

Literature Reviews

Sectoral patterns of tourism and technology across European NUTS-3 regions: dual specialization or divergent paths?

Especialização dual ou trajetórias divergentes? Padrões setoriais do turismo e da tecnologia nas regiões europeias NUTS-3

¿Especialización dual o trayectorias divergentes? Patrones sectoriales del turismo y la tecnología en las regiones europeas NUTS-3

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Keywords:

Regional specialisation;
Sectoral structure;
Tourism;
Technology;
European regions.

Abstract

This paper examines the coexistence of tourism and technology across European NUTS-3 regions using Eurostat employment data for 2003–2023. A relative specialisation index is constructed to classify regions according to their sectoral profiles, and a Bai–Perron test applied to regional income identifies a structural break around 2010, allowing comparison between pre- and post-break periods. The results show strong persistence in regional specialisation patterns, alongside moderate shifts away from dual-specialised configurations towards more asymmetric structures. Low-specialisation profiles dominate, particularly among lower-income regions, while higher-income regions are more frequently associated with technology-intensive and dual-specialisation patterns. Structural changes are sector-specific and income-dependent, with technology-related specialisation exhibiting greater variability in both income groups, particularly among higher-income regions. Overall, tourism and technology frequently coexist within differentiated regional configurations associated with different initial conditions and sectoral profiles. By providing evidence at a highly disaggregated territorial level, this paper contributes to the literature by moving beyond dichotomous interpretations of sectoral development and documenting the coexistence of multiple, heterogeneous regional trajectories in the interaction between tourism and technology.

Palavras-chave:

Especialização regional;
Estrutura setorial;
Turismo;
Tecnologia;
Regiões europeias.

Resumo

Este artigo examina a coexistência entre turismo e tecnologia nas regiões europeias NUTS-3, utilizando dados de emprego do Eurostat para o período 2003–2023. Um índice de especialização relativa é construído para classificar as regiões de acordo com seus perfis setoriais, e um teste de Bai–Perron identifica uma quebra estrutural em torno de 2010, permitindo a comparação entre os períodos pré e pós-choque. Os resultados mostram uma forte persistência nos padrões de especialização regional, juntamente com mudanças moderadas de configurações de dupla especialização para estruturas mais assimétricas. Perfis de baixa especialização predominam, especialmente nas regiões de menor renda, enquanto regiões de maior renda estão mais frequentemente associadas a perfis intensivos em tecnologia e de dupla especialização. As mudanças estruturais são específicas de cada setor e dependem do nível de renda, com a especialização relacionada à tecnologia apresentando maior variabilidade em ambos os grupos de renda, particularmente entre as regiões de maior renda. De forma geral, o turismo e a tecnologia coexistem frequentemente em configurações regionais diferenciadas associadas a diferentes condições iniciais e perfis setoriais. Ao fornecer evidência a um nível territorial bastante desagregado, este trabalho contribui para a literatura ao ir além das interpretações dicotômicas do desenvolvimento setorial e ao evidenciar a coexistência de múltiplas trajetórias regionais heterogêneas na interação entre turismo e tecnologia.

Palabras clave:

Especialización regional;
Estructura sectorial;
Turismo;

Resumen

Este artículo examina la coexistencia del turismo y la tecnología en las regiones europeas NUTS-3 utilizando datos de empleo de Eurostat para el periodo 2003–2023. Se construye un índice de especialización relativa para clasificar las regiones según sus perfiles sectoriales, y un test de Bai–

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Perron identifica un quiebre estructural en torno a 2010, permitiendo comparar los periodos pre y post shock. Los resultados muestran una fuerte persistencia en los patrones de especialización regional, junto con desplazamientos moderados desde configuraciones de doble especialización hacia estructuras más asimétricas. Los perfiles de baja especialización predominan, especialmente en las regiones de menor renta, mientras que las regiones de mayor renta se asocian con mayor frecuencia a perfiles intensivos en tecnología y de doble especialización. Los cambios estructurales son específicos de cada sector y dependen del nivel de renta, y la especialización relacionada con la tecnología presenta una mayor variabilidad en ambos grupos de renta, particularmente entre las regiones de mayor renta. En términos generales, el turismo y la tecnología coexisten frecuentemente dentro de configuraciones regionales diferenciadas asociadas a distintas condiciones iniciales y perfiles sectoriales. Aportando evidencia a un nivel territorial muy desagregado, este trabajo contribuye a la literatura al ir más allá de las interpretaciones dicotómicas del desarrollo sectorial y mostrar la coexistencia de múltiples trayectorias regionales heterogéneas en la interacción entre turismo y tecnología.



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1 INTRODUCTION

The Consolidated Version of the Treaty on European Union (European Union, 2010) establishes that “the Union (...) shall work for the sustainable development of Europe based on balanced economic growth (...) It shall promote economic, social and territorial cohesion, and solidarity among Member States” (Article 3[3]). This principle underpins the European Union’s (EU) long-standing commitment to economic, social, and territorial cohesion. Within this framework, understanding the drivers of regional development remains a central concern, particularly given the persistence of territorial disparities across European regions.

Economic growth theory, as reflected in the contributions of Solow (1956), Romer (1990) and Aghion and Howitt (1992), emphasises the central role of innovation and knowledge accumulation as key drivers of sustained economic growth. Building on this, the economic geography literature has debated whether specialisation or diversification better fosters regional development (Marshall, 1890; Jacobs, 1969; Glaeser et al., 1992), while the New Economic Geography (Krugman, 1991) has placed the spatial concentration of productive activity—driven by agglomeration forces—at the centre of analysis.

These theoretical frameworks gain particular relevance in the context of European economic integration, where the spatial distribution of economic activity has evolved in a non-uniform manner, combining “some degree of concentration, agglomeration and specialisation both across and within countries” (Cutrini et al., 2022, p. 1). This balance between centripetal and centrifugal forces occurs because while integration may promote agglomeration, specialisation, and the geographical concentration of economic activity (Krugman, 1993; Venables, 1995), it may also favour dispersion under certain conditions, particularly as trade costs decline and factor mobility increases (Krugman & Livas Elizondo, 1996; Puga, 1999; Alonso-Villar, 2001; Behrens et al., 2007).

In this context, the spatial distribution of economic activity cannot be understood independently of its sectoral composition, placing the specialisation vs. diversification debate at the centre of regional development analysis. While specialisation may enhance efficiency and exploit comparative advantages, diversification is often associated with greater resilience, adaptability, and long-term stability. A key unresolved issue, however, is whether sectors with distinct structural characteristics tend to co-locate within diversified regional economies or instead reflect alternative—and potentially competing—development trajectories.

Against this backdrop, tourism and technology emerge as two paradigmatic cases of sectoral specialisation with contrasting structural profiles: tourism is often characterised by its labour-intensive and limited endogenous innovation capacity (Romão & Nijkamp, 2019) and may become problematic for regions when overspecialisation occurs (Inchausti-Sintes, 2015); by contrast, technology-intensive sectors are driven by knowledge accumulation, innovation, and human capital—the very engines highlighted by endogenous growth theory. Additionally, existing evidence suggests that in Europe tourism-related activities are more prevalent in less developed regions, whereas technology-related employment tends to be more spatially concentrated in higher-income regions (Torres-Penalva et al., 2025). Together, these theoretical and empirical considerations motivate the central question of this article: to what extent do tourism and technology co-specialise within European regional economies, how do these configurations vary across income groups, and how did they evolve in the aftermath of the 2008 financial crisis?

To address this question, and using employment-based indicators of sectoral specialisation, the study adopts an exploratory and comparative approach to identify the simultaneous presence of tourism and technology specialisation across regions. In addition, the presence of a structural break associated with the global financial crisis is

explicitly considered through the application of the Bai–Perron test (Bai & Perron, 1998, 2003), allowing for a distinction between pre- and post-break dynamics.

This paper contributes to the literature in three main ways. First, it provides a sectoral perspective on the interaction between tourism and technology, offering new insights into their joint configuration within regional economies. Second, it delivers novel empirical evidence for the sub-national territorial unit of analysis employed in this study, as detailed in the methodology section. This allows the analysis to capture the diversity of territorial structures—something that is not possible when analytical units are too large to reflect underlying economic complexity (Demblans et al., 2020; Gagliardi & Percoco, 2017). Third, it introduces a dynamic dimension by examining how these sectoral configurations evolve over time in the presence of structural change.

