

“Analysis of asymmetry factors in the development of the EU tourism industry”

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ANALYSIS OF ASYMMETRY FACTORS IN THE DEVELOPMENT OF THE EU TOURISM INDUSTRY

Abstract

The effects of the economic recession and the COVID-19 crisis call for more active support for the tourism industry. To pursue a supranational tourism policy and create a favorable marketing environment at the national level, it is necessary to consider the objective differences between member states and their characteristics in the field of tourism. This study aims to highlight the main factors that characterize the asymmetry of the tourism industry in the EU countries, which allows ensuring the competitiveness of national tourism companies through the formation of an appropriate marketing strategy. The research methodology includes calculation of the asymmetry coefficient and cluster and classification analysis based on Eurostat data.

At the first stage, 27 indicators were selected that characterize the structural proportions of the tourism industry and the intensity of tourism in the EU countries. Based on the calculation of the asymmetry coefficient, a high level of heterogeneity of the tourism industry parameters in the EU countries for each of the indicators was demonstrated. At the second stage, clustering (algorithm – k-means, metric – Euclidean distance) of the EU countries was carried out according to the selected indicators. As a result, eight clusters were obtained, which showed asymmetry in developing national tourism sectors in the EU. At the third stage, as a result of classification (method – decision trees), seven combinations of indicators were identified, which completely distinguish the resulting clusters of the EU countries. The parameters included in these combinations are, in fact, the main factors of the asymmetry in the development of the EU tourism industry.

Based on the analysis of the asymmetric development of the tourism industry by country, it is possible to determine its growth points and competitiveness drivers in the EU internal market and identify marketing strategies.

Keywords

tourism, country clustering, asymmetry factors, supranational policy, marketing strategy

JEL Classification

M31, L83, O57, C38

INTRODUCTION

Tourism is an important part of the economy of all the EU member states. It forms a large proportion of their mutual and common trade and greatly impacts economic growth, employment, and cultural progress. In recent decades, in the European economy and worldwide, the tourism industry has developed dynamically. However, in 2019–2020, many new challenges arose related to the effects of the economic recession and the COVID-19 crisis, which reduced the sustainability and performance of the tourism industry. These circumstances necessitate more active support for the EU tourism industry, taking the form of an independent supranational policy.

The development of the tourism industry in the EU includes, first of all, expanding the opportunities of European tourism, stimulating tourism business, and spreading its new forms and directions. The

new supranational tourism policy sets a common course for all member states. However, the scale and structural proportions of the tourism industry in different EU countries vary widely, determining the specifics of the implementation of community tourism support programs. Besides, based on the established powers of the EU, its tourism policy complements the actions of national governments, which also provides a differentiated approach to the development of national tourism industries. Given, on the one hand, the need for a common course in support of tourism, and on the other hand, the specifics of individual countries, a prerequisite for supranational policy in this area is to consider the asymmetry of the tourism industry in the EU member states.

1. LITERATURE REVIEW

Numerous studies confirm the great importance and growing role of the tourism industry, particularly in the EU countries. As one of the largest and fastest-growing sectors of the economy, tourism significantly contributes to GDP, job creation, export promotion, and welfare, which is within the scope of the EU's tasks and is naturally related to its policy directions in various fields.

Tourism is considered a strategic priority for most EU countries. This applies not only to countries with traditional tourism specialization, where tourism plays an unprecedented role in the economy. In other countries, tourism is also seen as strategically important in terms of economic diversification. This is due to the growing demand for tourism services and opportunities for a relatively rapid accumulation of tourism potential, which has a multiplier effect on many economic sectors. For these reasons, tourism is particularly important for less prosperous EU member states, especially given the downturn.

Although at the beginning of European integration, tourism was not the main area of convergence between countries, it became one of those industries that initially benefited the most from the association. In the context of regional integration into the EU, tourism itself has acquired a new quality, developing in a single internal market and social mobility. On the other hand, tourism has been and remains one of the engines of integration into the EU itself, contributing to the merging of services and real estate markets, developing network forms of hotels and restaurants, social contacts, and consolidation of society. At the same time, each EU enlargement has contributed to the positive transformation of the tourism industry. The new countries joining the EU have added to its global competitiveness in the tour-

ism sector. The development of international tourism has become particularly useful for the economies of a group of new EU member states from Central and Eastern Europe (Kuliš et al., 2018). In the countries that joined the EU in 2004 and 2007, the integration effect was clearly shown, also facilitated by their support and investment inflows (Nicolescu & Ana, 2018). The rise of the tourism industry in Central and Eastern Europe has confirmed the feasibility of a supranational tourism policy (Mayer et al., 2019).

In the EU, intensive and diversified tourism is seen as the locomotive of systemic socio-economic changes (Shaheen et al., 2019). Given the complex impact on the EU economy and society, ensuring sustainable development of the tourism industry and maximizing economic performance and positive social impact is an urgent problem. These goals unite all the EU member states, shaping a common course of tourism development, which acquires supranational policy qualities. In this regard, the role of the European Commission in the field of tourism is optimized, which is designed to best unite, coordinate, and complement the actions of member states (Estol & Font, 2016).

The formation of a supranational tourism development policy requires appropriate analysis of the situation and sound scientific recommendations (Van der Schyff et al., 2019). The information and analytical framework of such a policy include a wide range of issues, the most common and important of which in the EU are the following: analysis of tourism performance in individual countries and the EU as a whole, assessment of the impact on GDP and employment at the macro level, including policy effectiveness (Barišić & Cvetkoska, 2020); assessment of tourism potential of countries and regions (Aytuğ & Mikaeili, 2017); analysis of tourism geography, forecasting tourist attractiveness and load, modeling of tourist flows between coun-

tries (Nielsen & Kaae, 2008); study of development trends of certain areas or types of tourism, for example, urban (Pasquinelli & Bellini, 2017) and rural (Ruukel et al., 2020) tourism, as well as tourism in coastal areas (Holleran, 2020); identifying comparative advantages of countries in tourism and their drivers (Algieri et al., 2016).

