Statistical Analysis on the Competitiveness of the Hungarian Sub-regions

MIKLÓS LUKOVICS
Institute of Economics and Economic Development
Faculty of Economics and Business Administration, University of Szeged
H-6722 Szeged, Kálvária sgt. 1.
Hungary
miki@eco.u-szeged.hu

Abstract

An obvious consequence of the globalization lies in the fact that the upvaluation of the local level exercises an increasing effect as the domain giving space to key problems, where the long-term competitive advantages of companies are concentrated and where local players can realize their ideas on economic development by joint action. In fact, **local regions** are the primary examination areas of economic advantages, within which changing jobs is possible without having to change residence (within the same commutation area). Consequently, regional analyses must devote increasing attention to studying local regions. The concept of competitiveness that, due to the special attributes of global competition, has become one of the central terms in economics, offers an opportunity for the analysis of local regions. Excellent competitiveness reports are completed each year at country level, however, in the case of studying regional competitiveness, focus must fall on smaller and smaller spatial units.

The present paper aims to develop an indicator system and a complex method to measure the competitiveness of local units. We try to demonstrate inequality among the Hungarian sub-regions (local level) with the help of multi-variable data analyzing methods based on a determined system of viewpoints, a correctly chosen theoretical model (the pyramidal model of regional competitiveness) and statistical data. When weighting the indicators, we used a weighting system that was used for this reason first ever, following the logic of the correctly chosen theoretical model. In the course of our work, using cluster analysis, MDS, factor analysis etc. the 168 Hungarian sub-regions will be classified according to their development phases.

Key words: regional competitiveness, spatial analysis, local units, typology of sub-regions

1. Introduction

Paralell to the globalization, knowledge-based economy seems to represent a highly important ground-gaining force – quasi becoming a trendy buzzword – that attracts increasing attention in developed countries, although its forms vary in different regions owing to the differing situation and set of conditions of the given area and the new type of international specialization emerging as a result of global competition. All this leads to a reinterpretation of the significance assumed by **local conditions**, as well. This is a fundamental factor at the level of local units, since competitiveness is determined by knowledge base on the local level.

The **upvaluation of the local level** exercises an increasing effect as the domain giving space to key problems, where the long-term competitive advantages of companies are concentrated and where local players can realize their ideas on economic development by joint action. In fact, local units are the primary examination areas of economic advantages, within which changing jobs is possible without having to change residence (within the same commuting area). Consequently, regional analyses must devote increasing attention to studying local units.

An obvious consequence of the above said, based on international experience, it can be said that considering the starting position and conditions of local units, different region types are likely to host highly different development paths, and economic development based on knowledge production can be expected to occur only in few regions. Today, spatial planning receives increasing attention, since completed spatial documents create the basis for winning the European Union's sources allocated for spatial units of different agglomeration levels.

For the success of national regional development, it is essential to be able to assess complex spatial processes as precisely as possible. The outstanding role of **precise situation analysis with development purposes** is beyond doubt, as the different nature of the starting conditions demands different interventions and strategies of economic development in the different regions. In order to achieve successful long-term performance in the global competition, regions characterized by differences in competitiveness must follow different paths. In fact, deriving from their significantly different departing positions, they cannot be handled with the help of a standard action plan on economic development. Beyond competitiveness types, increasing emphasis must also be lent to the position that the examined region assumes along the urban-rural dimension in harmony with international practice, since mainly large towns and their catchment areas prove to be successful in the global competition.

2. Theoretical background of the analysis

Due to the special attributes of global competition, the notion of regional competitiveness has become one of the central terms in economics. This offers an opportunity for the analysis of local units. The European Union's 2007-2013 programming period also devotes special attention to competitiveness as well as improving its influencing factors in order to facilitate cohesion and catching up ([1], [2], [3], [4]). International literature obviously ties analyzing the spatiality of economic influences to **competitiveness** and thoroughly designed models are available especially for the analysis of countries' competitiveness.