The remainder of the article is structured as follows. Section 2 outlines the data and empirical strategy. Section 3 presents the main results. Section 4 concludes and discusses the main implications for regional development and future research.

2 METHODOLOGY

2.1. Geographical scope of the analysis and variables used

This study uses data for the smallest territorial units in the EU's standard regional classification system, known as NUTS-3 regions (Eurostat, 2021). This system—the Nomenclature of Territorial Units for Statistics (NUTS)—organises territories into hierarchical levels: major socio-economic regions (NUTS-1), basic regions for the implementation of regional policies (NUTS-2), and smaller territorial units for specific analyses (NUTS-3).

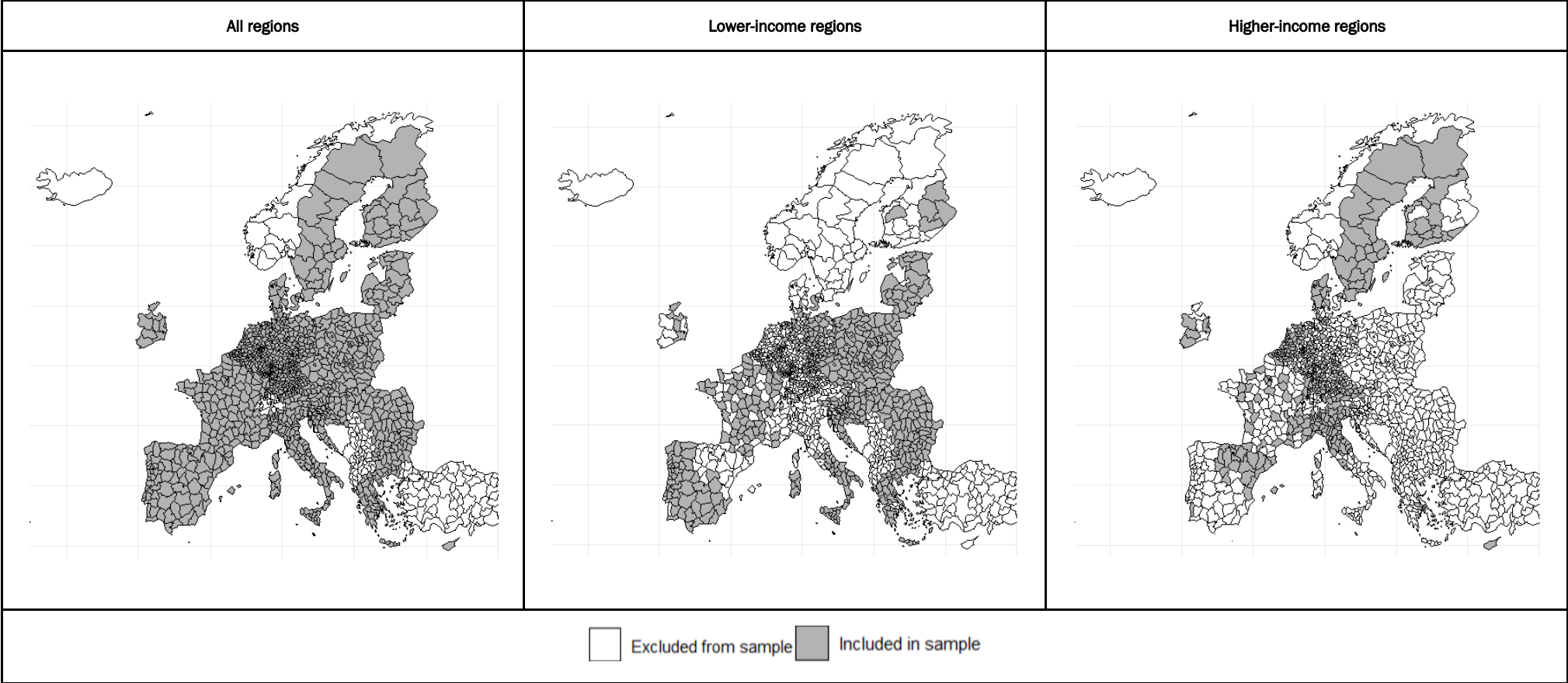
In total, this study covers 1,163 European NUTS-3 regions, representing approximately 95% of all such regions across 27 EU Member States (Figure 1). This constitutes a relevant methodological contribution, as, to the best of our knowledge, relatively few studies have examined economic growth and sectoral specialisation across European regions at the NUTS-3 level, with NUTS-2 remaining the most common unit of analysis—the same level at which European development and cohesion policies are implemented.

The analysis covers the period 2003–2023, the longest consistently available period for the variables and territorial coverage considered. It focuses on two sectors—tourism and technology—and on the degree of regional specialisation in these activities, measured as the share of employment in a given region allocated to each sector relative to total employment. These employment shares serve as the basis for constructing the relative specialisation indicators used in the empirical analysis. By defining both indicators in this way and using a consistent data source from Eurostat (Eurostat, 2024a), we ensure direct comparability across regions and over time.

Before defining the sectoral variables, GDP per capita in purchasing power standards (PPS) is used as the main indicator of regional economic performance, normalised by the European mean, so that a value of 1 corresponds to the EU average in order to facilitate cross-regional comparability (see Table 1). This variable, retrieved from Eurostat (2024b), is employed both to detect structural instability over time, as discussed in the following section, and to classify regions according to their relative income level. In this context, we conduct three types of analysis: one for the full sample, and two additional analyses distinguishing between regions above and below the European average, as discussed in Section 3.3.

As Eurostat (2024a) does not provide a direct measure of tourism-related employment, we approximate the sector using sections G, H, and I of the Statistical Classification of Economic Activities in the European Community (NACE Rev. 2)—“*Wholesale and retail trade; transport; accommodation and food service activities*” (WH)—following previous studies such as Bimonte et al. (2026), and Moreno-Izquierdo et al. (2026). This approximation introduces a well-known measurement bias in the definition of tourism activities (Brida et al., 2008), reflecting persistent statistical challenges in capturing tourism specialisation. For the technology-related employment variable, we use NACE Rev. 2 section J—“*Information and communication activities*” (IT)—while acknowledging similar limitations in its ability to fully capture the concept of technological specialisation. Throughout the paper, the terms ‘tourism’ and ‘technology’ are used as shorthand labels for these broader proxies; readers should bear in mind that both indicators encompass a wider set of activities than those strictly associated with each concept.

Figure 1 - NUTS-3 regions included in the dataset



Note: For visual clarity, the map displays only continental Europe. The dataset also includes the islands from the EU members located outside the displayed extent. Regions not included correspond either to areas not covered by the Eurostat NUTS classification or to regions excluded from the sample because of data availability constraints, such as boundary changes or missing values.

Table 1 - Core variables used in the analysis

Variable	Measure	Mean	S.D.
<i>GDPpc</i>	Average GDP per capita in PPS, normalised by the European mean (EU = 1)	1	0.473
<i>WH</i>	Average share of workers employed in tourism-related activities over total employment in the region (all regions)	0.235	0.052
	Lower-income regions	0.231	0.051
	Higher-income regions	0.239	0.052
<i>IT</i>	Average share of workers employed in information and communication activities over total employment in the region (all regions)	0.017	0.014
	Lower-income regions	0.012	0.007
	Higher-income regions	0.025	0.018

As the specialisation variables are not directly available for the full sample of European NUTS-3 regions—particularly for regions in Spain, Germany and Austria, which account for approximately 43% of the unique NUTS-3 codes in the sample—missing values were reconstructed by decomposing the aggregate WHO2 category, available in the original Eurostat database, into its two NACE-based components used throughout the paper: WHO (tourism-related activities) and IT (technology-related activities). The decomposition is performed using the sectoral structure observed in regions with complete information. Missing values are estimated through generalised linear models with a logit link, ensuring that reconstructed sectoral shares remain internally consistent, bounded between 0 and 1, and fully coherent with the accounting identity $WHO2 = WHO + IT$. The share of reconstructed observations remains limited relative to the full sample.