Digital technologies have significantly expanded the possibilities of self-service, which has largely replaced the person in the field of hospitality and actualized employment problems. However, given the potential for tourism development in many EU countries, much attention is paid to the tourism sector in terms of combating unemployment. Therefore, one of the mandatory research areas in the tourism industry is to analyze its impact on job creation and poverty reduction in the context of the EU social and anti-crisis policies (Boghean & State, 2019; Melián-González & Bulchand-Gidumal, 2020). Among other things, this applies to assessing working conditions and job satisfaction of those employed in the tourism industry, which allows classifying the countries to solve development problems and ensure employment growth (Díaz-Carrión et al., 2020).

Tourism is developing quite rapidly, accompanied by significant quantitative and qualitative changes, structural changes, diversification of types and forms. Therefore, there are many special tasks for analyzing the processes and features of the tourism industry, which must be taken into account for the appropriate support from the EU. These tasks include, for example, measuring the seasonality of tourism by country, determining national similarities and differences, finding common patterns in groups of countries (Ferrante et al., 2018); analyzing the consequences of climate change for the tourism industry (Barrios & Ibañez, 2015); exploring the mutual influence of air quality and tourism intensity by country, and in this context, changes in demand for certain types of tourism and tourist destinations (Robaina et al., 2020); assessing direct and indirect, positive and negative impacts of foreign investment in the tourism industry on the economy (Sokhanvar, 2019); analyzing the factors of change and sustainability of value chains in tourism (Breiling, 2020); studying the preferences of tourists in different EU countries, including different types of tourism, identifying factors influ-

encing such preferences (Amaral & Serra, 2019); studying the parameters of efficiency (including environmental) of using resources in tourism, and hence compliance with the principles of sustainable development and the role of innovation (Robaina & Madaleno, 2019); exploring the role and activities of small business in rural tourism and agritourism by country (Mura & Kljucnikov, 2018); assessing the consequences of the coronavirus pandemic, including by countries, regions, types of tourism and tourist destinations (Zenker & Kock, 2020); analyzing the spatial and temporal models of tourism by country (Batista e Silva et al., 2018); analyzing the entrepreneurial risks in tourism (Weiss et al., 2018). All of these issues are important for defining the vector and objectives of the supranational policy, developing an action program for numerous EU bodies in agreement with national governments. However, the analysis of each research field has its methodological difficulties and requires special methodological approaches, mathematical and statistical tools (Antolini & Grassini, 2020).

Given the membership of many countries in the EU, tourism research in this association often uses different benchmarking options to study processes in the tourism industry, in particular, to assess its development level, performance parameters, competitiveness, consumption of tourism services, tourism potential, etc. (Gabor et al., 2012; Malec et al., 2020). However, the comparative analysis is complicated not only by a large number of countries but also by the multiplicity of parameters for assessing the tourism industry, the natural heterogeneity of available statistics. Thus, the methodological complexity of the comparison task does not allow using economic aggregates and traditional statistical tools.

Many studies confirm the feasibility of using mathematical methods to consider the heterogeneity of tourism development in different countries, such as fuzzy logic in assessing the sustainability of tourist destinations and the uncertainty of variables involved (Andria et al., 2019). Mathematical models are also widely used in tourism research, for example, to study the demand for international tourism using exponential random graph models (Lyócsa et al., 2019), or to assess the tourism potential, covering various resources and their status (Yan et al., 2017), which is related to planning in public policy.

With the advent of big data, data mining (data analysis) methods have been used in tourism research that differ from traditional statistical and econometric approaches and effectively solve various research problems (Li & Law, 2020; Xu et al., 2016). Data mining methods allow covering multidimensional sets of various empirical data and, after processing, finding in them hidden nontrivial patterns practically useful for science and management. Such methods are widely used in the social analysis of tourism, for example, to study the motives and preferences of tourists, tourism activities (Pitchayadejanant & Nakpathom, 2018), spatial structures of tourist destinations (Park et al., 2020), as well as in forecasting (Roskladka et al., 2018). The data mining approach results are valuable for planning within the framework of state or supranational tourism development policy. In this context, data mining methods can be used to study the asymmetry in the development of the EU tourism industry, which is of interest to these countries themselves, supranational bodies, and partner countries on the path to European integration. This creates a basis for managing changes in tourism and inclusion in sectoral integration with the EU and allows building a tourism system in the pan-European channel (Mazaraki et al., 2018).

The development of tourism is directly related to economic, social, regional, cohesion policies, and other areas of the EU supranational policy. However, the EU is stepping up its efforts in the field of tourism and developing a coherent supranational policy. In this context, it is necessary to consider the asymmetry in the development of the tourism industry in the member states, which gives rise to relevant scientific and practical tasks. In solving them, it is advisable to use data mining methods to compare multidimensional sets of different empirical data, revealing the hidden patterns and basic factors in structuring a set of objects.

2. AIMS

The study aims to highlight the main factors that characterize the asymmetry in the development of the EU tourism industry in order to ensure the competitiveness of national tourism companies and select adequate marketing strategies.