At country level, excellent competitiveness reports are completed each year, however, in the case of studying regional competitiveness, focus must fall on smaller and smaller

spatial units. Towns and town areas constitute the obvious basic units of such analyses, since the competitiveness of a country or region is mostly determined by towns, whose competitiveness tends to significantly exceed the competitiveness of the areas situated among them. International surveys dealing with the competitiveness of towns have also pointed out that the competitiveness of towns is also defined by the agglomeration area surrounding the town core that can be regarded as a nodal region, and therefore, is difficult to handle in the case of empirical analyses ([21], [22], [23]). Sub-regions as administrative-statistical spatial units mostly correspond to the category of local unit as an economic criterion; however, the boundaries of these obviously somewhat differ from the actual economic catchment areas. Based on all this, **the present paper analyzes the competitiveness of Hungarian sub-regions**.

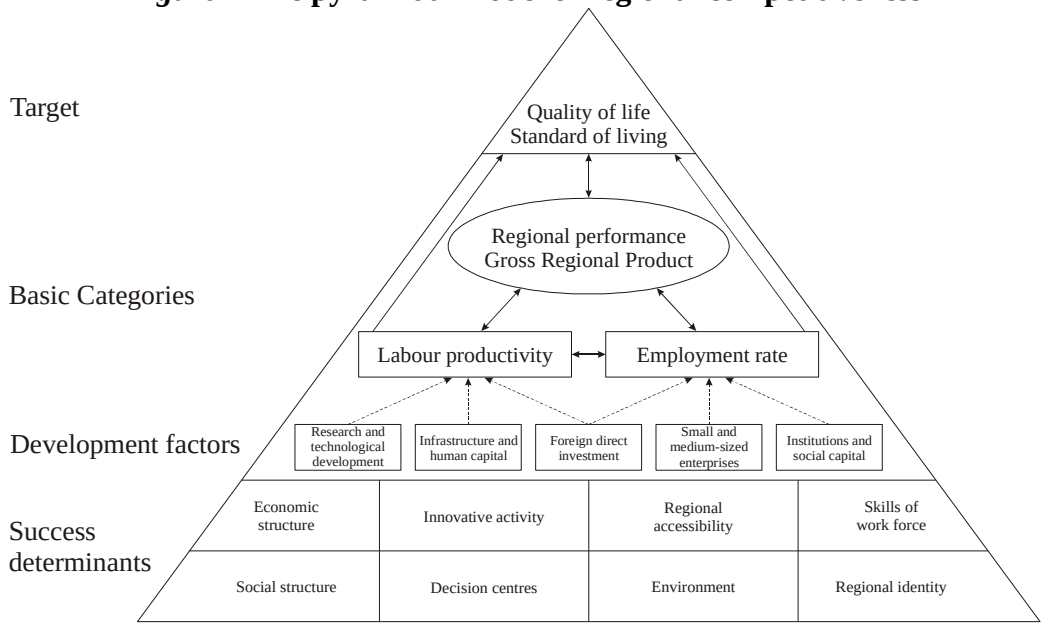
There are several, well known definitions of regional competitiveness, which interpret the approach of competitiveness on territorial units variously. Perhaps, the approach of regional competitiveness, published in the Sixth Periodic Report of the EU is based on the widest consensus: *"The ability of companies, industries, regions, nations and supra-national regions to generate, while being exposed to international competition, relatively high income and employment levels"* ([1], p. 75.). In our research we depend on this standard definition of competitiveness, which is increasingly used in the regional policy of the European Union ([16], [2]). The final output of the analysis becomes less attackable if the selected definition receives wide recognition among professionals, and the analysis is characterized by a consistent use of concepts. The theoretical foundedness of the analysis may largely grow if a solid and also widely accepted pattern that is built on the selected concept and this way coordinates the formation of indicators in a closed logical system can be inserted between the applied concept and the final indicators. Depending on the selected concept and the goal of the analysis, Porter's diamond model, the pyramid model ([13]), the competitiveness cylinder ([18]), etc. can serve this objective. In the course of reviewing competitiveness studies, the clarity, simple structure and refinement of analyses based on certain models became apparent.

To carry out an analysis of competitiveness, there are more and more clear-out models, which can serve as the basis of an empirical research. The above mentioned standard definition and the resulting economic indicators enable us to measure competitiveness fairly precisely. The **pyramidal model of regional competitiveness** seeks to provide a systematic account to describe the basic aspects of improved competitiveness ([13]). The development (programming) factors and success determinants placed in the model reinforce prejudice significantly regional disparities ([1]). Because of the logical framework (figure 1), and transparency of the pyramidal model based on wide professional consensus, it is serving as the basis of our empirical research. The model is internationally highly respected, it is more and more used as a theoretical basis of several competitiveness reports, spatial documents, decision preparation papers etc ([6], [7], [8]). The pyramidal model, with its original logic and figure has been utilized in a governmental document of the United Kingdom ([24]), however, the basic model – published in 2000 – has been rethought and developed by several authors during their research ([9], [22]).

