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Analysis of Cross-Border Regional Homogeneity and Its Effects on Regional Resilience and Competitiveness

With the Western Transdanubian region (HUN) and Burgenland (AUT) as examples

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Abstract. The resilience of a region may affect how it reacts to economic crises and exogenous shocks. In a complex study, it is not sufficient merely to have knowledge of all the macro-indices of the regions, but it is also necessary to study internal micro-structures. This study introduces the regional homogeneity index, using a novel approach and as yet unused indicators by means of the example of two neighbouring NUTS 2 statistical regions. The results can be useful for understanding the regions' economic development. The methodology and indicators created may also be suitable for European regional pilot research projects.[1]

Keywords: homogeneity, heterogeneity, regional resilience, competitiveness, Western Transdanubia, Burgenland

JEL Classifications: R11, R12, R58

1. Introduction

In recent years, many international studies (Dawley et al., 2010; Foster, 2010; Gunderson & Holling, 2002; Martin & Simmie, 2010) have concentrated on research into the resilience of regions. In their analyses, they were looking for an answer to how the regions react to the economic challenges of the business environment. Studies and models found in the literature (Martin, 2010; Pendall et al., 2007) usually interpret and examine the whole region as a single entity. The

1 The research was accomplished with the support of the Pallas Athéné Geopolitical Foundation.

indices used in the models track the temporal changes of the economic indicators concerning the whole region.

In the course of the foregoing regional studies, numerous questions have remained unanswered: When analysing competitiveness, is it proper to examine the region inherently as a single entity? Do the homogeneity and heterogeneity of regions influence their resilience and competitiveness? Which new endogenous variables could influence the resilience and competitiveness of regions? Is it possible to create a new methodology starting from the territorial level (lower than the regional) with which answers could be obtained to these questions? How could all these be incorporated into a regional development policy?

To answer these questions, the authors were looking for the most important indicators which define the strength of a region and play a role in obtaining a successful response to crisis situations. According to the authors' basic suppositions, the social and economic homogeneity of the regions play an important role in this. In this research, two regions have been analysed on the NUTS 2 level (second planning and statistical level of the Nomenclature of Territorial Units for Statistics developed by the European Union), the Burgenland region in Austria and the Western Transdanubian region in Hungary, and the NUTS 3 territories (third level of NUTS, Hungarian counties and Austrian political districts) located within the NUTS 2 regions. 225 surveys from Western Transdanubia and 74 from Burgenland proved to be suitable for analysis.

The indices most typical of the region were examined for determining environmental and corporate functioning using factor analysis and their territorial distribution within the region using cluster analysis. The study compared the results obtained with official statistical data (KSH-TEIR;[2] Statistik Austria; Bundesministerium für Verkehr, Innovation und Technologie[3]). The extent to which the given region is homogeneous or heterogeneous was measured according to the results of the factor analysis. For further investigations and analyses, the authors propose a new methodology and a regional homogeneity index.

At the beginning of the study, it was assumed that with regard to their (economic, social, etc.) development the NUTS 2 planning and statistical regions do not always consist of NUTS 3 territories which are on an equal level or are developing at the same pace; the resilience of the regions and the way they react to crisis are determined by the development level, response capability,

2 Központi Statisztikai Hivatal – Országos Területfejlesztési és Területrendezési Információs Rendszer [Hungarian Central Statistical Office – National Local Developmental and Integrational Information System].

3 Federal Ministry of Austria for Transport, Innovation and Technology.

and resilience of the NUTS territories which frame them. The interaction of these areas influences the resilience level of a region.

A more detailed examination of the territorial structures making up the region was considered to be necessary in order to receive a more realistic picture of the competitiveness and resilience of the regions.

It was assumed that besides the indicators which fundamentally influence the resilience of the regions ("hard elements") there also exist other indices not primarily of an economic nature ("soft elements"), which can be coupled with the adaptability of the regions and thus influence their resilience as well.

It is believed that the indices deemed most important by the local society may be defined in every region, and these indices have an effect on the environmental, economic, social, and cultural development of the location and on companies' adaptability and their own development.

In the authors' opinion, the indices most closely associated with the development of individual regions may be defined using this new methodology as well as their influence on the homogeneity or heterogeneity of the regions.

The remainder of the paper is organized as follows. The next section expounds in detail what is known so far about regional resilience, competitiveness, and homogeneity. Section 3 describes the definition of a homogeneous or heterogeneous region, and Section 4 presents the bases of the applied methodology. Section 5 presents the principal component and cluster analysis, Section 6 describes the regional homogeneity index (RHI) and Section 7 the results. Section 8 contains the comparative analysis of the Western Transdanubian and Burgenland regions. Finally, Section 9 concludes, and Section 10 recommends further research opportunities.

2. On Regional Resilience, Competitiveness, and Homogeneity

In the international literature, the concept of regional resilience has been approached differently by many authors (Foster, 2007; Hill et al., 2008; Christopherson et al., 2010; Hassink, 2010). It has also been interpreted and defined in a variety of ways. The investigation of regional resilience is a new line of research, which is still in an initial phase even for the researchers who have been dealing with the topic. There is no settled, universally accepted definition either.

Path dependence theories set up in the course of resilience investigations have examined the historical background to the development of crises (Pendall, 2007), the effect of the vision created by certain social systems on the development of a region (Grabher, 1993), and the structural change ensuing in the region (Martin, 2010). The success of the structural change, however, depends on how local companies and institutions are able to form an alliance.