3. METHODS

The Treaty on the Functioning of the European Union (Article 6) provides that in the field of tourism, the European Union has the competence to carry out activities aimed at supporting, coordinating, or complementing the actions of the member states. Section XXII (Article 195) of the Treaty states that the EU complements the activities of its member states in the field of tourism, in particular by contributing to the competitiveness of the EU enterprises. To this end, the European Union is competent to promote a favorable environment for the development of enterprises and create favorable conditions for cooperation between the member states. Supranational authorities may establish appropriate special measures, complementing the activities carried out in the member countries while excluding the harmonization of national laws and regulations. In fact, even given the lack of harmonization requirements in the countries' legislations, it is the basis for a supranational tourism policy. Within the framework of a single policy direction, common priorities for all member states were identified, related to ensuring competitiveness, sustainable development, responsible and quality tourism, strengthening the image of Europe as a complex of ecological and high-quality tourism destinations, which became the basis for the EU bodies.

The need for a supranational policy stems from the very nature of European integration and the EU's mission to achieve common goals for member states in various fields. The supranational policy is understood as a set of general tasks, rules, procedures, tools, methods, and practical measures implemented as part of a single international integration structure of institutions and supranational mechanisms for making and implementing decisions. Supranational policy as a mode of action is approved by sovereign countries and includes all the necessary functions of strategic and operational management, previously agreed by them; it is seen as a higher macroeconomic management level. This is quite true for the EU's actions in the tourism sector. A special international regional regime is being formed in this area, ensuring the interaction of supranational institutions with national and regional structures and actors in the governance process. The implementation of decisions taken at the EU level and approved by national governments is based on the principles of solidarity,

subsidiarity, partnership, mutual recognition, and reconciling the interests of all countries and reaching full consensus.

Based on the established form of EU competence, supranational tourism policy is based not on “hard” (prescriptive), but mainly on “soft” (political) methods, which involve reconciling interests, developing common goals, principles and priorities, and coordinating actions. In this regard, a set of tools for soft governance, stimulation, encouragement, and motivation of national governments in the spirit of continuous improvement of European rules is being formed. A transition to deeper cooperation characterizes the tourism sector, and as part of the EU’s single internal market, conditions are being created for harmonization in those areas, if necessary. The EU as a whole is beginning to define the logic and direc-

tions of the tourism industry, providing support for its initiatives, including financial.

The EU countries have natural differences that affect the structure and level of tourism industry development. Therefore, in the process of integrating and constructing a single internal market, institutional convergence can only concern certain parameters of tourism functioning, such as the quality of service or infrastructure. However, as noted earlier, the assessment and analysis of the factors of asymmetric development are necessary to develop individual measures for countries to support the tourism industry, complementing the actions of national governments. Based on this, initiatives can be launched that bring together groups of countries distinguished by their similarity. Besides, an assessment of development asymmetry will take into account the unevenness,

Table 1. List of selected indicators for assessing the EU tourism industry, 2019

Source: Eurostat.

Indicators	
1. Number of establishments, number (x1).	15. Number of establishments by degree of urbanization (towns and suburbs), number (x15).
2. Number of bed places, number (x2).	16. Number of establishments by degree of urbanization (rural areas), number (x16).
3. Annual enterprise statistics by size class for special aggregates of activities (accommodation), enterprises – number (x3).	17. Number of bed places by degree of urbanization (cities), number (x17).
4. Annual enterprise statistics by size class for special aggregates of activities (accommodation), persons employed – number (x4).	18. Number of bed places by degree of urbanization (towns and suburbs), number (x18).
5. Employed persons by full-time/part-time activity, thousand, total – all NACE activities (x5).	19. Number of bed places by degree of urbanization (rural areas), number (x19).
6. Employed persons by educational attainment level (tertiary education), thousand (employed persons) (x6).	20. Number of establishments, coastal area, number (x20).
7. Permanency of job (permanent or temporary) (air transport), total, thousand (x7).	21. Number of establishments, non-coastal area, number (x21).
8. Permanency of job (permanent or temporary) (accommodation), thousand (unlimited duration of an employment contract) (x8).	22. Number of bed places, coastal area, number (x22).
9. Permanency of job (permanent or temporary) (accommodation), thousand (limited duration of an employment contract) (x9).	23. Number of bed places, non-coastal area, number (x23).
10. Permanency of job (permanent or temporary) (accommodation and food service activities), thousand (unlimited duration of an employment contract) (x10).	24. Nights spent at tourist accommodation establishments (hotels; holiday and other short-stay accommodation; camping grounds, recreational vehicle parks, and trailer parks), total, number (x24).
11. Permanency of job (permanent or temporary) (accommodation and food service activities), thousand (limited duration of an employment contract) (x11).	25. Nights spent at tourist accommodation establishments (hotels; holiday and other short-stay accommodation; camping grounds, recreational vehicle parks, and trailer parks), total, per thousand inhabitants (x25).
12. Permanency of job (permanent or temporary) (travel agency, tour operator, and other reservation service and related activities), thousand (unlimited duration of an employment contract) (x12).	26. Nights spent at hotels and similar accommodation by size class, number (x26).
13. Permanency of job (permanent or temporary) (travel agency, tour operator, and other reservation service and related activities), thousand (limited duration of an employment contract) (x13).	27. Arrivals at tourist accommodation establishments, number (x27).
14. Number of establishments by degree of urbanization (cities), number (x14).	

Note: Data for all countries: x3 and x4 – 2018. Data for Greece: x1-x4, x14-x24, x26, x27– 2018; x25 – 2017. Data for Ireland: x1, x2 – 2018, x24-x27 – 2016. Data for Croatia: x7 – 2014. Data for Cyprus: x7 – 2018. Data for Latvia: x7, x12 – 2018. Data for Estonia: x7 – low reliability. Data for Luxembourg: x12, x24-x27 – 2018.

fragmentation, and polarization in the development of the tourism industry, which will eliminate gaps and inconsistencies and optimize its geographic and typical structure throughout the EU.