In fact, the pyramid model is **built upon the standard definition of competitiveness** selected as the basis of the analysis, it follows the structure of input-output-outcome corresponding to the relevant international recommendations ([28]), its structure follows a simple but at the same time strict logic, and its elements can easily be transformed into indicators at the level of local units, as well. From the aspect of analyzing local units, the strength of the model lies in integrating a great number of factors outside economy. It is

exactly this level that proves especially heterogeneous in the case of sub-regions; therefore, in the empirical analyses of sub-regions, examining input factors must receive great emphasis.

Figure 1 **The pyramidal model of regional competitiveness**



Source: [13].

Due to its logical structure, manageability, transparency and wide recognition, the pyramid model of regional competitiveness qualifies for becoming the basis of a competitiveness analysis and revealing causalities as it is also demonstrated by international examples. All this is especially true in regard to local units: based on the results of international and Hungarian efforts to measure regional competitiveness and on the pyramid model, the competitiveness of local units becomes objectively and comparably measurable and assessable in the model. In my opinion, this type of methodological approach is ideally applicable for competitiveness analyses on the county and sub-regional level, reviewing the logical interrelations of economic questions and effects and developing strategic programs.

3. Modeling criteria and database

The paper **introduces a possible method of assessing regional competitiveness using the example of sub-regions**. At the same time, the analysis method based on the pyramid model unfolding the European Union's standard definition of competitiveness also offers a chance **to create a typology of the spatial units and elaborate situation analyses with development purposes**. The empirical application of the developed method also includes creating a **complex competitiveness typology** of the 168 Hungarian sub-regions.

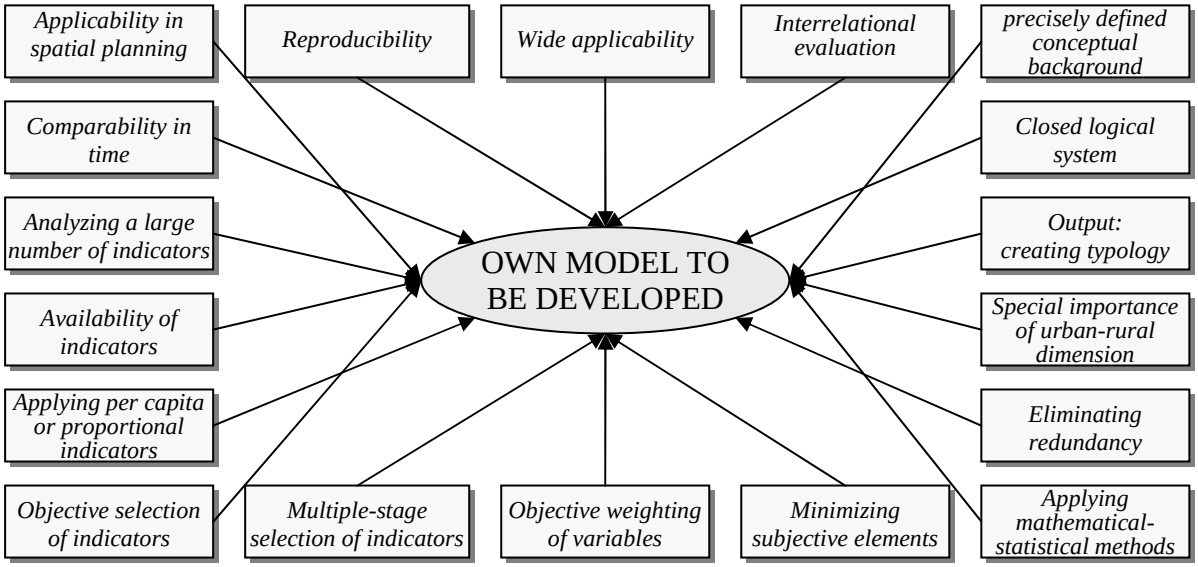
In the following, first of all we will **set up some criteria** required from the own model to be developed, based on the benchmarked national and international competitiveness analysis. Than we will examine the relevancy of the firstly selected indicators, representing the basic categories, development factors and success determinants of the pyramidal model. Than we will demonstrate an attempt to classify the 168 Hungarian sub-regions (LAU-1 level) on their competitiveness, using our own weighting system. Finally, the rate of the useful data in our model will be measured. Before demonstrating our empirical research, some typologies of regions will be presented. The results of the following typologies will be highly considered in our research.