For decades, the international literature has been dealing with the concept of competitiveness, and there are international institutions and periodically or continuously published international studies which have specialized in ranking the various countries of the world in terms of their competitiveness.

The measurement of competitiveness is a complex analysis, difficult to measure with only one indicator, but it can give us an overview of the skills and development level of a given area (Lengyel, 2000).

3. A Homogeneous or Heterogeneous Region

When the homogeneity of a region was defined by the authors, the demarcation of the given area was based on the similarity principle. If a spatial structure was characterized by identical economic, social, and natural elements as well as similar values, which exist continuously and permanently, then we have been dealing with a homogeneous region or area, but if these features visibly differed or diverged from one other, then it would be considered a heterogeneous region. The homogeneity or heterogeneity of a region was established by using statistical and mathematical methods.

We definitely need a partition of spaces since homogeneous space does not exist. "Social space is generated by human acts, but humans are different from the perspective of their age, gender, educational level, mother tongue, religion, habits, tastes and a million other factors" (Dusek, 2004); so, in general, spaces should be considered as heterogeneous.

Examples of the indicators used for the examination of regional inequality and orderliness are the dual indicator (Éltető–Frigyes index), weighted relative scatter, logarithmic scatter, the Hoover index and its "relatives", and the Gini index. Each indicator takes different factors into consideration, but it is difficult to use them for wide-ranging regional comparative analysis (Nemes Nagy, 2009).

4. Methodology

The proper selection and weighting of index numbers is a key issue. Indices which were characteristic of the region as a whole were chosen, were independently weighted, or, in the case of indicators, used for comparing the regions. These specific indices were made independent of the size of the region and capable of depicting individual changes as a function of time.

The questionnaire method was chosen for framing the indicators. By means of 30 questions asked in the employed questionnaire survey, it was examined how the regions' residents judge the situation and adaptability of their own region. The structure of the questionnaire was compiled on the pattern of the worldwide "GLOBE" survey, which is a cultural survey extending to 62 countries with the aid of distinctive culture variables and socio-economic development indicators (Bakacsi, 2006), with the very significant difference that the questions were focused on the micro-level – in the present case, on the town level. The NUTS 2 regional level data were composed by collecting the data systematized at the NUTS 3 level. Although with the questionnaire method the answers are rather subjective, this subjectivity was considered very important as in the case of an answer given in a regional crisis situation the motivation and willingness to develop shown by workers in the towns can be crucial. In the analysis, these subjective answers were also compared in a random check with the official statistical data in order to assess whether the picture formed in the minds of the regions' residents was corroborated by the official statistical data.

5. Principal Component and Cluster Analysis

The population of the Western Transdanubian Region is 3.5 times that of the Burgenland Region, and the number of towns is 2.5 times as much. 225 questionnaires from the Western Transdanubian Region (77.3% of the respondents coming from settlements with over 3,000 residents) and 74 from the Burgenland Region (36.5% from settlements with over 3,000 people) could be included in the investigation, with 8,970 data points in total being subject to examination. The interrelationship and connection of the data with each other and their influence on one another was discovered by correlation analysis, clarification of the data set was performed by principal component analyses, and regional grouping of the obtained results was carried out by cluster analyses. The correlation matrix value of the data included in the examination was 450 items. In the examination of the regions, those of the indices for responses given to external influences or crises which could be highlighted by the performed principal component analysis were the ones which are in close correlation relationship with one another and which are the most characteristic of the given region. 6 principal components were determined in the Western Transdanubian Region and 2 principal components in the Burgenland Region. With the cluster analyses, however, the regional distribution of these closely correlated indices was determinative. For the given region, those of the most characteristic indices according to the respondents were subjected to further examination, which decisively determine the economic and social condition of the region and for which regular, periodic, and officially provided statistical data were also available. Besides these, certain process indicators appeared which cannot always be expressed with exact index numbers, but they still have an influence on the economic processes and social image of the region. These components refer to, for instance, the sophistication, morale, and satisfaction of the region's population and form an important part of the investigation into the region. The investigations were also extended to how much of a role is played in the development of the individual regions by traditions, community beliefs, systems of cultural norms in communities, and behaviour patterns inherited and passed on to descendents.

6. Regional Homogeneity Index (RHI)

Since usage of the listed indices is limited, in this study, an index has been elaborated which can be used for measuring regional inequality and could also be equally suitable for the examination of various features of individual regions. Having designated the "regional homogeneity index" (RHI), it does not depend on the unit of measurement for the parameters, and it can be used uniformly because it shows the homogeneity or heterogeneity of the given area by the divergence from the average value and – patterned after analysis of variance – by the 30 percentage change from the quotient of the average value.