Assessment and determination of asymmetry factors in the development of the tourism industry of the EU member states is expected to be carried out from different positions in three stages.

At the first stage, it is planned to demonstrate a high level of heterogeneity in the parameters of development and functioning of the EU tourism industry. For this, a list of 27 indicators of official statistics provided by Eurostat was chosen (Table 1).

The indicators are selected to cover the assessment of tourism potential, infrastructure, employment, and business activity, including the degree of urbanization, attitudes towards the coastal zone, and tourist travel intensity. The selected indicators are heterogeneous and specific. The nature of their interconnections (dependence) and mutual influence is not taken into account; horizontal equality and equal significance of all indicators are considered. There are no duplicate and mutually exclusive parameters and indicators at which saturation or minimal demand is possible. In general, the set of selected indicators is representative.

The heterogeneity of the parameters is estimated based on the asymmetry coefficient, which is presented in the Microsoft Excel program and is calculated as follows:

$$K_a = \frac{n}{(n-1)(n-2)} \sum \left(\frac{x_j - \bar{x}}{\sigma} \right), \quad (1)$$

where n is the number of observations, x_j is the current value of the factor (feature), \bar{x} is the average value of the factor (feature), and σ is a root-mean-square deviation (standard deviation).

The coefficient returns the distribution asymmetry and characterizes the degree of asymmetric distribution relative to its mean. Positive asymmetry indicates a deviation of the distribution towards positive values.

At the second stage, it is planned to cluster the EU countries in terms of development and func-

tioning of their tourism industries. The clustering aims to divide objects (countries) into clusters, which demonstrates the asymmetry of the population. This is because each cluster is formed so that the objects in it would be most similar to each other and not similar to the objects included in other clusters. As a result, this not only produces the characteristic of an object by assigning it to a particular cluster (which includes objects most similar to this one) but also demonstrates the asymmetry of the whole set of objects. The set is divided into relatively homogeneous groups, which shows their difference (remoteness) and allows one to compare clusters.

The basis for the clustering of EU countries will be a multidimensional set of empirical data on selected indicators that characterize their tourism industry (Table 1). This set of parameters satisfies the following conditions: consistency, completeness, and sufficiency in describing object properties. Based on the specifics of the data set, a k-means algorithm was chosen for the clustering countries, which is effective when the data form compact clumps that differ well from each other (Everitt et al., 2011). In this case, the data will be normalized.

Clustering was performed using the k-means algorithm presented on Science Hunter (<http://sciencehunter.net>). To get correct results, one must check the data quality and determine the optimal number of clusters before using the clustering algorithm. Data quality is checked based on three-dimensional visualization built using the principal component analysis and multidimensional scaling and allows one, with some allowable curvatures, to maintain the basic structural relationships between objects of different clusters. The optimal number of clusters is determined based on the calculation of many special design criteria (the sum of squared errors index, the trace index, the Dunn index, the Davies-Bouldin index, the Calinski-Harabasz index, and PBM index). To check the data quality and determine the optimal number of clusters, the Science Hunter web portal tools (<http://sciencehunter.net>) are also used.

At the third stage, it is planned to classify the obtained clusters (classes) of EU member states in terms of development and functioning of the tour-

ism industry. The classification aims to determine the indicators that most distinguish all clusters and can be considered the main factors of asymmetric development of the EU tourism industry. The classification is based on mathematical data processing by the logical-combinatorial method of decision trees (Vasylenko & Shevchenko, 1979), as it allows one to choose relatively small combinations of indicators with the maximum, if possible absolute, discriminating ability (information content), which indicates the most significant differences between clusters. The basis for the classification is the obtained training sample (TS), presented in the form of a table of empirical data according to the list of selected indicators (Table 1) and taking into account the distribution of countries by classes based on the clustering results. The informativeness of the TS and all its indicators was evaluated, and combinations with the maximum discriminating ability were selected based on the corresponding tools presented on Science Hunter.

The informativeness of arbitrary groups of parameters is calculated by the formula:

$$V(x_{i1}, \dots, x_{ij}) = \frac{1}{k} \sum_{\Delta \in \Gamma} \max_Y \left(\frac{m_{\Delta Y}}{m_Y} \right), \quad (1)$$

where k is the number of classes (clusters), m_Y is the number of objects belonging to class (cluster) Y , $\Delta = t_{i1}, t_{i2}, \dots, t_{ij} (0 \leq t_{ij} \leq k_{ij} - 1)$, $j = 1, \dots, \Gamma$ means the arbitrary set of parameter values $x_{i1}, \dots, x_{ij} (1 \leq \Gamma \leq n)$, $m_{\Delta Y}$ denotes the number of sampling sets of the m class, for which the relation $x_{ij} = t_{ij} (j = 1, \dots, \Gamma)$ is performed, t_{ij} are the values of parameters x_{ij} in the set of Δ , Γ means variety of all sets of parameter values x_{i1}, \dots, x_{ij} .

The assessment performed by formula (1) allows selecting the combinations of parameters with the highest discriminating ability. In fact, these will be the main factors in the asymmetric development of the EU tourism industry.

Thus, the results of all three stages should confirm and evaluate the asymmetric development of the tourism industry in the EU from different perspectives. This is subject to research and management objectives, which allows considering the specifics of individual countries in terms of support for this industry and optimizing the spatial

structure of the development of this industry and tourist flows in the EU.

4. RESULTS

The first stage is the calculation of the asymmetry coefficient. This ratio was calculated using the Microsoft Excel computer program. The calculation results presented in Table 2 indicate a high level (positive value of the coefficient is close to or above 2) of asymmetry in the distribution of selected indicators for evaluating the tourism industry throughout the EU.