2.2. Detecting structural breaks in the series

Before comparing the evolution of tourism and technology specialisation across European regions, we assess potential temporal instability by applying the multiple breakpoint procedure developed by Bai and Perron (1998, 2003) to the series of regional GDP per capita (PPS), as it provides the most robust and comparable indicator consistently available at the NUTS-3 level over the full sample period.

This methodology has been widely applied across different fields, including energy, sports, legal studies, and various economic and financial applications, as well as in tourism-related research (Cró & Martins, 2017; Mérida et al., 2016; among others). Its use is particularly suitable in this context, as tourism is highly sensitive to external shocks—such as economic crises, geopolitical events, and health-related disruptions—while the intensity of its response is further conditioned by the degree of tourism specialisation and regional dependence. Structural-break methods have also been applied in tourism economics (Cró & Martins, 2017; Mérida et al., 2016; Moreno-Izquierdo et al., 2026). These methods can capture broad macroeconomic disruptions affecting the economy as a whole—such as the global financial crisis and the COVID-19 shock—which may alter the composition and relative weight of regional sectoral employment (Bartelsman et al., 2019).

In general terms, the model can be expressed as:

$$y_t = \alpha_j + \beta_j t + \varepsilon_t, \quad t = T_{j-1} + 1, \dots, T_j$$

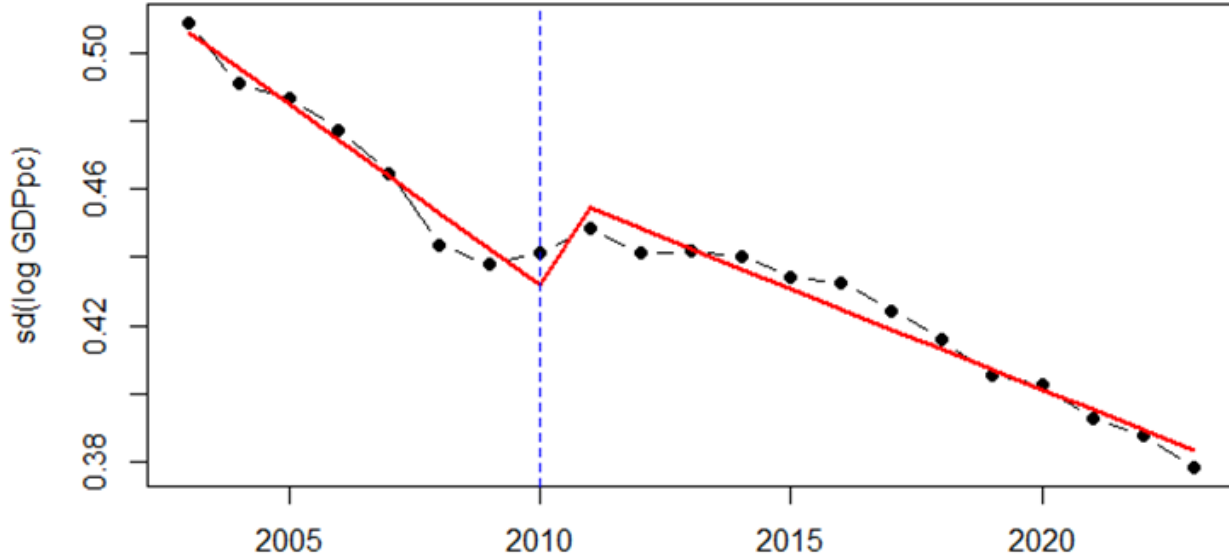
for $j = 1, \dots, m + 1$, where T_j denotes the unknown break dates, m is the number of structural breaks, and the coefficients are allowed to vary across segments. This framework makes it possible to detect changes in the underlying trajectory of the series over time.

Break dates are selected by minimising the residual sum of squares subject to a minimum segment length, ensuring that each regime contains enough observations. Their relevance is evaluated using sequential testing procedures and complementary information criteria, particularly the Bayesian Information Criterion (BIC). The estimation is implemented in R using the *strucchange* package (Zeileis et al., 2002).

Prior to applying the Bai–Perron procedure, an Augmented Dickey–Fuller (ADF) test was conducted to assess the stationarity properties of the series. The ADF tests fail to reject the null hypothesis of a unit root for both the dispersion series (ADF = -1.751 , $p = 0.667$) and the mean series (ADF = -1.545 , $p = 0.746$).

The Bai–Perron procedure was applied to an aggregate time series of regional GDP per capita (PPS)—specifically, the cross-sectional standard deviation of log GDP per capita across all NUTS-3 regions in each year—rather than to individual regional series or panel data. Its results indicate the presence of multiple structural breaks (2006, 2010, 2016, and 2019), while we retain 2010 as the single breakpoint for two reasons: first, implementing all identified breaks would generate subperiods of insufficient length to obtain stable estimates of sectoral specialisation patterns; second, and more importantly, 2010 corresponds to the most pronounced structural change (Figure 2), while the remaining breaks are associated with comparatively smaller deviations in regional income dispersion. We therefore distinguish between the pre-break period (2003–2010) and the post-break period (2011–2023).

Figure 2 - Structural break in regional income dispersion: Bai–Perron test results



2.3. Analysis for the pre-break and post-break periods

The empirical strategy adopted in this article is exploratory and descriptive, focusing on identifying, describing, and comparing regional patterns of tourism and technology specialisation across Europe before and after the identification of a structural break.

To capture heterogeneity in development levels, regions are classified according to their average pre-break GDP per capita (PPS). Based on this measure, regions are classified as either above the European mean standard of living (*higher-income*, HI) or below it (*lower-income*, LI). These labels are purely relative and descriptive, referring to a region's position with respect to the European mean rather than to any absolute characterisation of income level. The sample includes 1,163 NUTS-3 regions, of which 660 are classified as lower-income and 503 as higher-income regions.

To assess whether regions are relatively specialised in tourism and technology, the analysis constructs a Relative Specialisation Index (RSI). The RSI is constructed from the employment shares described in Section 2.1 by comparing each region's sectoral share to the corresponding European benchmark. It is defined as the ratio between the sectoral employment share of each NUTS-3 region and the corresponding benchmark for the full European sample. Formally, for each region i and sector s , the RSI is defined as:

$$RSI_{s,i} = \frac{S_{s,i}}{\bar{S}_s}$$

where $S_{s,i}$ denotes the share of employment in sector s in region i , and $\bar{S}_s$ represents the average sectoral share across all European NUTS-3 regions. Separate RSI values are computed for the pre-break and post-break periods, using the corresponding European sectoral employment share in each period as the benchmark.

Values greater than one indicate that the region is more specialised in that sector than the European average, while values below one denote under-specialisation. Applied to the two sectors examined in this study, this formulation yields two indicators of regional specialisation: RSIWH, capturing specialisation in tourism-related activities, and RSIIT, capturing specialisation in technology-related activities. This index is equivalent to the Location Quotient (LQ)

commonly used in the regional economics literature; the term RSI is adopted consistently throughout this paper. The RSI therefore allows for the identification of genuine specialisation patterns in the European context, beyond simple internal sectoral composition, complementing approaches based on the internal structure of regional economies.

Using the computed values, we construct a quadrant-based classification that assigns each region to a quadrant separately for the pre- and post-break periods (with 2010 as the break year). Within this framework, *Quadrant I* includes regions with high tourism-related and high technology-related relative specialisation; *Quadrant II* includes regions with high tourism but low technology; *Quadrant III* groups regions with low tourism and low technology; and *Quadrant IV* captures regions with low tourism and high technology.

These quadrant classifications enable a comparison of structural change over time. The analysis is further complemented by transition matrices that track changes in quadrant membership across periods, as well as by examining variations in the RSI between the pre-break and post-break periods, capturing both the direction and the intensity of changes in sectoral specialisation.

3 RESULTS

3.1. Sectoral specialisation patterns and stability of RSI across all regions

The joint distribution of tourism and technology specialisation is presented in the quadrant-based figures (Figure 3, complemented by the tables in Annex A1), distinguishing between three groups of regions (full sample, lower-income, and higher-income) and the two periods under analysis. For consistency with Figure 4, we refer to the four quadrant configurations using the acronyms HH (high tourism–high technology), HL (high tourism–low technology), LL (low tourism–low technology), and LH (low tourism–high technology), where the first letter refers to tourism and the second to technology.