In examining a certain economic indicator, for instance, the temporal change in economic development, the following has been determined based on the answers given in the questionnaire:

The average of the results from the answers in the NUTS 2 region (*Figure 1*), which is a total of the answers given on a scale from 1 to 7, divided by the number of persons who filled in the questionnaire:

$$\overline{x_R} = \frac{\sum_{i=1}^{n} x_i}{n}$$

R = the given NUTS 2 region
n = number of elements in the NUTS 2 region

Source: the authors' own editing

Figure 1. *Average of the answers from the NUTS 2 region*

The average of the results from the answers in the NUTS 3 territories (*Figure 2*), which is a total of the answers given on a scale from 1 to 7, divided by the number of persons who filled in the questionnaire:

$$\overline{x_{T_1}} = \frac{\sum_{j=1}^{m} x_j}{m}$$

T_1 = the first NUTS 3 region tested
m = number of elements in the first NUTS 3 region

⋮

$$\overline{x_{T_r}} = \frac{\sum_{k=1}^{o} x_k}{o}$$

T_r = number of NUTS 3 regions
o = number of elements in the given NUTS 3 region
$n = m + \cdots + o$

Source: the authors' own editing

Figure 2. *Averages of the answers from the NUTS 3 territories*

The above formulae define, first of all, the averages of the results for all the NUTS 2 regions examined with respect to the targeted indices (*Figure 1*); then, following this, they test how big the average is for the NUTS 3 regions making up the NUTS 2 regions, i.e. within the NUTS 2 regions, with respect to the same targeted indices. The average of the result for every NUTS 3 region located in the examined NUTS 2 regions has been calculated (*Figure 2*).

The extent of the differences between the results of the NUTS 3 and NUTS 2 territorial averages (*Figure 3*), which consists of the disparities between the average *R* of the NUTS 2 region and each of the averages of the NUTS 3 territories:

$$|RAE_1| = \bar{x}_R - \overline{x_{T_1}}$$

RAE_1 = the difference of the first NUTS 3 region from the average for the NUTS 2 region
R = given NUTS 2 region
T_1 = the first NUTS 3 region tested

⋮

$$|RAE_r| = \bar{x}_R - \overline{x_{T_r}}$$

RAE_r = the difference of the r[th] NUTS 3 region from the average for the NUTS 2 region
R = given NUTS 2 region
T_r = r[th] NUTS 3 region tested
r = number of NUTS 3 regions

Source: the authors' own editing

Figure 3. *Formulae for the difference from the region average*

With the above formulae, therefore, it can be calculated how big the differences are between the average of the results obtained in the NUTS 2 region and the averages of the results for the NUTS 3 regions making up that NUTS 2 region. These differences have been recorded. For the sample variance analysis, the acceptable limiting value of the difference was set at 0.3. This limiting value may also be defined in other ways, of course, but in general it is advisable for the limiting value to be smaller than the difference from the average and 30% of the quotient of the average. If $|RAE_r| \geq 0.3$, then the given NUTS 3 region exceeds the limiting value of 0.3, which means the results of the given NUTS 3 region average deviate by 30 or more percent from the average of the NUTS 2 region. These excess values were marked within the NUTS 2 region with *KE* (number of critical deviations, "Kritikus Eltérés" in Hungarian) (*Figure 4*).

$$\frac{KE}{r} = RHI_a$$

RHI = region homogeneity index for a variable within the principal component

KE = number of critical deviations

a = number of principal component variables

r = number of NUTS 3 regions

Source: the authors' own editing

Figure 4. *Formula for the regional homogeneity index (RHI) for the variables in the principal components*

With respect to the variable within the principal component, the above formula shows the average number of "critical deviations" of the average of the results for the NUTS 3 regions within a given NUTS 2 region from the average results of the NUTS 2 region.

The RHI was calculated for every single principal component variable, which means "a" times, the RHI value being expressed as a percentage (%) in all cases (*Figure 5*).

$$\frac{\sum_{l=1}^{a} RHI_l}{a} = RHIF$$

RHI = region homogeneity index for a variable within the principal component

a = number of principal component variables

$RHIF$ = region homogeneity index for the whole principal component

Source: the authors' own editing

Figure 5. *Formula for the regional homogeneity index, calculated for the whole principal component*

If all of the NUTS 3 territorial data in a NUTS 2 region are *within* the limiting value, the region is considered to be *homogeneous*.

If less than 35% of the NUTS 3 territorial data in a NUTS 2 region diverge from the regional average to a greater extent than the limiting value, the region is considered to be *weakly heterogeneous* (mildly unsettled).

If more than 35% but less than 70% of the NUTS 3 territorial data in a NUTS 2 region diverge from the regional average to a greater extent than the limiting value, the region is considered to be *heterogeneous* (unsettled).

If more than 70% of the NUTS 3 territorial data in a NUTS 2 region diverge from the regional average to a greater extent than the limiting value, the region is considered to be *strongly heterogeneous* (highly unsteady).

The differences from the average calculated with the regional homogeneity index provide the opportunity to examine not only the homogeneity but also the direction and extent of the difference from the average, thus enabling a deeper analysis of the region.

With the help of this method, the homogeneity or heterogeneity of a region can be easily estimated. It must be accepted, however, that only an informative picture, a first impression of a region can be obtained using this method with regard to the fact that the behaviour of individual areas may be defined to varying degrees of strength by many indices.

7. Results

Principal Component Analysis of the Western Transdanubian Region

During the principal component analysis of the data, 30 variables and 225 item numbers were processed. In the analysis of the correlation matrix, the strength of the correlations between the variables was weak or moderately strong in general, the highest correlation value being 0.740. Of the 420 values in the matrix, 266 values were below the smallest significance level of 0.05, which is 63.33%, and 214 were below 0.01, which is 50.95% of the variables. The items located on the diagonal in the anti-image correlation matrix and in the principal component analysis – the MSA (*measure of sampling adequacy*) values corresponding to these were between 0.556 (educational level) and 0.858 (cultural development). The examination of the KMO criterion (Kaiser–Meyer–Olkin criterion) came out to 0.731, which means that the data are adequate for the principal component analysis, as was also confirmed by Bartlett's test (^{2} = 1433.665, df = 153, p = 0.00).