Table 2. The results of calculating the asymmetry coefficient of indicators for assessing the EU tourism industry

K_a				
x1: 3,442	x7: 2,400	x13: 2,123	x19: 2,277	x25: 1,667
x2: 1,980	x8: 2,969	x14: 4,651	x20: 3,135	x26: 1,995
x3: 1,528	x9: 2,010	x15: 3,974	x21: 3,528	x27: 1,999
x4: 2,718	x10: 2,276	x16: 2,489	x22: 2,076	
x5: 2,352	x11: 2,510	x17: 1,966	x23: 2,114	
x6: 2,066	x12: 3,511	x18: 2,471	x24: 1,849	

The second stage is the clustering of the EU countries according to the tourism industry assessment indicators. Based on the three-dimensional visualization and design criteria, the optimal number of clusters was adopted – 8. Mathematical processing using the k-means algorithm (metric – Euclidean distance) showed the division of the EU countries into clusters (Table 3).

Table 3. Clusters of the EU countries according to tourism industry assessment indicators*

Clusters	EU member states
I	Italy
II	Spain
III	Germany, France
IV	Croatia
V	Greece, Portugal
VI	Cyprus, Malta
VII	The Netherlands, Poland
VIII	Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Ireland, Latvia, Lithuania, Luxembourg, Hungary, Romania, Slovenia, Slovakia, Finland, Sweden

Note: * The order number of the cluster does not characterize the absolute level of development of the tourism industry and its importance for the economy of a particular country.

Clustering has shown a high degree of asymmetry in development and a diverse spatial picture of the development of the tourism industry. The largest centers of attraction for tourists from around the world – Italy and Spain – are divided into separate clusters; this indicates a high development level of the tourism industry and tourism intensity. Despite significant differences in the tourism industry structure, Germany and France are united in one cluster, as they were relatively close to each other and relatively far from other countries and clusters. Croatia, which is one of the most popular destinations for international tourism and is very far from other countries, especially of comparable scale, has also stood out in a separate cluster due to the extremely high level of indicators characterizing its tourism industry, which is one-fifth of GNP in this country. Italy, Spain, Germany, France, and Croatia are many times higher than other EU countries in most indicators, but they naturally differ in the structural proportions of tourism. Clusters V (Greece and Portugal), VI (Cyprus and Malta), and VII (the Netherlands and Poland) included the countries with similar levels of indicators and structural proportions of the tourism industry due to the natural conditions and scale of these countries. The rest of Cluster VIII countries are similar in terms of most tourism industry indicators due to their size and geographic location. Simultaneously, even considering structural differences, Bulgaria entered the cluster due to similar indicators with other countries in this group, even those where coastal tourism is not developed.

The third stage is the classification of the obtained clusters of EU countries according to the appraisal indicators of the tourism industry in order to find the main factors of asymmetric development. Qualitative distribution of a set of countries into clusters gives grounds to find the indicators by which all clusters differ the most. The assessment of the quality of TS showed its high informativeness – 100%. This indicates the possibility of finding relatively small (not more than four indicators) combinations with absolute discriminating ability. As a result of classification processing using the decision trees method, seven combinations of three indicators in each were identified, namely 1) “ x_2 - x_3 - x_{25} ”; 2) “ x_2 - x_4 - x_{25} ”; 3) “ x_2 - x_{11} - x_{25} ”; 4) “ x_2 - x_{13} - x_{25} ”; 5) “ x_3 - x_{20} - x_{25} ”; 6) “ x_3 - x_{22} - x_{26} ”; and 7) “ x_4 - x_{19} - x_{25} ”. The indicators included in these

combinations can be considered the main factors in the asymmetric development of the EU tourism industry. To assess the degree of asymmetry in development, it is advisable to compare these indicators between clusters (Table 4). The asymmetry coefficient, additionally calculated for Cluster VIII countries, showed a much higher degree of country homogeneity.

The most common indicators in the selected combinations are x_2 (the main indicator characterizing the infrastructure component of tourism potential), x_3 (the main indicator characterizing business activities and the number of entities that provide services, which is also part of tourism potential), and x_{25} (the indicator that was basic characterizing intensity of tourism).

It should be noted that during the study, the EU countries were experimentally divided into four and six clusters. Classification according to the results of these divisions allowed identifying other combinations with absolute discriminating ability, consisting of two indicators, namely:

when divided into four clusters: “ x_1 - x_2 ”, “ x_1 - x_3 ”, “ x_1 - x_6 ”, “ x_1 - x_7 ”, “ x_1 - x_9 ”, “ x_1 - x_{10} ”, “ x_1 - x_{12} ”, “ x_1 - x_{13} ”, “ x_1 - x_{17} ”, “ x_1 - x_{18} ” (the “Number of establishments” parameter clearly had an advantage in the asymmetry of countries in combination with other indicators); when divided into six clusters: “ x_1 - x_{24} ”, “ x_1 - x_{26} ”, “ x_3 - x_5 ”, “ x_3 - x_6 ”, “ x_{13} - x_{16} ”, “ x_{14} - x_{26} ”, “ x_{15} - x_{24} ”, “ x_{15} - x_{26} ”, “ x_{16} - x_{26} ”, “ x_{20} - x_{26} ”. These results also indicate the multifaceted asymmetry in the development of the EU tourism industry. Therefore, the search for combinations can be carried out adaptively to different control and research problems. This paper is based on the division into eight clusters, which is more in line with natural conditions, country scale and economic reasons.