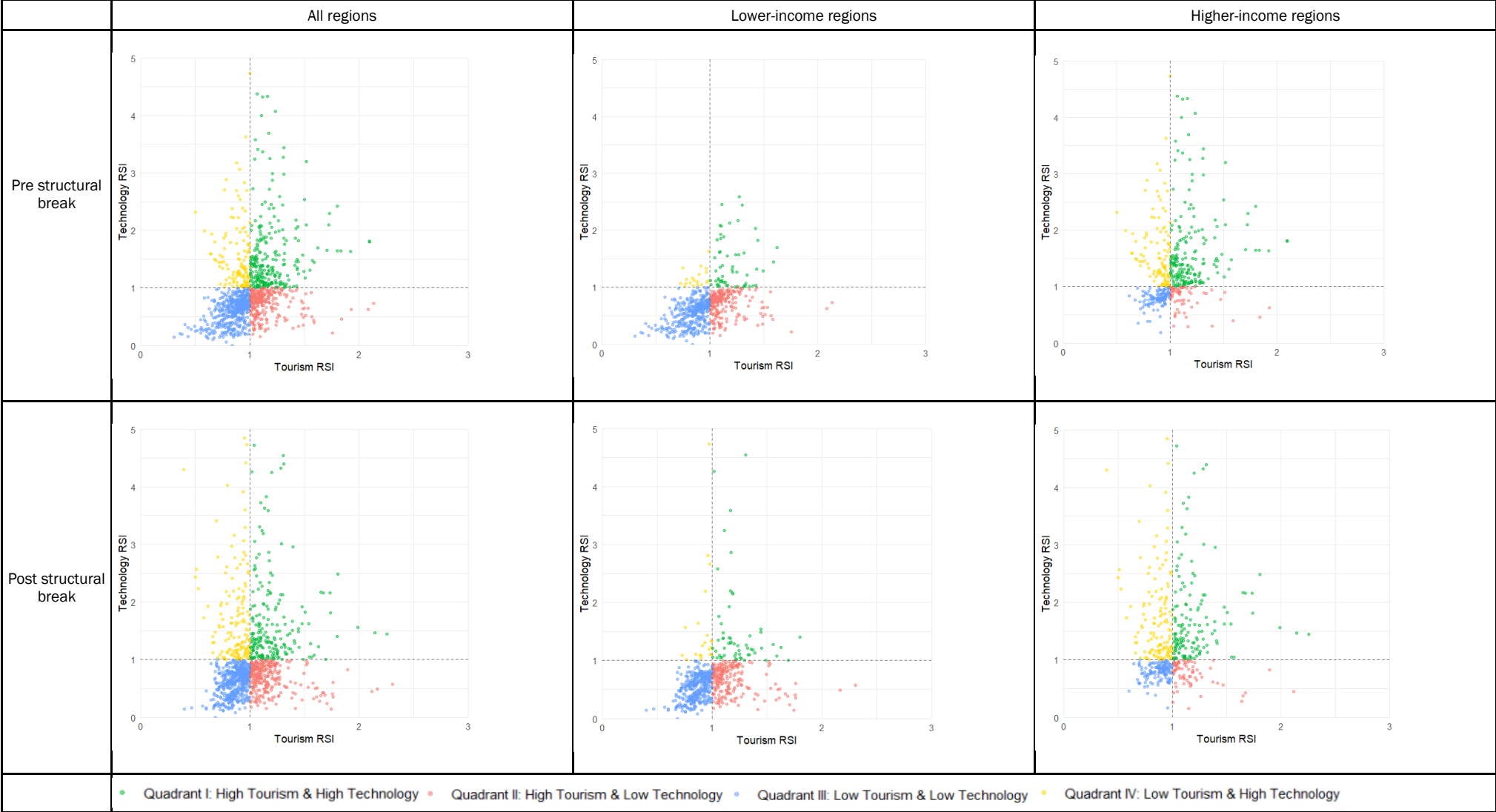
For the full sample, the comparison between the pre-break and post-break periods reveals several shifts in the distribution of regions. In particular, the number of regions exhibiting relatively high levels of specialisation in both sectors (Quadrant I, HH) declines markedly, from 254 to 205. At the same time, regions characterised by low levels of specialisation in both activities (Quadrant III, LL) increase from 484 to 506. A more moderate expansion is observed in Quadrant IV (LH), which rises from 135 to 158 regions, while Quadrant II (HL) remains broadly stable, increasing only slightly from 290 to 294 regions.

For lower-income regions, the distribution is strongly concentrated in Quadrant III (LL) in both periods. The number of regions in this quadrant increases only marginally, from 360 to 363, while the number of regions combining relatively high levels of specialisation in both sectors (HH) remains unchanged at 58. Changes in the remaining quadrants are limited, with a slight decrease in Quadrant II (HL), from 223 to 218 regions, and a small increase in Quadrant IV (LH) from 19 to 21 regions. Overall, the structure of specialisation among lower-income regions appears highly persistent over time.

By contrast, higher-income regions display more pronounced changes across quadrants. The number of regions with high levels of specialisation in both sectors (Quadrant I, HH) declines from 196 to 147, indicating a reduction in dual-specialised configurations. At the same time, all other quadrants expand: Quadrant II (HL) increases from 67 to 76 regions, Quadrant III (LL) from 124 to 143, and Quadrant IV (LH) from 116 to 137. This suggests greater sectoral mobility and more heterogeneous changes in relative specialisation patterns within more developed regions.

To further explore these dynamics, Figure 4 presents the transition matrices for the three groups. For the full sample, the matrix shows a strong concentration of observations along the main diagonal, indicating a high degree of persistence in regional specialisation patterns. In particular, LL exhibits especially high stability, with 426 out of 484 regions (approximately 88%) remaining in the same quadrant. Nevertheless, some mobility is observed, particularly involving movements from HH towards HL and LH.

Figure 3 - Tourism vs. technology specialisation for all regions (pre vs. post structural break)



Note: RSI denotes the relative specialisation index. Values above 1 indicate above-average specialisation. Quadrants are defined as HH (high tourism–high technology), HL (high tourism–low technology), LL (low tourism–low technology), and LH (low tourism–high technology). A small number of regions with extreme RSI values are excluded from the figure for visual clarity.

Figure 4 - Transition matrix of regional specialisation patterns (pre-break vs. post-break)

All regions				
Pre-shock quadrant	Q1 (HH)	Q2 (HL)	Q3 (LL)	Q4 (LH)
	176 (69.3%)	41 (16.1%)	3 (1.2%)	34 (13.4%)
	22 (7.6%)	208 (71.7%)	56 (19.3%)	4 (1.4%)
	1 (0.2%)	42 (8.7%)	426 (88%)	15 (3.1%)
	6 (4.4%)	3 (2.2%)	21 (15.6%)	105 (77.8%)
Post-shock quadrant				
Lower-income regions				
Pre-shock quadrant	Q1 (HH)	Q2 (HL)	Q3 (LL)	Q4 (LH)
	43 (74.1%)	13 (22.4%)	0 (0%)	2 (3.4%)
	12 (5.4%)	165 (74%)	44 (19.7%)	2 (0.9%)
	1 (0.3%)	39 (10.8%)	312 (86.7%)	8 (2.2%)
	2 (10.5%)	1 (5.3%)	7 (36.8%)	9 (47.4%)
Post-shock quadrant				
Higher-income regions				
Pre-shock quadrant	Q1 (HH)	Q2 (HL)	Q3 (LL)	Q4 (LH)
	133 (67.9%)	28 (14.3%)	3 (1.5%)	32 (16.3%)
	10 (14.9%)	43 (64.2%)	12 (17.9%)	2 (3%)
	0 (0%)	3 (2.4%)	114 (91.9%)	7 (5.6%)
	4 (3.4%)	2 (1.7%)	14 (12.1%)	96 (82.8%)
Post-shock quadrant				

Note: Cells report the number of regions, with percentages in parentheses. Quadrants are defined as HH (high tourism–high technology), HL (high tourism–low technology), LL (low tourism–low technology), and LH (low tourism–high technology).