In order to determine the number of principal components, the Varimax rotation method was used with Kaiser normalization. Of the 30 variables, 18 proved to be relevant indices at a factor weight limit of 0.4, and in the end 6 principal components were determined, the cumulative variance of which was 68.81%. The variances of the individual principal components fell between 12.89% and 10.16%, which were found to be adequate in every case. Each constituent of every principal component has a positive value in the rotation matrix, so its importance exercises a positive effect on the given area or cluster.

Table 1. *Regional and settlement-environmental characteristics of the Western Transdanubian Region – the constituents of the principal components*

Principal components		***Weight****
Area development and presence of interest representation	Purposefulness of town development	0.755
	Representation of residents' interests with the regional leadership	0.708
	Economic development of the region in the past 5 years (2009–2014)	0.679
	Cultural development of the region in the past 5 years (2009–2014)	0.501
Presence of educational and cultural programmes	Extent of education above the basic level (8 years) in the region	0.741
	Organization of cultural programmes in the region	0.717
	Attitude of the population to the importance of further education	0.710
Equal opportunities and lack of corruption	Equal opportunity for women with secondary school graduation certificate at most	0.833
	Equal opportunity for women with diploma/degree	0.767
	Lack of corruption among regional leadership	0.763
Healthy population with good living standards	Low morbidity rate in the region	0.811
	Significance of healthy lifestyle among the population	0.664
	Population's standard of living in the past 5 years (2009–2014)	0.531
Future- and environmentally aware population	Effect of company activity on the region's development	0.843
	Development of environmental awareness in the region in the past 5 years (2009–2014)	0.649
	The population's future awareness	0.589
Adequate infrastructure	The road network and road conditions in the region	0.831
	Infrastructure development in the region in the past 5 years (2009–2014)	0.826

**Note: at a communality value above 0.500 and a factor weight limit of 0.400*

Source: authors' own editing

In the 6 principal components, 18 variables were found which were in close relationship and thus played a dominant role in determining the regional and settlement-environmental characteristics of the Western Transdanubian Region (*Table 1*).

Cluster Analysis of the Western Transdanubian Region (Using Ward's Method)
Following the examination of the principal components, the occurrence of the most important characteristics in the settlements of the given region was investigated with cluster analysis. The cluster analysis was carried out using Ward's method, in consideration of the fact that no prior information was available regarding the number of clusters to be formed; so, the hierarchical analysis method was the procedure to be chosen. When classifying the settlements in detail at the cluster level, a total of 255 settlement data were classified into 4 clusters (*Table 2*).

The examination of the settlements classified into the clusters showed that in general the major cities of the region have significant dominance and that these possess positive power for determining development, whilst the small settlements lag behind the above cities, which represent a driving force for the region. The detailed cluster analyses enable a detailed examination of the connection systems between the cities.

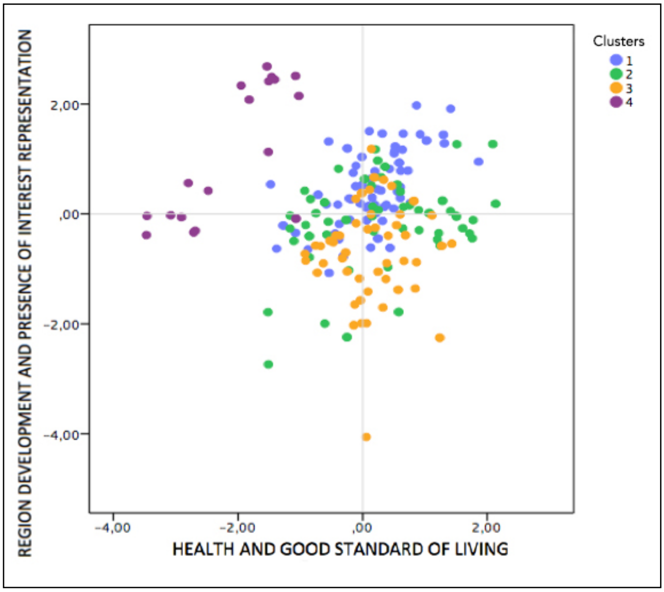
Table 2. *Clusters defined on the basis of the regional and settlement-environmental characteristics of the Western Transdanubian Region*

Principal components	**1 (79 items)**	**2 (67 items)**	**3 (59 items)**	**4 (20 items)**
Regional development and presence of interest representation	0.4127	-0.1637	-0.6985	0.9787
Presence of educational and cultural programmes	0.2769	0.2388	-0.3922	-0.7367
Equal opportunities and lack of corruption	0.7592	-0.3884	-0.3260	-0.7358
Health and good standard of living	0.1284	0.2846	0.2124	-2.0872
Appropriate future and environmental awareness	0.1981	-0.9542	0.9192	-0.2975
Adequate infrastructure	0.5058	-0.6563	-0.0137	0.2411

Source: authors' own editing

During the hierarchical cluster analysis, the cluster with the largest positive cluster value may be regarded as the definitive factor for the region (e.g. the 4th cluster in the principal component: "Regional development and presence of interest representation").