In harmony with their actual survey objective, national works engaging in the analysis of spatial processes on the level of sub-regions approached spatial process and sometimes regional competitiveness **with different sets of terms, index-numbers or systems of index-numbers**, using **different analysis methods**. A significant similarity of the examined approaches lies in the fact that applied indicators **display overlaps**, what leads to the hypothesis that the given indicator(s) is/are really relevant in terms of analyzing spatial processes. It can also be said that the examined analyses do not differ significantly concerning their final conclusions, which suggests that, regardless of their basic scientific branch, the players of regional science tend to perceive spatial processes that took place in Hungary after 1990 similarly, although they emphasize different aspects.

What has been described above shows that so far, **only few attempts focused on analyzing competitiveness on an exclusively sub-regional level in the literature**. However, the number of researchers using a system of index-numbers for analyzing spatial processes is much greater. Furthermore, **analyses display some kind of evolution**, since the mathematical-statistical background of these analyses is increasingly serious. **On the other hand, rather few deal with weighting and differentiating the importance of variables within the model**.

While considering my own methodology to be developed and constructing the model I intended to unite all the advantages of the methods introduced above, and at the same time to eliminate the elements – that I define as disadvantages – that failed to support the construction of a reliable and realistic comprehensive picture of the spatial units to the necessary extent. Based on this, it could be determined what features my model designed for quantifying regional competitiveness is expected to fulfill (figure 2).

Figure 2 **Modeling criteria of measuring regional competitiveness**

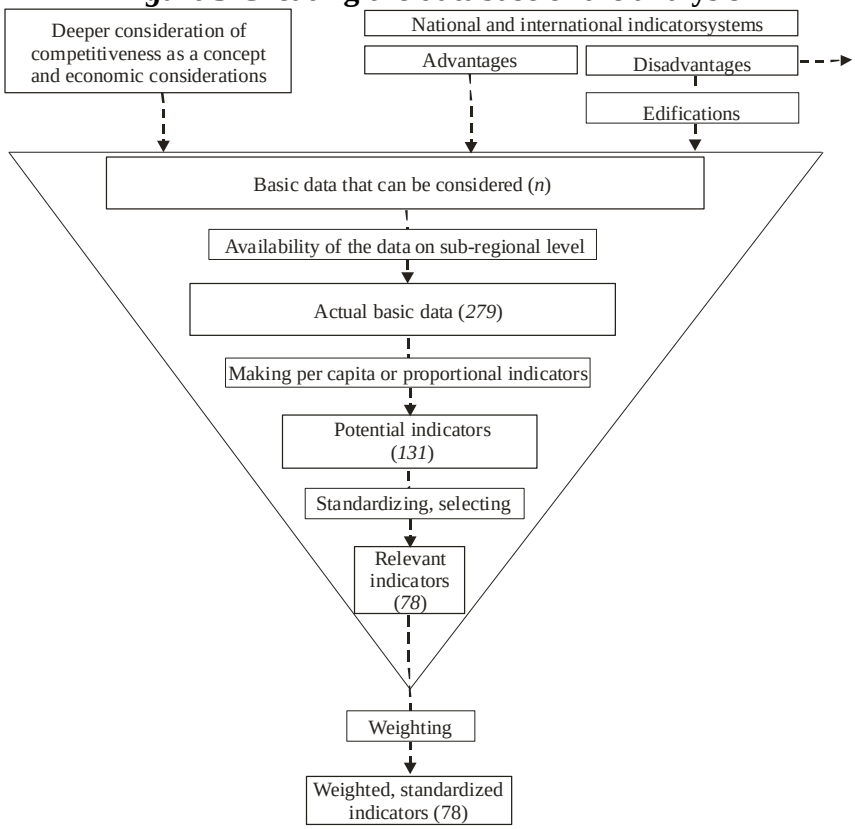


Source: own construction

Competitiveness is a **rather complex category**, which usually cannot be merely measured by some marked indicators. Similarly to international surveys (IMD, WEF), measurement occurs by using **systems of index numbers**, where determining and selecting the variables providing an adequate description of the examined phenomenon represent a key task. In the model to be developed for measuring competitiveness, I follow the logic of the pyramid model when selecting indicators.