For lower-income regions, the transition matrix confirms the strong persistence observed in the descriptive analysis. Quadrant III (LL) clearly dominates, with 312 out of 360 regions (around 87%) remaining in the same quadrant. Similarly, Quadrant II (HL) shows a relatively high degree of stability, with 165 out of 223 regions (approximately 74%) maintaining their position, while the total number of regions in this quadrant decreases slightly to 218 in the post-break period (see Annex A1). Transitions from HH are limited and occur mainly towards HL (13 out of 58 regions), while movements towards other quadrants are minimal. Overall, these results point to a high degree of structural inertia among lower-income regions, with limited evidence of shifts towards more diversified or technology-intensive specialisation patterns.

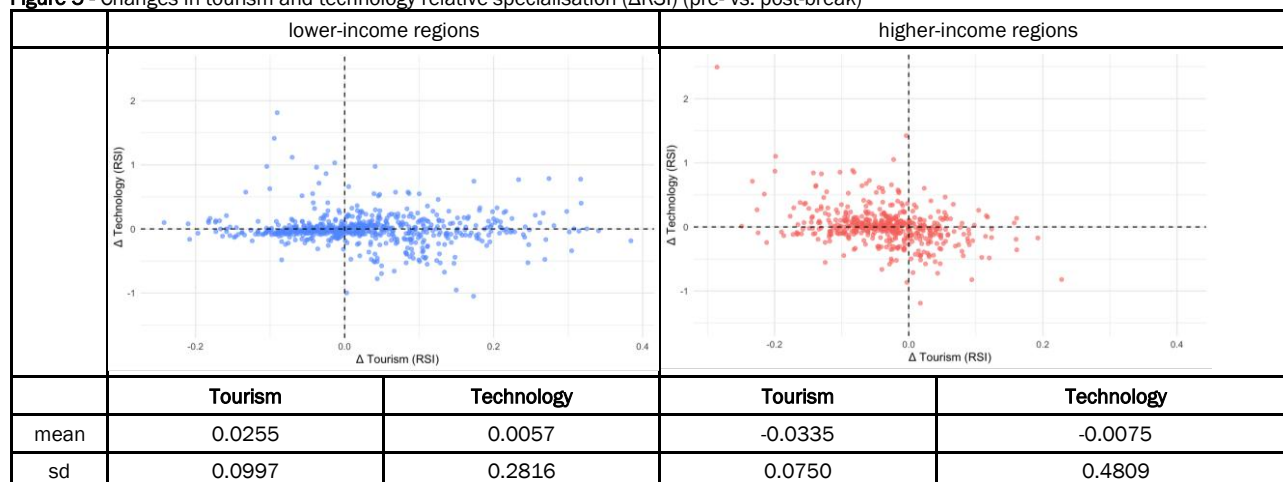
Finally, for higher-income regions, the transition matrix reveals a combination of persistence and more pronounced mobility. While a substantial share of regions remains in the same quadrant—particularly in the LH quadrant, where 96 out of 116 regions (around 83%) remain stable—movements from HH are significantly more frequent than in lower-income regions. Only 133 out of 196 regions (approximately 68%) remain in HH, with notable transitions towards HL (28 regions) and LH (32 regions). Transitions towards HL are consistent with a relative decline in technology specialisation, while movements towards LH suggest a relative weakening of tourism. These shifts do not necessarily imply an absolute contraction in either sector but may rather reflect increasing diversification in higher-income regions, where growing economic complexity tends to reduce the relative weight of any single sector without diminishing its absolute presence. This pattern suggests that higher-income regions are not consolidating dual specialisation, but rather undergoing processes of asymmetric reconfiguration, either reinforcing one sector over the other or moving towards weaker forms of combined specialisation.

Taken together, the comparison across income groups reveals notable differences in sectoral specialisation patterns across income levels. Lower-income regions display persistent concentration in low-specialisation configurations (LL), while higher-income regions show greater heterogeneity in sectoral transitions, although not towards balanced or dual-specialised configurations (HH). Importantly, low levels of specialisation in WH and IT should not be interpreted as an absence of specialisation altogether, but rather as reflecting the presence of alternative sectoral structures not captured within the scope of the present analysis. This evidence may be interpreted considering institutional and evolutionary perspectives, which emphasise the historical specificity of regional development processes and the existence of multiple development trajectories, rather than a single ideal-type path of economic growth (Boschma & Frenken, 2006).

3.2. Intensity of changes in sectoral specialisation

To complement the quadrant-based analysis, this section examines the intensity and direction of changes in relative specialisation between the pre-break and post-break periods (Figure 5), plotting the variation in sectoral specialisation across regions. In this regard, we measure the difference in the relative specialisation index between the two periods, revealing clear asymmetries between lower- and higher-income regions.

Figure 5 - Changes in tourism and technology relative specialisation (Δ RSI) (pre- vs. post-break)



Note: RSI denotes the relative specialisation index. Changes (Δ RSI) represent the difference between the post-break and pre-break periods. Positive values indicate increasing relative specialisation, while negative values indicate a decline. Tourism refers to the proxy based on NACE Rev. 2 sections G–H–I (WH). A small number of regions with extreme RSI values are excluded from the figure for visual clarity.

On average, lower-income regions exhibit slight increases in both tourism- and technology-related specialisation (mean Δ RSI = 0.026 and 0.006, respectively), while higher-income regions show small declines in relative terms (mean Δ RSI = -0.034 and -0.007). This pattern suggests a relative narrowing in sectoral positioning differences, whereby lower-income regions gain relative weight while higher-income regions experience a modest decline. It is important to note that these results should be interpreted with caution, as the use of employment-based measures may partly reflect productivity dynamics rather than pure changes in sectoral importance.

Beyond average changes, the distribution of adjustments provides additional insights. For lower-income regions, most observations are concentrated around small positive changes in tourism, with relatively limited dispersion, indicating gradual and relatively homogeneous adjustments. In contrast, changes in technology display greater variability, although still centred around modest gains, suggesting that changes in technology-related relative specialisation remain uneven within this group.

For higher-income regions, the distribution is more dispersed and asymmetric. While average changes are slightly negative, a non-negligible number of regions experience sizable positive and negative shifts, particularly in technology. This is consistent with the higher standard deviation observed in this sector ($sd = 0.48$), pointing to stronger and more heterogeneous reconfiguration processes. In contrast, changes in tourism are more contained ($sd = 0.08$), suggesting that adjustments in this sector are more limited among higher-income regions.

Taken together, these results indicate that structural change is not uniform across regions or sectors. Rather than reflecting a generalised transformation of regional productive structures, the observed patterns point to sector-specific and income-dependent dynamics. Lower-income regions exhibit modest but relatively consistent gains—particularly in tourism—while higher-income regions display more volatile and heterogeneous adjustments, especially in technology-related activities.

4 CONCLUSION AND DISCUSSION

4.1. Sectoral configurations and regional heterogeneity

This paper examines the coexistence and interaction between tourism and technology across European regions, adopting a sectoral perspective based on relative specialisation patterns at the NUTS-3 level. The results reveal multiple, heterogeneous regional configurations rather than a single structural trajectory.

In this context, working at a disaggregated territorial scale—specifically at NUTS-3 level—is particularly relevant, allowing for a more granular and accurate assessment of structural differences. In this regard, relatively aggregated units may conceal substantial intra-national heterogeneity (Gagliardi & Percoco, 2017), especially in regions containing sectors characterised by strong local embeddedness, such as tourism.

Focusing on the activities under analysis, four broad configurations can be identified across European regions: (1) regions exhibiting high levels of specialisation in both tourism and technology (HH) reflect dual-specialisation configurations, characterised by the simultaneous presence of relatively high levels of specialisation in both activities within diversified regional structures; (2) regions characterised by high tourism and low technological specialisation (HL) display a structural profile associated with a stronger orientation towards tourism and a more limited technological presence; (3) regions with high technological specialisation but limited tourism activity (LH) correspond to more technology-intensive profiles, typically associated with more advanced economic structures; (4) regions displaying low levels of specialisation in both sectors (LL) represent low-specialisation configurations with respect to the two activities examined here, potentially reflecting stronger specialisation in other sectors.