The scatter of the principal component values in a negative direction (e.g. 3rd and 4th cluster) shows that there is a significant difference in the settlements within the region in the assessment of the importance of development and a healthy lifestyle. On the scatter chart produced from this (*Figure 6*), the powerful scatter of the principal component elements is clearly seen, which indicates the division or heterogeneity of the region from this point of view.



Source: authors' own editing, using SPSS

Figure 6. *Examination of the environmental characteristics of the Western Transdanubian Region – the scatter of the principal component elements by cluster within the principal components "Regional development and presence of interest representation" and "Health and good standard of living"*

Principal Component Analysis of the Burgenland Region

The principal component analysis was performed with 75 item numbers and the same 30 variables. In the correlation analysis, weak and in a few cases moderate correlation values were obtained, the highest being 0.661. Of the 420 values in the matrix, 157 (below the significance level of 0.05) and 104 (below the significance level of 0.01) values proved to be significant (which is 37.38% and 24.76% of all the values), which means that relatively few factors correlated with one another.

Taking into account the principal component analysis information loss criteria and those related to its MSA values and after testing the data set four times, 6 variables proved to be suitable for analysis. The KMO criterion (0.787) and Bartlett's test (χ^2 = 128.800, df = 15, p = 0.00) confirmed the adequacy of the data. The MSA values of the anti-image correlation matrix fall between 0.835 (health consciousness) and 0.661 (corruption). When using the Varimax rotation method, two principal components were determined, where 67.94% of the total information content was retained, which can be regarded as acceptable, and the variances of the individual principal components were 41.73% and 26.22%. The values obtained with the orthogonal rotation procedure feature positively in the matrix, thus exercising a positive influence on the Burgenland Region (*Table 3*).

Table 3. *Regional and settlement-environmental characteristics of the Burgenland Region – constituents of the principal components*

Principal components		**Weight***
Settlement and infrastructure development, presence of healthy lifestyle	Purposefulness of town development	0.857
	Infrastructure development in the region in the past 5 years (2009–2014)	0.797
	Motivation for town development among the residents	0.776
	Significance of a healthy lifestyle for the residents	0.690
Environmental awareness and lack of corruption	Lack of corruption among regional leadership	0.865
	Environmentally aware development of the region over the past 5 years (2009–2014)	0.772

* Note: at a communality value above 0.500 and a factor weight limit of 0.650

Source: authors' own editing

Cluster Analysis of the Burgenland Region (Using Ward's Method)

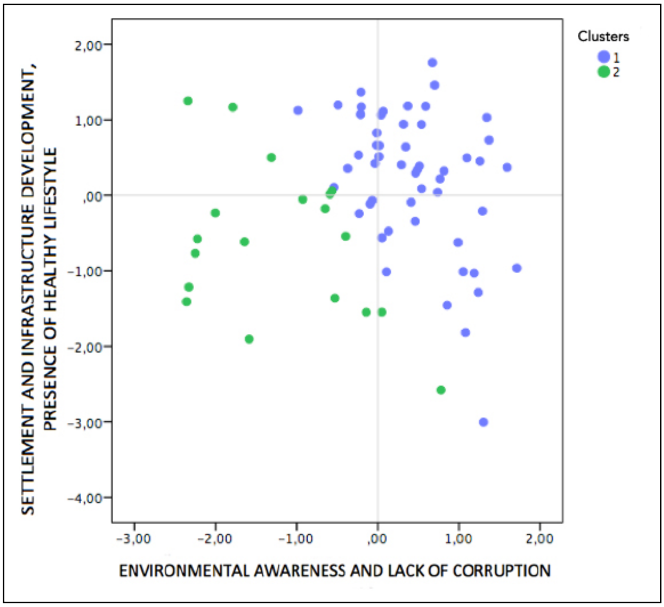
The cluster analysis classified the 74 element numbers into two clusters – the positive and negative values of these can be seen in *Table 4*.

Table 4. *Clusters defined on the basis of regional and settlement-environmental characteristics for the Austrian Burgenland Region*

Principal components	**1 (55 items)**	**2 (19 items)**
Settlement and infrastructure development, presence of healthy lifestyle	0.2099	-0.6076
Environmental awareness and lack of corruption	0.4147	-1.2005

Source: authors' own editing

The results point back to the principal component results previously determined for the region, as the dominant cluster with the largest number of elements carries the same values, according to which the importance of environmental awareness and the lack of corruption here too show a correlation with settlement and infrastructure development and with the presence of a healthy lifestyle.



Source: authors' own editing, using SPSS

Figure 7. *Examination of the environmental characteristics of the Burgenland Region – the scatter of the principal component elements by cluster within the principal components "Environmental awareness and lack of corruption" and "Settlement and infrastructure development, presence of healthy lifestyle"*

The divergent negative values of primarily the north Burgenland towns belonging to the 2nd cluster show a looser connection of the indices belonging to both principal components, all this suggesting that those who were questioned in the Burgenland Region are not of a fully uniform opinion on settlement and infrastructure development and on environmental awareness. Even so, these two principal components were conceived as a highlighted question based on the overall close connection in the whole region, which is caused by the dominance of the 1st cluster with its large number of elements. All this is clearly seen in *Figure 7*, where the elements of the two clusters are sharply separated from one another, at the same time showing scatter in the positive and negative directions.