5. DISCUSSION

The study results allow considering the EU countries and their groups, bearing in mind the asymmetry in the development and functioning of their tourism industries, as well as the main factors that give rise to such heterogeneity. The obtained results can be used in at least three areas. First,

Table 4. Parametric analysis of the main asymmetry factors in the development of the EU tourism industry by the obtained clusters

Countries (cluster)	Indicators included in combinations that completely distinguish all clusters									
	x2	x3	x4	x11	x13	x19	x20	x22	x25	x26
Italy (I)	5175803	53623	295889	414,9	8,3	1812248	114809	2942775	7235,63	280937897
Spain (II)	3638875	26966	322472	500,7	9,6	880939	18479	2530107	10009,44	342995595
Germany (III)	3594701	46546	616755	182,4	13,8	1508396	8117	708562	5263,3	306848903
France (III)	5098729	51354	224803	177,2	8,9	2861202	8025	2019792	6663,7	219255965
Croatia (IV)	1157870	3368	39171	33,1	1,4	776393	104775	1052425	22368,15	25904793
Greece (V)	1340451	29158	145492	84,2	1,9	1011537	35512	1262926	10333,35	89905217
Portugal (V)	671644	37408	107590	85,4	3	197412	4225	515822	7550,56	59946819
Cyprus (VI)	90188	627	22644	8,3	0,1	35202	642	85098	20063,6	17571292
Malta (VI)	48096	494	8299	2,5	0	944	244	48096	20081,25	9600059
The Netherlands (VII)	1412906	9559	89655	146,9	2,5	592627	2912	485724	7142,77	54402830
Poland (VII)	825522	16380	80295	135,9	3,2	344694	2700	225779	2458,15	53717139
Cluster VIII										
Austria	1038208	16260	121821	32,3	1	728412	0	0	14436,6	95267629
Belgium	395585	3662	24837	43,4	1,3	115722	642	51074	3711,12	20794744
Bulgaria	341506	4916	45871	17,1	0,3	119974	1565	233259	3879,23	24922811
Czech Republic	743737	10204	37963	24	1,1	430238	0	0	5354,54	42008870
Denmark	436011	1621	23986	15,6	0,9	311759	1096	403093	5912,01	17067618
Estonia	60957	919	7130	1,4	0	28487	804	41297	5258,86	5541070
Ireland	207974	4010	62068	29,3	1,1	87838	1524	131714	6581,42	26264513
Latvia	55800	1055	7570	0,9	0,1	22403	528	35269	2869,67	4318094
Lithuania	108488	3370	9406	0,9	0	48932	1015	31769	3201,92	4818166
Luxembourg	62609	272	3476	1,3	0,1	45063	0	0	4850,87	1714113
Hungary	414233	4724	31252	12	0,1	148795	0	0	3397,2	25807181
Romania	351161	6418	51677	4,4	0,2	108726	1163	93362	1539,57	24328701
Slovenia	186590	3815	13142	10,1	0,7	91567	1863	30650	7572,99	8263114
Slovakia	206104	3414	14882	13	0,4	104394	0	0	3160,37	11843846
Finland	257041	2056	11838	14,9	1,1	139278	434	79516	4185,57	18759853
Sweden	823331	4999	55972	58,9	1,4	456760	1961	453119	6175,38	39515192
K_g (Cluster VIII)	1,182	1,991	1,796	1,217	0,155	1,791	0,298	1,809	2,225	2,297

clustering allows for the development of the EU supranational tourism policies concerning relatively homogeneous groups of countries. This allows forming programs to support the tourism industry based on group coordination and cohesion. Within the clusters that can be considered an independent object of support, the search for asymmetric development factors or other types of parametric analysis can also be done to understand the profiles of individual countries. Second, the classification is useful in assessing differences between the EU countries and finding growth points and drivers of tourism competitiveness in

the European economy. Third, both clustering and classification are ways of assessing the competitive environment of the EU tourism industry and tools for positioning countries throughout the EU. In general, the obtained results allow applying a differentiated approach to the support of the tourism industry of various countries by the EU, quantifying their features. Adapting tourism support programs to the specificities of individual countries and their groups will ultimately increase the effectiveness of supranational policies and help unite countries in meeting modern challenges.

CONCLUSION

A three-stage approach is proposed to assess and highlight the main factors of asymmetry in the development of the EU tourism industry in the context of a supranational policy. As a result of calculating the asymmetry coefficient at the first stage, a high level of unevenness in the development and functioning of the EU tourism industry was confirmed for all 27 selected indicators. As a result of clustering at the second stage, the countries were divided into eight clusters: I – Italy; II – Spain; III – Germany, France; IV – Croatia; V – Greece, Portugal; VI – Cyprus and Malta; VII – the Netherlands and Poland; and VIII – the rest of the EU. The selected groups showed the structure of differences between countries in terms of the tourism industry indicators. The cluster classification obtained at the third stage allowed identifying ten combinations of three indicators with absolute discriminating ability. All indicators included in these combinations can be considered the main factors of asymmetric development of the EU tourism industry. The most frequently used combinations were indicators such as: “Number of bed places, number” (characteristics of the infrastructure component of tourist potential); “Annual enterprise statistics by size class for special aggregates of activities (accommodation), “Enterprises – number” (entrepreneurial activity characteristics) and “Nights spent at tourist accommodation establishments (hotels; holiday and other short-stay accommodation; camping grounds, recreational vehicle parks, and trailer parks), total, per thousand inhabitants” (tourism intensity characteristics).

The proposed approach to the analysis of asymmetry factors in the development of the EU tourism industry and the obtained results can be a basis for further theoretical and practical analytical studies, for developing supranational policy measures to support the tourism industry in individual countries and their groups. They also characterize the spatial tourism economy and the marketing environment of the European tourism market. Further research plans to use the proposed approach in analyzing asymmetry factors in the development of international hotel chains.