The distribution of these configurations across regions reveals a strong association with levels of economic development. Lower-income regions are predominantly concentrated in low-specialisation configurations, with a secondary presence of tourism-related specialisation profiles, while higher-income regions are more frequently associated with dual-specialisation configurations and technology-related specialisation profiles.

4.2. Structural constraints, sectoral characteristics and development pathways

The observed patterns are consistent with heterogeneous regional sectoral configurations and differentiated patterns of relative specialisation. In lower-income regions, the relative prominence of tourism reflects its role as a comparatively accessible economic activity, given its relatively low entry barriers (Benavides & Pérez-Ducy, 2001; Ashley & Mitchell, 2009), its capacity to absorb labour—particularly among more vulnerable groups (World Tourism

Organization & International Labour Organization, 2008; International Labour Organization, 2017)—and its connection to external demand (Schubert et al., 2011).

However, tourism is also typically associated with relatively low productivity, strong seasonality, and a high concentration of low-skilled employment, raising concerns about its capacity to sustain long-term development trajectories (Perles-Ribes and Moreno-Izquierdo, 2024). As a result, tourism has increasingly been analysed not only as a source of growth, but also in relation to broader questions of resilience, sustainability, and structural balance (Amore et al., 2020; Berselli et al., 2022; Gyamfi et al., 2021; Gössling et al., 2015; Paramati et al., 2018).

At the same time, the limited presence of technology-intensive activities in lower-income regions may be associated with structural constraints related to human capital, innovation capacity, and access to resources, which are widely recognised as key barriers to structural transformation (Iammarino et al., 2019). In contrast, higher-income regions display a stronger orientation towards ICT and knowledge-intensive activities, reflecting their greater capacity to sustain innovation-driven sectors, supported by higher levels of capital, skilled labour, and infrastructure (Touray et al., 2013; Pikkemaat et al., 2018). These regions face increasing challenges in maintaining technological and sectoral leadership, as innovation diffuses geographically and requires continuous processes of adaptation and upgrading (Iammarino et al., 2019).

Importantly, tourism-related and technology-related activities may coexist within the same regional productive structures and may interact indirectly through broader processes of technological change. Indeed, this coexistence is consistent with the dual rationale highlighted in the literature: on the one hand, digital technologies act as key drivers of tourism competitiveness, as reflected in the development of smart destinations (Romão & Nijkamp, 2019; Guaita Martinez et al., 2020), but also with relevant transformations driven by technological innovation such as the expansion of low-cost airlines (McIvor et al., 2003; Ramón-Rodríguez et al., 2011), the rise of platform economies (Hall et al., 2022; Sigala, 2022), and the automation of services (Ivanov, 2020; Jabeen et al., 2022). On the other hand, urban tourism in major European cities often overlaps with areas of high technological intensity and innovation, such as Paris, Rome, or Munich (Moreno-Izquierdo et al., 2018). This connection situates our findings within the broader smart tourism literature, while extending it to a regional perspective based on sectoral specialisation patterns.

4.3. Structural dynamics, persistence and policy implications

From a dynamic perspective, the analysis reveals a high degree of persistence in regional specialisation patterns before and after the structural break detected in 2010. Although some mobility is observed—particularly a shift away from dual-specialised configurations towards more asymmetric profiles—these changes are not descriptively consistent with a generalised movement towards more balanced regional configurations. Instead, they point to the coexistence of structural persistence and gradual reconfiguration.

This interpretation is reinforced by the analysis of changes in relative specialisation, which shows that structural adjustments are not uniform across sectors. Lower-income regions exhibit relatively modest adjustments, with greater variability in technology-related than in tourism-related specialisation, while higher-income regions display even stronger dynamics in technology-intensive activities, suggesting sector-specific and income-dependent patterns of relative specialisation adjustment.

At the same time, the relative nature of the specialisation indicators must be taken into account. The European benchmark for both tourism and technology increased over time, particularly in the case of technology, implying that part of the observed reallocation across quadrants reflects changes in relative positioning rather than absolute declines in sectoral activity. This is particularly relevant in large metropolitan regions, where a relatively low RSI may coexist with a substantial volume of absolute employment in tourism or technology, reflecting the dominance of other activities rather than a genuine absence of sectoral presence.

These dynamics are broadly aligned with previous literature highlighting heterogeneous regional responses following the global financial crisis. Regions with higher levels of innovation capacity were better able to resist the shock and recover more rapidly (Bristow & Healy, 2014), in line with broader evidence highlighting the role of knowledge-intensive sectors in enhancing resilience and facilitating structural adaptation (Cooke, 2012; Simmie, 2014a, 2014b; Wolfe, 2014; Wolfe & Gertler, 2016).

Importantly, the results do not provide evidence consistent with a clear structural substitution between tourism and technology specialisation. Although a reduction in dual-specialised regions is observed, this does not imply substitution between sectors. On the contrary, the observed patterns are consistent with the possibility that both sectors

may coexist within the same regional economy—as illustrated by Northern Estonia (EE001: Põhja-Eesti), which moves towards a dual-specialisation configuration in the post-break period. These results are consistent with Perles-Ribes and Moreno-Izquierdo (2024), who argue that the key issue is not whether tourism contributes to growth, but whether it constitutes an optimal path for development.

4.4. Limitations and future lines of work

Working at the NUTS-3 level of disaggregation, while a relevant methodological contribution, introduces important statistical limitations. The proxies used for both tourism (NACE sections G, H and I) and technology (section J) capture a broader set of activities than the activities that this paper seeks to analyse; the results should therefore be interpreted not as exclusive measures of tourism and technology, but as encompassing adjacent activities. Additionally, at this level of disaggregation and for such a large sample, no other variables are available that would allow the activities of interest to be isolated—such as overnight stays or R&D expenditure data.

A further limitation, common in tourism economics research, concerns the difficulty of statistically defining the boundaries of tourism activity. In particular, current statistical frameworks do not allow identification of which technology firms operate within the tourism sector. Such information would enable a more precise characterisation of sectoral interactions and, crucially, would allow assessment of the extent to which the significant share of tourism-generated value captured by external digital actors (Garrigós-Simón et al., 2015; Chaitanya and Swain, 2024; Garrido & Moreno-Izquierdo, 2025) is offset by income and employment generated by destination-based digital technology firms.

Additionally, a significant share of technological innovation operates directly within and in service of tourism systems, even when classified under generic ICT categories. Future research could explore how destination-based technology firms contribute to sustainability outcomes, including more efficient use of natural resources, reduction of environmental externalities, and improved carrying capacity management, building on the growing literature on smart destinations and digital innovation in tourism (Romão & Nijkamp, 2019; Guaita Martinez et al., 2020).

These limitations collectively define a substantive agenda for future research. As more granular sectoral data become available, future work could isolate tourism- and technology-specific activities more precisely, enabling sharper empirical analysis. In the case of large metropolitan regions, incorporating absolute employment figures alongside relative specialisation indicators would also allow future research to disentangle whether observed shifts reflect genuine sectoral decline or the relative growth of other activities, particularly in contexts where a relatively low RSI may coexist with substantial absolute sectoral employment.

Finally, a particularly relevant question is whether regions transitioning towards higher levels of dual specialisation achieve superior productivity and income growth compared to those that do not. Extending this framework to causal identification strategies would allow researchers to assess which structural, institutional, and policy-related factors—including income growth, relative price dynamics, sectoral linkages, sector-biased technological change, human capital endowments, and shifts in comparative advantage through globalisation and trade (Van Neuss, 2019; Świącki, 2017; Matsuyama, 2008)—drive changes in regional specialisation patterns and condition the capacity of regions to transition towards more diversified and technologically intensive configurations.