8. Comparative Analysis of the Western Transdanubian and Burgenland Regions

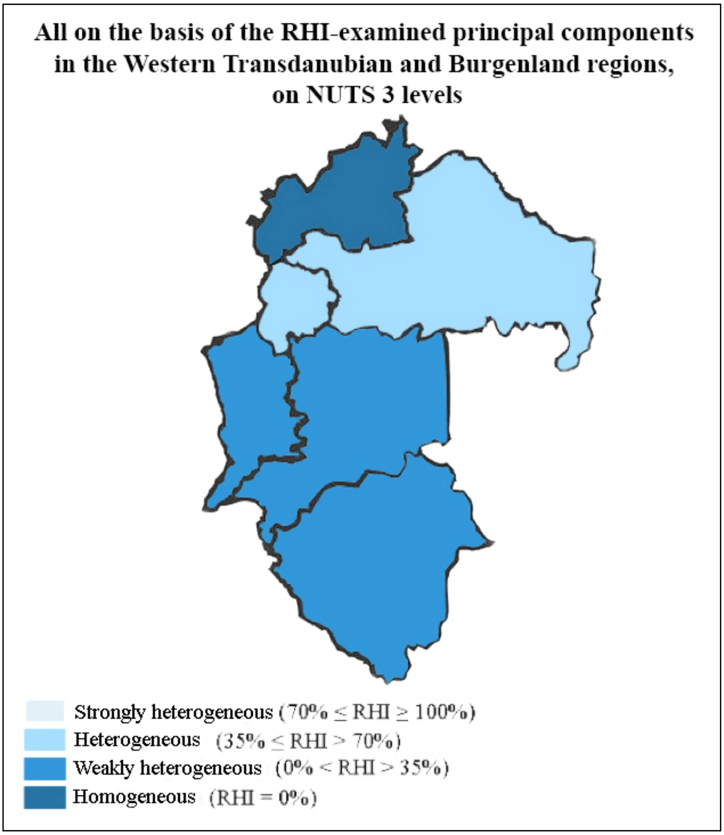
The homogeneity investigations performed on the principal components defined the following results for the two NUTS 2 regions (*Table 5*).

Table 5. *Combined examination of the principal components analysed in the Western Transdanubian and Burgenland regions, on NUTS 3 territorial levels*

Combined examination of the principal components analysed in the Western Transdanubian region, on NUTS 3 levels						
NUTS 3	*"Area development and presence of interest representation"*	*"Healthy population with good living standard"*	*"Existence of business culture"*	*"Developed companies, healthy, future-conscious and tradition-keeping employees"*	RHI (average of principal components, percentage (%)	Characterization
Győr-Moson-Sopron County	0%	33.33%	80%	60%	43%	heterogeneous
Vas County	25%	0%	80%	20%	31.25%	weakly heterogeneous
Zala County	25%	33.33%	0%	60%	29.8%	weakly heterogeneous
Combined examination of the principal components analysed in the Burgenland region, on NUTS 3 levels						
NUTS 3	*"Environment consciousness and lack of corruption"*	*"Existence of local and infrastructural development, healthy lifestyle"*	*"Developed business culture and public safety"*	*"Developed working conditions, infrastructure, and community participation"*	RHI (average of principal components, percentage (%)	Characterization
North Burgenland	0%	0%	0%	0%	0.00%	homogeneous
Central Burgenland	25%	0%	33.33%	100%	39.58%	heterogeneous
South Burgenland	0%	0%	66.67%	0%	16.67%	weakly heterogeneous

Source: the authors' own editing

The principal components listed by NUTS 3 region in *Table 1* are depicted on the map below (*Figure 8*). As it can be seen, only the respondents from North Burgenland have a similar, homogeneous opinion about their region. Based on the heterogeneous results from the neighbouring Győr-Moson-Sopron County, it can be stated that this Hungarian county needs greater development to attain closer contact with the neighbouring homogenous region and to design and implement more dynamic cross-border schemes and improvements. The same can be said about the Central Burgenland district, the development of which would not only further common developments and cooperation in the cross-border area, but it could also serve the joint interests of the Austrian NUTS 2 province.



Source: the authors' own editing

Figure 8. *Analysis of all of the principal components investigated on the basis of the regional homogeneity index in the Western Transdanubian and Burgenland regions, on the NUTS 3 level*

Weakly heterogeneous results were obtained from the analyses of the South Burgenland district, Vas and Zala Counties, which are likewise immediate neighbours. In these NUTS 3 regions, minor developments are also needed in order to achieve closer, more resilient cross-border cooperation.

9. Conclusions

From a development policy angle, it is not sufficient merely to be familiar with regional indices, but as detailed a knowledge as possible of the inner structure of the region is also necessary. Using a complex methodology, the internal attributes of a region which would otherwise be difficult to measure may be recognized and investigated. New indicators may be configured, which make a complex definition of the competitiveness, flexibility, and efficiency of a region as well as a more successful regional development policy, more precise and sensitive. The methodology and indicators thus developed may be useful in the future for research uses in European regional-level "pilot" projects.