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REFERENCES

- Algieri, B., Aquino, A., & Succurro, M. (2016). Drivers of comparative advantages in tourism: The EU-case. *Annals of Tourism Research*, 61, 247-250. <https://doi.org/10.1016/j.annals.2016.09.006>
- Amaral, R., & Serra, J. (2019). Back to the Same Place of Holidays. An Analysis of European Tourists' Preferences Towards Cultural Tourism. In *Trends in Tourist Behavior. Tourism, Hospitality & Event Management*. Springer, Cham. https://doi.org/10.1007/978-3-030-11160-1_12
- Andria, J., Tollo, G., & Pesenti, R. (2019). A Fuzzy Evaluation of Tourism Sustainability. In *Business and Consumer Analytics: New Ideas*. Springer, Cham. https://doi.org/10.1007/978-3-030-06222-4_24
- Antolini, F., & Grassini, L. (2020). Methodological problems in the economic measurement of tourism: the need for new sources of information. *Quality & Quantity*, 54, 1769-1780. <https://doi.org/10.1007/s11135-019-00962-x>
- Aytuğ, H.K., & Mikaeili, M. (2017). Evaluation of Hopa's Rural Tourism Potential in the Context of European Union Tourism Policy. *Procedia Environmental Sciences*, 37, 234-245. <https://doi.org/10.1016/j.proenv.2017.03.039>
- Barišić, P., & Cvetkoska, V. (2020). Analyzing the Efficiency of Travel and Tourism in the European Union. In *Advances in Operational Research in the Balkans. Springer Proceedings in Business and Economics*. Springer, Cham. https://doi.org/10.1007/978-3-030-21990-1_10
- Barrios, S., & Ibañez, J.N. (2015). Time is of the essence: adaptation of tourism demand to climate change in Europe. *Climatic Change*, 132, 645-660. <https://doi.org/10.1007/s10584-015-1431-1>
- Batista e Silva, F., Marín-Herrera, M. A., Rosina, K., Ribeiro Baranco, R., Freire, S., & Schiavina, M. (2018). Analysing spatio-temporal patterns of tourism in Europe at high-resolution with conventional and big data sources. *Tourism Management*, 68, 101-115. <https://doi.org/10.1016/j.tourman.2018.02.020>
- Boghean, C., & State, M. (2019). Statistical Correlation between Tourism and Poverty in EU Countries. In *Caring and Sharing: The Cultural Heritage Environment as an Agent for Change. Springer Proceedings in Business and Economics*. Springer, Cham. https://doi.org/10.1007/978-3-319-89468-3_6
- Breiling, M. (2020). A Contingent Resource-Based Perspective of Tourism Value Chain and Robustness: European Experiences. In *Supply Chain Resilience*. Springer, Singapore. https://doi.org/10.1007/978-981-15-2870-5_8
- Díaz-Carrión, R., Navajas-Romero, V., & Casas-Rosal, J.-C. (2020). Comparing working conditions and job satisfaction in hospitality workers across Europe. *International Journal of Hospitality Management*, 90. <https://doi.org/10.1016/j.ijhm.2020.102631>
- Estol, J., & Font, X. (2016). European tourism policy: Its evolution and structure. *Tourism Management*, 52, 230-241. <https://doi.org/10.1016/j.tourman.2015.06.007>
- Everitt, B., Landau, S., Leese, M., & Stahl, D. (2011). *Cluster Analysis*. John Wiley & Sons Ltd.
- Ferrante, M., Lo Magno, G.L., & De Cantis, S. (2018) Measuring tourism seasonality across European countries. *Tourism Management*, 68, 220-235. <https://doi.org/10.1016/j.tourman.2018.03.015>
- Gabor, M. R., Conțiu, L., & Oltean, F. D. (2012). A Comparative Analysis Regarding European Tourism Competitiveness: Emerging Versus Developed Markets. *Procedia Economics and Finance*, 3, 361-366. [https://doi.org/10.1016/S2212-5671\(12\)00165-7](https://doi.org/10.1016/S2212-5671(12)00165-7)
- Holleran, M. (2020). *Tourism, Urbanization, and the Evolving Periphery of the European Union*. Palgrave Pivot, Singapore. <https://doi.org/10.1007/978-981-15-0218-7>
- Kuliš, Z., Šimundić, B., & Pivčević, S. (2018). The Analysis of Tourism and Economic Growth Relationship in Central and Eastern European Countries. In *Economy, Finance and Business in Southeastern and Central Europe. Springer Proceedings in Business and Economics*. Springer, Cham. https://doi.org/10.1007/978-3-319-70377-0_37
- Li, X., & Law, R. (2020). Network analysis of big data research in tourism. *Tourism Management Perspectives*, 33. <https://doi.org/10.1016/j.tmp.2019.100608>
- Lyócsa, Š., Vašaničová, P., & Litavcová, E. (2019). Interconnectedness of international tourism demand in Europe: A cross-quantile network approach. *Physi-*