REFERENCES

- Aghion, P., & Howitt, P. (1992). A model of growth through creative destruction. *Econometrica*, 60(2), 323-351. <https://doi.org/10.2307/2951599>
- Alonso-Villar, O. (2001). Large metropolises in the third world: An explanation. *Urban Studies*, 38(8), 1359-1371. <https://doi.org/10.1080/00420980120061070>
- Amore, A., Falk, M., & Adie, B. A. (2020). One visitor too many: Assessing the degree of overtourism in established European urban destinations. *International Journal of Tourism Cities*, 6(1), 117-137. <https://doi.org/10.1108/IJTC-09-2019-0152>
- Ashley, C., & Mitchell, J. (2009). *Tourism and poverty reduction: Pathways to prosperity*. Routledge. <https://doi.org/10.4324/9781849774635>
- Bai, J., & Perron, P. (1998). Estimating and testing linear models with multiple structural changes. *Econometrica*, 66(1), 47-78. <https://doi.org/10.2307/2998540>

- Bai, J., & Perron, P. (2003). Computation and analysis of multiple structural change models. *Journal of Applied Econometrics*, 18(1), 1-22. <https://doi.org/10.1002/jae.659>
- Bartelsman, E., Lopez-Garcia, P., & Presidente, G. (2019). Labour reallocation in recession and recovery: Evidence for Europe. *National Institute Economic Review*, 247(1). <https://doi.org/10.1177/002795011924700113>
- Behrens, K., Gaigné, C., Ottaviano, G. I., & Thisse, J. F. (2007). Countries, regions and trade: On the welfare impacts of economic integration. *European Economic Review*, 51(5), 1277-1301. <https://doi.org/10.1016/j.euroecorev.2006.08.005>
- Benavides, D. D., & Pérez-Ducy, E. (2001). *Tourism in the least developed countries*. Third United Nations Conference on the Least Developed Countries, Maspalomas, Gran Canaria, Spain, 26-29 March 2001. <https://www.cabidigitallibrary.org/doi/full/10.5555/20013086319>
- Berselli, C., Pereira, L. A., Pereira, T., & Limberger, P. F. (2022). Overtourism: Residents' perceived impacts of tourism saturation. *Tourism Analysis*, 27(2), 161-172. <https://doi.org/10.3727/108354221X16187814403074>
- Bimonte, S., López-Milla, J., Moreno-Izquierdo, L., & Torres-Penalva, A. (2026). *Tourism and Regional Economic Convergence in Europe: A Sectoral Comparative Analysis at The NUTS 3 Level*. SSRN. <http://dx.doi.org/10.2139/ssrn.6383838>
- Boschma, R. A., & Frenken, K. (2006). Why is economic geography not an evolutionary science? Towards an evolutionary economic geography. *Journal of Economic Geography*, 6(3), 273-302. <https://doi.org/10.1093/jeg/lbi022>
- Brida, J. G., Pereyra, J. S., & Such Devesa, M. J. (2008). Evaluating the contribution of tourism to economic growth. *Anatolia*, 19(2), 351-357. <https://doi.org/10.1080/13032917.2008.9687079>
- Bristow, G., & Healy, A. (2014). Regional resilience: an agency perspective. *Regional Studies*, 48(5), 923-935. <https://doi.org/10.1080/00343404.2013.854879>
- Chaitanya, A. K., & Swain, S. K. (2024). Economic leakages in tourism: A comprehensive review of theoretical and empirical perspectives. *Tourism Economics*, 30(5), 1306-1323. <https://doi.org/10.1177/13548166231204648>
- Cooke, P. (2012). *Complex adaptive innovation systems: Relatedness and transversality in the evolving region*. Routledge. <https://doi.org/10.4324/9780203126615>
- Cró, S., & Martins, A. M. (2017). Structural breaks in international tourism demand: Are they caused by crises or disasters? *Tourism Management*, 63, 3-9. <https://doi.org/10.1016/j.tourman.2017.05.009>
- Cutrini, E., Gardiner, B., & Martin, R. (2022). EU integration and the geographies of economic activity: 1985-2019. *Environment and Planning A: Economy and Space*, 55(2), 274-302. <https://doi.org/10.1177/0308518X221127028>
- Demblans, A., Martínez, M. P., & Laval, C. (2020). Place-based solutions to territorial challenges: How policy and research can support successful ecosystems. *Science for policy handbook* (pp. 224-238). Elsevier. <https://doi.org/10.1016/B978-0-12-822596-7.00019-X>
- European Union. (2010). *Consolidated version of the Treaty on European Union*. Publications Office of the European Union. https://eur-lex.europa.eu/resource.html?uri=cellar:2bf140bf-a3f8-4ab2-b506-fd71826e6da6.0023.02/DOC_1&format=PDF
- Eurostat (2021). *Nomenclature of Territorial Units for Statistics (NUTS)*. European Commission. <https://ec.europa.eu/eurostat/web/nuts>
- Eurostat (2024a). *Employment by industry and region (nama_10r_3empers)*. European Commission. https://doi.org/10.2908/NAMA_10R_3EMPERS
- Eurostat (2024b). *Gross domestic product (GDP) at regional level (nama_10r_3gdp)*. European Commission. https://doi.org/10.2908/NAMA_10R_3GDP
- Gagliardi, L., & Percoco, M. (2017). The impact of European Cohesion Policy in urban and rural regions. *Regional Studies*, 51(6), 857-868. <https://doi.org/10.1080/00343404.2016.1179384>
- Garrido, N., & Moreno-Izquierdo, L. (2025). An analysis of the Latin America value-added chain of tourism. *Tourism Economics*, 0(0), 1-19. <https://doi.org/10.1177/13548166251339372>
- Garrigós-Simón, F. J., Galdón-Salvador, J. L., & Gil-Pechuán, I. (2015). The economic sustainability of tourism growth through leakage calculation. *Tourism Economics*, 21(4), 721-739. <https://doi.org/10.5367/te.2014.0372>
- Glaeser, E. L., Kallal, H. D., Scheinkman, J. A., & Shleifer, A. (1992). Growth in cities. *Journal of Political Economy*, 100(6), 1126-1152. <https://doi.org/10.1086/261856>

