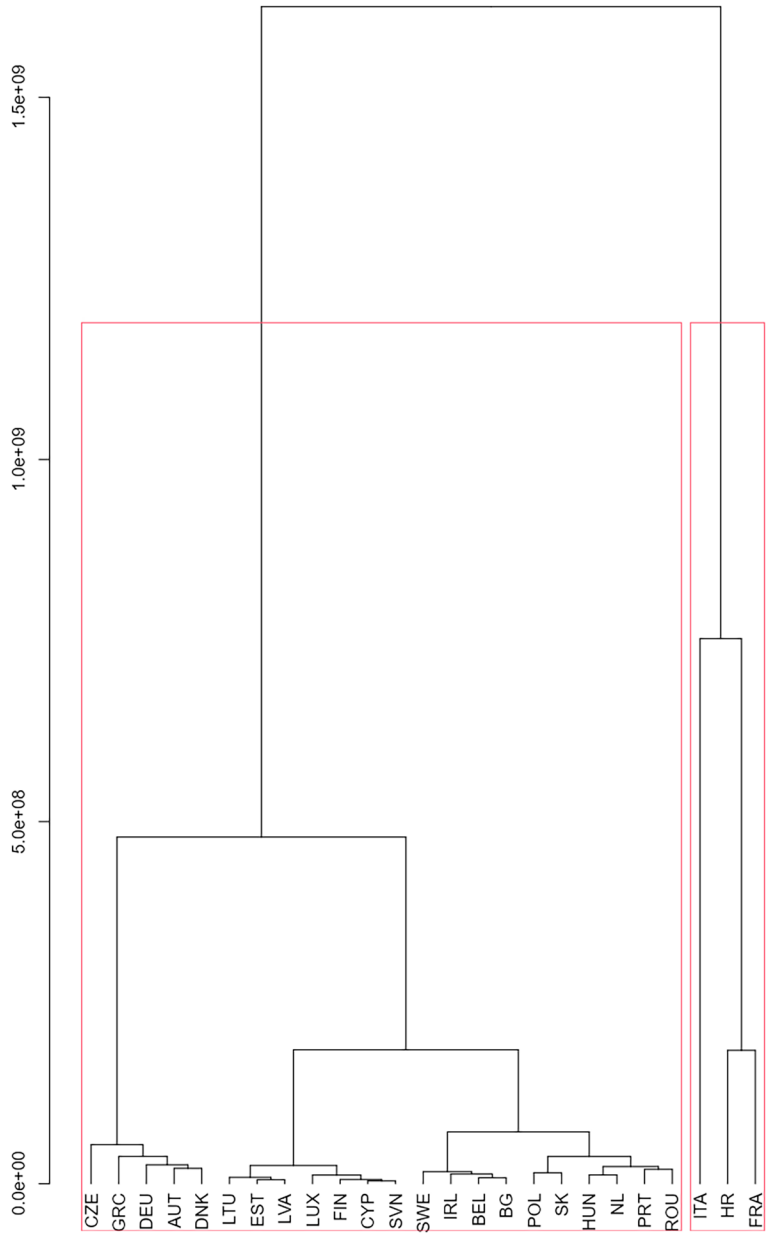

Figure A1. Dendrogram – TOURARRIV

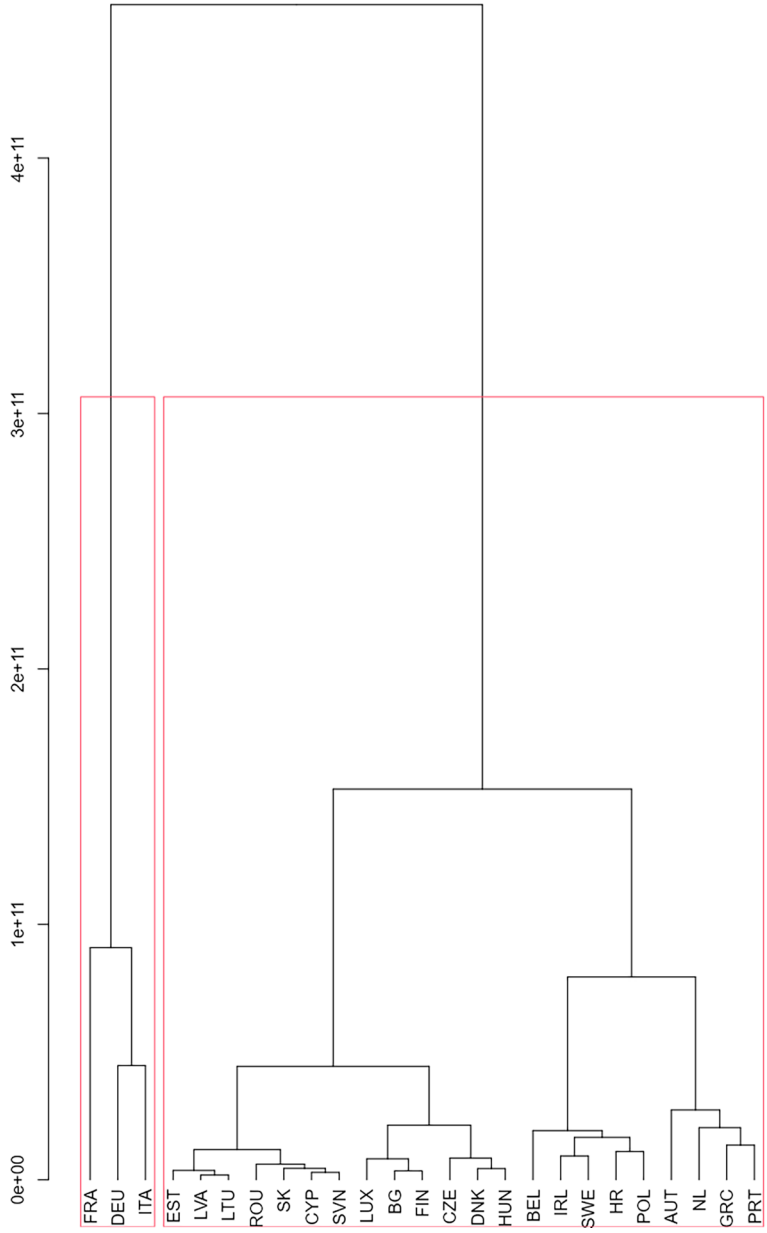

Figure A2. Dendrogram – TOURREC