It has been proven empirically that in the regions studied, based on the most important economic and social characteristics, the NUTS 3 units do not all have identical vitality, and the values of their indices do not correspond to those of the NUTS 2 level indicators. The study has determined the most important properties typical of the regions investigated as well as their distribution within the region. A close relationship has been demonstrated in the regions studied between development and the main characteristics of the region, as detected in the principal component analyses. The study has determined the homogeneity of the regions studied and found that both national and regional data are available for defining economic efficiency. At the same time, the NUTS 3 data provided by the population and needed for examining additional indicators which define the life of the regions are very difficult to access and are incomplete in some areas.

It has been confirmed that the spatial structures making up the regions may differ from one another, the groups of major characteristics defining their development as obtained by the principal component analysis are also different, but those typical of the region in question and the distribution of these gave differing results by cluster analysis within each group of attributes. It has been confirmed that investigation and analysis of the spatial structures making up the regions are necessary in order to gain a realistic picture of the competitiveness and flexibility of the regions.

By examining the regional principal components obtained by correlation analysis and principal component analysis, the research has confirmed that, besides the indicators of an economic nature, there are important "soft" indicators in all the regions, which could be linked with the development of the regions.

In the regions studied, it is possible to determine the regional, environmental, and business qualities considered to be the most important by the surveyed population, and based on their correlations the research has ascertained that the economic and social development in all the regions studied may be linked with public awareness about development and with future environmental awareness and motivation. In addition, the economic development of the region could be correlated with the impact of business activities.

Methods were selected for performing a complex analysis of the regions used as a sample in order to determine the indicators which could best be correlated with the development of individual regions, the relationship strengths of these, the distribution of relationship strengths within a region, as well as regional heterogeneity and homogeneity. A series of formulae can be worked out for uniformly defining the flexibility, competitiveness, and efficiency of the regions, but this requires further complex analysis, to lay the groundwork for which it could be proposed the following, additional opportunities for research into the calculation methodology to be studied.

10. On the Way towards a Reinterpretation of Regional Competitiveness

The methods of investigation employed may open up a new way into examining the competitiveness of the regions. In the authors' view, the competitiveness of a region depends on adaptability, which itself depends on how flexible the region is, how quickly it can respond to external and internal changes.

The resilience of the region, the indices defining the flexibility can thus be linked with the competitiveness of the region and the indicators defining this. Therefore, it was investigated which indicators may play a role in the resilience of the individual regions according to the people who live there (the question being asked in an indirect sense) and whether these may really be proposed as a new research line in determining the competitiveness of the regions.

As Professor Imre Lengyel writes: competitiveness can be predicted mainly by the growth of market share, profitability, and business success (Lengyel, 2000). The definition of the prosperity indicator is the subject of further research; according to some authors, changes in prosperity can be measured in terms of the results of economic policy (e.g. profit, price index, unemployment, export, etc.) (Batey–Friedrich, 2000). Regional competitiveness is thus defined fundamentally by the effectiveness of a region, namely the economic efficiency and the prosperity thus achieved. According to the authors' proposal, the correlation between effectiveness, economic efficiency, and prosperity can be written as follows (*Figure 9*):

$$E_R = E_{ER} \cdot W_R$$

E_R = regional effectiveness
E_{ER} = regional economic efficiency
W_R = prosperity of the regional population

Source: the authors' own editing

Figure 9. *Formula for regional efficiency*

The territorial or regional economic efficiency can be measured by the change over time in the totality of goods produced (GDP) per capita in a given period in the area in question, that is, by how quickly the area is developing over time and how the economy and fiscal capacity of the region are changing. Temporal changes in GDP per capita measured in purchasing power standards (PPS) is an indicator which can be used in territorial units, regions, countries, or even smaller geographical units within a region (e.g. counties) for the sake of comparison. If the test is performed within a country, the GDP and the GDP (PPS) are obviously the same.

In terms of profitability, a region's development may be classified as uniform (homogeneous) or non-uniform (heterogeneous). The goods produced and the degree of economic development also depend on the economic structure of the regions and the sectoral distribution of companies, i.e. in what proportions are the companies operating in the region divided up into agricultural, industrial, and service sectors.

Based on this theory, the following formula can be created for regional economic efficiency:

$$E_{ER} = \Delta \frac{GDP(PPS)_R}{P_R}$$

E_{ER} = regional economic efficiency
$\Delta \frac{GDP(PPS)_R}{P_R}$ = changes in GDP per capita as Purchasing Power Standards (PPS)

Source: the authors' own editing

Figure 10. *Formula for regional economic efficiency*

The temporal changes to and the extent of regional economic efficiency can be measured using the following formula:

$$\Delta \frac{GDP(PPS)_R}{P_R} = \frac{GDP(PPS)_{Rt}}{P_{Rt}} = \frac{GDP(PPS)_{R(t-i)}}{P_{R(t-i)}}$$

t = the year in question

t-i = i^{th} year before the year in question

$GDP(PPS)_R$ = GDP of the region as Purchasing Power Standards (PPS)

P_R = population of the region

Source: the authors' own editing

Figure 11. *Formula for the temporal changes to the economic efficiency of a region*

With the above formulae (*Figure 10* and *Figure 11*), the economic efficiency of a region (E_{ER}) is determined based on the temporal changes in the GDP per capita measured as PPS.