- ca A: *Statistical Mechanics and its Applications*, 526. <https://doi.org/10.1016/j.physa.2019.04.155>
20. Malec, L., Hamarneh, I., Poživil, J., & Pavlíček, A. (2020). Comparative analysis of the accommodation capacities in selected European tourist destinations. *Problems and Perspectives in Management*, 18(1), 345-358. [http://dx.doi.org/10.21511/ppm.18\(1\).2020.30](http://dx.doi.org/10.21511/ppm.18(1).2020.30)
21. Mayer, M., Zbaraszewski, W., Pieńkowski, D., Gach, G., & Gernert, J. (2019). Cross-Border Politics and Development in the European Union with a Focus on Tourism. In *Cross-Border Tourism in Protected Areas. Geographies of Tourism and Global Change*. Springer, Cham. https://doi.org/10.1007/978-3-030-05961-3_3
22. Mazaraki, A., Boiko, M., Bosovska, M., Vedmid, N., & Okhri-menko, A. (2018). Formation of the national tourism system of Ukraine. *Problems and Perspectives in Management*, 16(1), 68-84. [http://dx.doi.org/10.21511/ppm.16\(1\).2018.07](http://dx.doi.org/10.21511/ppm.16(1).2018.07)
23. Melián-González, S., & Bulchand-Gidumal, J. (2020). Employment in tourism: The jaws of the snake in the hotel industry. *Tourism Management*, 80. <https://doi.org/10.1016/j.tourman.2020.104123>
24. Mura, L., & Kljucnikov, A. (2018). Small Businesses in Rural Tourism and Agrotourism: Study from Slovakia. *Economics and Sociology*, 11(3), 286-300. <https://doi.org/10.14254/2071-789X.2018/11-3/17>
25. Nicolescu, L., & Ana, M-I. (2018). The Effects of European Integration in the Tourism Industry: Consequences of the Last Accession Waves. In *Doing Business in Europe. Contributions to Management Science*. Springer, Cham. https://doi.org/10.1007/978-3-319-72239-9_13
26. Nielsen, T. S., & Kaae, B. C. (2008). Tourism geography in Europe. In *Sustainability Impact Assessment of Land Use Changes*. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-78648-1_10
27. Park, S., Xu, Y., Jiang, L., Chen, Zh., & Huang, Sh. (2020). Spatial structures of tourism destinations: A trajectory data mining approach leveraging mobile big data. *Annals of Tourism Research*, 84. <https://doi.org/10.1016/j.annals.2020.102973>
28. Pasquinelli, C., & Bellini, N. (2017). Global Context, Policies and Practices in Urban Tourism: An Introduction. In *Tourism in the City*. Springer, Cham. https://doi.org/10.1007/978-3-319-26877-4_1
29. Pitchayadejanant, K., & Nakpathom, P. (2018). Data mining approach for arranging and clustering the agro-tourism activities in orchard. *Kasetsart Journal of Social Sciences*, 39(3), 407-413. <https://doi.org/10.1016/j.kjss.2017.07.004>
30. Robaina, M., & Madaleno, M. (2019). Resources: Eco-efficiency, Sustainability and Innovation in Tourism. In *The Future of Tourism*. Springer, Cham. https://doi.org/10.1007/978-3-319-89941-1_2
31. Robaina, M., Madaleno, M., Silva, S., Eusébio, C., Carneiro, M.J., Gama, C., Oliveira, K., Russo, M.A., & Monteiro, A. (2020) The relationship between tourism and air quality in five European countries. *Economic Analysis and Policy*, 67, 261-272. <https://doi.org/10.1016/j.eap.2020.07.012>
32. Roskladka, A., Roskladka, N., Dluhopolskyi, O., Kharlamova, G., & Kiziloglu, M. (2018). Data analysis and forecasting of tourism development in Ukraine. *Innovative Marketing*, 14(4), 19-33. [http://dx.doi.org/10.21511/im.14\(4\).2018.02](http://dx.doi.org/10.21511/im.14(4).2018.02)
33. Ruukel, A., Reimann, M., & Tooman, H. (2020). Rural Tourism as a Tool for Sustainable Development: Lessons Learned in Estonia. In *Tourism Development in Post-Soviet Nations*. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-30715-8_2
34. Shaheen, K., Zaman, K., Batool, R., Khurshid, M. A., Aamir, A., Shoukry, A. M., Sharkawy, M. A., Aldeek, F., Khader, J., & Gani, S. (2019). Dynamic linkages between tourism, energy, environment, and economic growth: evidence from top 10 tourism-induced countries. *Environmental Science and Pollution Research*, 26, 31273-31283. <https://doi.org/10.1007/s11356-019-06252-1>
35. Sokhanvar, A. (2019). Does foreign direct investment accelerate tourism and economic growth within Europe? *Tourism Management*, 29, 86-96. <https://doi.org/10.1016/j.tourman.2018.10.005>
36. Van der Schyff, T., Meyer, D., & Ferreira, L. (2019). An analysis of impact of the tourism sector as a viable response to South Africa's growth and development challenges. *Journal of International Studies*, 12(1), 168-183. <https://doi.org/10.14254/2071-8330.2019/12-1/11>
37. Vasilenko, Y. A., & Shevchenko, H. Y. (1979). Analytical Method for Test Finding. *Avtomatika*, 2, 3-8.
38. Weiss, R., Zuzik, J., Weiss, E., Labant, S., & Gergeľová, M. (2018). Analyzing the risk of entrepreneurship in tourist traffic. *Problems and Perspectives in Management*, 16(1), 199-206. [http://dx.doi.org/10.21511/ppm.16\(1\).2018.19](http://dx.doi.org/10.21511/ppm.16(1).2018.19)
39. Xu, X., Law, R., Chen, W., & Tang, L. (2016). Forecasting tourism demand by extracting fuzzy Takagi-Sugeno rules from trained SVMs. *CAAI Transactions on Intelligence Technology*, 1(1), 30-42. <https://doi.org/10.1016/j.trit.2016.03.004>
40. Yan, L., Gao, B.W., & Zhang, M. (2017). A mathematical model for tourism potential assessment. *Tourism Management*, 63, 355-365. <https://doi.org/10.1016/j.tourman.2017.07.003>
41. Zenker, S., & Kock, F. (2020). The coronavirus pandemic – A critical discussion of a tourism research agenda. *Tourism Management*, 81. <https://doi.org/10.1016/j.tourman.2020.104164>