- Gössling, S., Scott, D., & Hall, C. M. (2015). Inter-market variability in CO₂ emission-intensities in tourism: Implications for destination marketing and carbon management. *Tourism Management*, 46, 203-212. <https://doi.org/10.1016/j.tourman.2014.06.021>
- Guaita Martínez, J. M., Martín Martín, J. M., & Salinas Fernández, J. A. (2020). Innovation in the measurement of tourism competitiveness. In M. A. Galindo-Martín, M. T. Méndez-Picazo, & M. S. Castaño-Martínez (Eds.), *Analyzing the relationship between innovation, value creation, and entrepreneurship* (pp. 268–288). IGI Global. <https://doi.org/10.4018/978-1-7998-1169-5.ch013>
- Gyamfi, B. A., Bein, M. A., Adedoyin, F. F., & Bekun, F. V. (2021). To what extent are pollutant emissions intensified by international tourist arrivals? *Starling evidence from G7 Countries. Environment, Development and Sustainability*, 24, 7896-7917. <https://doi.org/10.1007/s10668-021-01765-7>
- Hall, C. M., Prayag, G., Safonov, A., Coles, T., Gössling, S., & Naderi Koupaei, S. (2022). Airbnb and the sharing economy. *Current Issues in Tourism*, 25(19), 3057-3067. <https://doi.org/10.1080/13683500.2022.2122418>
- Iammarino, S., Rodríguez-Pose, A., & Storper, M. (2019). Regional inequality in Europe: evidence, theory and policy implications. *Journal of Economic Geography*, 19(2), 273-298. <https://doi.org/10.1093/jeg/lby021>
- Inchausti-Sintes, F. (2015). Tourism: Economic growth, employment and Dutch disease. *Annals of Tourism Research*, 54, 172-189. <https://doi.org/10.1016/j.annals.2015.07.007>
- International Labour Organization. (2017). *Pautas de la OIT sobre trabajo decente y turismo socialmente responsable*. <https://www.ilo.org/es/media/267976/download>
- Ivanov, S. (2020). The impact of automation on tourism and hospitality jobs. *Information Technology & Tourism*, 22, 205-215. <https://doi.org/10.1007/s40558-020-00175-1>
- Jabeen, F., Al Zaidi, S., & Al Dhaheri, M. H. (2022). Automation and artificial intelligence in hospitality and tourism. *Tourism Review*, 77(4), 1043-1061. <https://doi.org/10.1108/TR-09-2019-0360>
- Jacobs, J. (1969). *The Economy of Cities*. New York: Random House.
- Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy*, 99(3), 483-499. <https://doi.org/10.1086/261763>
- Krugman, P. (1993). Lessons of Massachusetts for EMU. In F. Giavazzi (Ed.), *Adjustment and Growth in the European Monetary Union* (pp. 241-261). Cambridge: Cambridge University Press. <https://doi.org/10.1017/CBO9780511599231.016>
- Krugman, P., & Livas Elizondo, R. (1996). Trade policy and the Third World metropolis. *Journal of Development Economics*, 49(1), 137-150. [https://doi.org/10.1016/0304-3878\(95\)00055-0](https://doi.org/10.1016/0304-3878(95)00055-0)
- Marshall, A. (1890). *Principles of economics*, by Alfred Marshall. Macmillan and Company.
- Matsuyama, K. (2008). Structural Change. In *The New Palgrave Dictionary of Economics*. Palgrave Macmillan, London. https://doi.org/10.1057/978-1-349-95121-5_1775-2
- McIvor, R., O'Reilly, D., & Ponsonby, S. (2003). The impact of Internet technologies on the airline industry: Current strategies and future developments. *Strategic Change*, 12(1), 31-47. <https://doi.org/10.1002/jsc.618>
- Mérida, A. L., Carmona, M., Congregado, E., & Golpe, A. A. (2016). Exploring the regional distribution of tourism and the extent to which there is convergence. *Tourism Management*, 57, 225-233. <https://doi.org/10.1016/j.tourman.2016.06.012>
- Moreno-Izquierdo, L., Ramón-Rodríguez, A., & Such-Devesa, M. J. (2018). The challenge of long-term tourism competitiveness in the age of innovation: Spain as a case study. *Journal of Regional Research*, 42, 13-34. <http://hdl.handle.net/10045/86771>
- Moreno-Izquierdo, L., Torres-Penalva, A., Bimonte, S., & Matesanz-Gómez, D. (2026). Structural breaks and regional convergence clubs in Europe. *Investigaciones Regionales – Journal of Regional Research*, (58), 1-21. <https://doi.org/10.38191/iirr-jorr.26.011>
- Paramati, S. R., Alam, M. S., & Lau, C. K. M. (2018). The effect of tourism investment on tourism development and CO₂ emissions: Empirical evidence from the EU nations. *Journal of Sustainable Tourism*, 26(9), 1587-1607. <https://doi.org/10.1080/09669582.2018.1489398>
- Perles-Ribes, J. F., & Moreno-Izquierdo, L. (2024). Testing the Tourism Led Growth Hypothesis: A nonsensical exercise? *European Journal of Tourism Research*, 38, 3817. <https://doi.org/10.54055/ejtr.v38i.3637>
- Pikkemaat, B., Peters, M., & Chan, C. S. (2018). Needs, drivers and barriers of innovation: The case of an alpine community-model destination. *Tourism Management Perspectives*, 25, 53-63. <https://doi.org/10.1016/j.tmp.2017.11.004>

- Puga, D. (1999). The rise and fall of regional inequalities. *European Economic Review*, 43(2), 303-334. [https://doi.org/10.1016/S0014-2921\(98\)00061-0](https://doi.org/10.1016/S0014-2921(98)00061-0)
- Ramón-Rodríguez, A. B., Moreno-Izquierdo, L., & Perles-Ribes, J. F. (2011). Growth and internationalisation strategies in the airline industry. *Journal of Air Transport Management*, 17(2), 110-115. <https://doi.org/10.1016/j.jairtraman.2010.11.002>
- Romão, J., & Nijkamp, P. (2019). Impacts of innovation, productivity and specialization on tourism competitiveness: A spatial econometric analysis on European regions. *Current Issues in Tourism*, 22(10), 1150-1169. <https://doi.org/10.1080/13683500.2017.1366434>
- Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5, Part 2), S71-S102. <https://doi.org/10.1086/261725>
- Schubert, S. F., Brida, J. G., & Risso, W. A. (2011). The impacts of international tourism demand on economic growth of small economies dependent on tourism. *Tourism Management*, 32(2), 377-385. <https://doi.org/10.1016/j.tourman.2010.03.007>
- Sigala, M. (2022). Sharing and platform economy in tourism: An ecosystem review of actors and future research agenda. In *Handbook of e-Tourism* (pp. 1521-1543). Springer International Publishing. https://doi.org/10.1007/978-3-030-48652-5_89
- Simmie, J. (2014a). *Evolutionary growth theory and resilience in UK cities: Re-invention versus replication* (Oxford Brookes Working Paper). Oxford Brookes University, Department of Planning.
- Simmie, J. (2014b). Regional economic resilience: A Schumpeterian perspective. *Raumforschung und Raumordnung*, 72(2), 103-116. <https://doi.org/10.1007/s13147-014-0274-y>
- Solow, R. M. (1956). A contribution to the theory of economic growth. *The Quarterly Journal of Economics*, 70(1), 65-94. <https://doi.org/10.2307/1884513>
- Świącki, T. (2017). Determinants of structural change. *Review of Economic Dynamics*, 24, 95-131. <https://doi.org/10.1016/j.red.2017.01.007>
- Torres-Penalva, A., Moreno-Izquierdo, L., & Ramón-Rodríguez, A. (2025). Digitalization in the tourism sector: The adaptation of innovation and convergence issues. In L. A. Garay-Tamajón (Ed.), *A research agenda for tourism, digitalisation and sustainability*. Edward Elgar Publishing. <https://doi.org/10.4337/9781035346011.00021>
- Touray, A., Salminen, A., & Mursu, A. (2013). ICT barriers and critical success factors in developing countries. *The Electronic Journal of Information Systems in Developing Countries*, 56(1), 1-17. <https://doi.org/10.1002/j.1681-4835.2013.tb00401.x>
- Van Neuss, L. (2019). The drivers of structural change. *Journal of Economic Surveys*, 33(1), 309-349. <https://doi.org/10.1111/joes.12266>
- Venables, A. J. (1995). Economic integration and the location of firms. *American Economic Review*, 85(2), 296-300. <https://www.jstor.org/stable/2117936>
- Wolfe, D. A. (2014). Introduction to the dynamics of innovation in city-regions. In D. A. Wolfe (Ed.), *Innovating in urban economies: Economic transformation in Canadian city-regions* (pp. 3-32). University of Toronto Press.
- Wolfe, D. A., & Gertler, M. S. (2016). *Growing urban economies: Innovation, creativity, and governance in Canadian city-regions*. University of Toronto Press.
- World Tourism Organization & International Labour Organization. (2008). *Empleo y trabajo decente en el sector turístico: Proyecto conjunto OIT-OMT*. <https://www.unwto.org/es/project/empleo-y-trabajo-decente-en-el-sector-turistico-proyecto-conjunto-oit-omt>
- Zeileis, A., Leisch, F., Hornik, K., & Kleiber, C. (2002). strucchange: An R package for testing for structural change in linear regression models. *Journal of Statistical Software*, 7, 1-38. <https://doi.org/10.18637/jss.v007.i02>

Data availability statement

Data must be requested from the author at the email luis.moreno@ua.es

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Anexx

A1. Net change in tourism / technology specialisation (pre vs. post structural break)

	Quadrant	Pre-break	Post-break	Net change	% change
All regions	I (High WH & High IT)	254	205	-49	-19.3%
	II (High WH & Low IT)	290	294	+4	+1.4%
	III (Low WH & Low IT)	484	506	+22	+4.5%
	IV (Low WH & High IT)	135	158	+23	+17.0%
	Quadrant	Pre-break	Post-break	Net change	% change
Lower- income regions	I (High WH & High IT)	58	58	0	0.0%
	II (High WH & Low IT)	223	218	-5	-2.2%
	III (Low WH & Low IT)	360	363	+3	+0.8%
	IV (Low WH & High IT)	19	21	+2	+10.5%
	Quadrant	Pre-break	Post-break	Net change	% change
Higher- income regions	I (High WH & High IT)	196	147	-49	-25.0%
	II (High WH & Low IT)	67	76	+9	+13.4%
	III (Low WH & Low IT)	124	143	+19	+15.3%
	IV (Low WH & High IT)	116	137	+21	+18.1%

Note: Values represent the number of regions in each quadrant for the pre-break and post-break periods. Net change indicates the difference in the number of regions between both periods.