The reactions of the regions to crisis situations, however, depend not only on territorial efficiency but also on the speed and nature of changes and response, which has been formulated as regional resilience (Foster, 2010; Hassink, 2010; Christopherson et al., 2010). Regional development indicators typical of individual countries have also been defined (Srebotnjak et al., 2014). Besides regional efficiency (E_R), therefore, regional resilience (R_R) is also a determining factor in the efficiency analysis of crisis situations (K_R). These can be defined by the following formula:

$$R_R \cdot E_R = K_R$$

R_R = regional resilience

E_R = regional efficiency

K_R = regional crisis efficiency

Source: the authors' own editing

Figure 12. *Formula for a region's crisis efficiency*

The above formula shows that the responses given by a region to crises, i.e. the crisis efficiency (K_R), is influenced both by the efficiency of the region (E_R), which is a function of economic efficiency (E_{ER}) and the prosperity of the population (W_R), and the resilience of the region (R_R) (*Figure 12*).

Regional resilience (R_R) can be influenced by the homogeneity or heterogeneity of the regions (*RHI*) as well as by their adaptability (A_R). The following formula can therefore be written for regional resilience:

$$R_R = A_R \cdot RHI$$

R_R = regional resilience
A_R = regional adaptability
RHI = regional homogeneity index

Source: the authors' own editing

Figure 13. *Formula for a region's resilience*

The resilience of a region (R_R) depends on the extent of the differences between the state of development and the efficiency of the areas making up the regions (RHI) and how great the adaptability of the region is (A_R) to the crisis, i.e. how quickly it is able to correct a disadvantageous situation (*Figure 13*).

When studying the competitiveness of a region (C_R), the crisis efficiency of a given region (K_R) is compared with the crisis efficiency of the other regions or with the average for the regions. As a formula:

$$C_R = \frac{K_R}{K_{\overline{Ri}}}$$

C_R = regional competitiveness
K_R = regional crisis efficiency
$K_{\overline{Ri}}$ = arithmetic mean of the regional crisis efficiencies in the regions studied

Source: the authors' own editing

Figure 14. *Formula for a region's competitiveness*

Substituting the foregoing formulae into the formula for competitiveness, the following is obtained:

$$C_R = \frac{K_R}{K_{\overline{Ri}}} = \frac{R_R \cdot E_R}{R_{\overline{Ri}} \cdot E_{\overline{Ri}}} = \frac{A_R \cdot RHI \cdot E_R}{A_{\overline{Ri}} \cdot RHI_{\overline{i}} \cdot E_{\overline{Ri}}} = \frac{A_R \cdot RHI \cdot E_{ER} \cdot W_R}{A_{\overline{Ri}} \cdot RHI_{\overline{i}} \cdot E_{\overline{ERi}} \cdot W_{\overline{Ri}}}$$

C_R = regional competitiveness
K_R = regional crisis efficiency
K_{Ri} = arithmetic mean of the regional crisis efficiencies in the regions studied
R_R = regional resilience
R_{Ri} = arithmetic mean of the regional resiliencies in the regions studied
E_R = regional efficiency
E_{Ri} = arithmetic mean of the regional efficiencies in the regions studied
A_R = regional adaptability
A_{Ri} = arithmetic mean of the regional adaptabilities in the regions studied
RHI = regional homogeneity index
RHI_i = arithmetic mean of the regional homogeneity indices in the regions studied
E_{ER} = regional economic efficiency
E_{ERi} = arithmetic mean of the regional economic efficiencies in the regions studied
W_R = prosperity of the regional population
W_{Ri} = arithmetic mean of the prosperities of the regional populations in the regions studied

Source: the authors' own editing

Figure 15. *Formula for a region's competitiveness – in detail*

The above formula illustrates well that when examining the competitiveness of a region (C_R) the complex comparative analysis of another or several other regions is necessary, in which the extent of the crisis efficiency of the region must be examined in comparison with the other (or the others) (K_R/K_{Ri}). The crisis efficiency (K_R) can in turn be expressed with the regional resilience (R_R) and the regional efficiency (E_R). When comparing the regional resilience (R_R), it is proposed that the regional adaptability (A_R) and the regional homogeneity index (R_{HI}) be examined. The regional efficiency (E_R) can in turn be expressed with the regional economic efficiency (E_{ER}) and the prosperity of the population living there (W_R).

In the formula for competitiveness, economic efficiency (E_{ER}) can be determined according to *Figure 9* and further substituted.

In the course of further research, the principal component analyses defined by the methods described may take us closer to clarifying and justifying the above competitiveness and flexibility equations as well as to justifying additional indices, significant from the point of view of the region's crisis efficiency (K_R).

It is essential to try out the *methods* used in the study and to do further research on the proposed *regional homogeneity index* within the scope of regional pilot projects on a European level in order to ascertain whether this idea is suitable for comparing a larger number of regional units. The results may help with comparative analysis of regional competitiveness. All this could provide motivation for collective development and ensure new grounds for efficient distribution and usage of cross-border resources.

The efficiency of the NUTS 3 regions within a NUTS 2 region needs further investigation in order to produce a comparative economic efficiency analysis and to determine the prosperity of the regional population. These studies could help to find indicators that can be used to determine the adaptability and resilience of the regions.

Taking these into account, it would be possible to benchmark the competitiveness of the regions. Furthermore, it would be possible to resolve the differences between the states of development of the cross-border territories. All this could encourage joint development and provide new foundations for the allocation and use of cross-border resources.

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