The data set serving as the foundation of the analysis is designed **based on the standard definition of competitiveness and the pyramid model** unfolding it. It is important, that the final data base – that serves as the basis of multivariable data analysis methods – **emerges as a result of a multiple-stage process**. The first step defines the **basic data** that can be considered in the case of surveying competitiveness on the sub-regional level. These data can be defined based on a deeper consideration of competitiveness as a concept and economic considerations, taking into account the most important experience of the reviewed international and national analyses. The fact that certain data are absolutely unavailable on the sub-regional level limits the inclusion of a great number of data as actual basic data; therefore, **actual basic data** are made up of the basic data available on the sub-regional level. These basic data may be considered as raw data, from which **potential indicators** can be produced with the help of simple mathematical operations. Selecting potential indicators with the help of principal components analysis leads to the **actual, relevant indicators** that finally serve as the basis of the analysis. The database reaches its final form after **standardizing** and **weighting** relevant indicators (figure 3).

***Figure 3* Creating the database of the analysis**



Source: own construction

The set of indicators consists exclusively of data **deriving from hard, secondary sources** – not checked by the analyst –, although we recognize the **importance** and significant information content **of soft data** used in international surveys on competitiveness. The present research did not offer a chance for data collection in the different sub-regions via questionnaires and interviews, however, subjective data may also play an important role in further developing the present methodology.

4. Selecting indicators

The key issue is to select the relevant and adequate indicators. In our survey, selection of the indicators is based on the logical framework of the pyramidal model, which seeks to provide a systematic account of the measuring and to describe the basic aspects of improved competitiveness ([13]). The measurement of the regional competitiveness in the European Union is derived from GDP/capita, which can be factored into well known economic categories:

income generated in the region ≈ labour productivity × employment rate *(1)*

Measuring regional competitiveness has been traced back to three related economic categories: income generated in the region, labour productivity, and employment rate. The three coefficients of equation 1 correspond with the basic categories at the top of the pyramidal model, which fact underpins their accentuated role in describing regional competitiveness. According to the build-up of the chosen logical model, in our research we would like to characterize the basic categories (ex post), the development factors (improve competitiveness in short term directly) and success determinants (have indirect, long term impact on basic categories and development factors) **in the first round** with at least of three indicators. The model contains the three named indicators of the standard competitiveness definition (**GDP per capita, labour productivity, employment rate**) and other chosen indicators representing the basic categories, development factors and success determinants of the pyramid model. The first selection of the indicators has been driven by economic theories and the principles of competitiveness. In the following chapters we would like to design a complex competitiveness picture about the Hungarian sub-regions with multivariate data analysis about the correctly chosen indicators.

So, we examine the amount of the information of the variables in each basic categories, development factors and success determinants. Using the **Principal Component analysis** for each basic category, development factors and success determinants, we left those variables, which had a bad goodness of fit in the representing Principal component(s). Naturally we used standardized variables because of the variety of the unit of the measure. We used principal component analysis because on the one hand the first selection of the indicators has been driven by economic theories and the principles of competitiveness and the basic categories, development factors and success determinants of the pyramid ([10]). On the other hand a perspective aim of the examination is clustering the sub-regions directly by the basic categories, development factors and success determinants of the pyramid. So, we substitute each basic category, development factor and success determinant with one (ore more) principal component. The coordinates of these principal components that are the factor scores mark the sub-regions by the categories.

The main aspect of the **second selection** of the variables was marking each basic categories, development factors and success determinants with one principal component, which has **at least 70% amount of information**. In each basic category, development factor and success determinant the numbers of the principal components were determined by the eigenvalues of the correlation matrix of the marking variables, which are greater then 1 ([10]). If the result of Principal component analysis was one principal component we would attempt growing the amount of information of that by **leaving those variables, which has low communality**. Namely the low communality means that the principal component less interpret the variance of the variable. So the principal component less keeps the amount of information of the variable.

Naturally, there are such development factors and success determinants, for example the infrastructure and the human capital, which can't be marked with one 'good' principal component (22 principal components has been created to describe the whole pyramid model). We analyzed the connection between the variables and the principal components by the **loading variables**. If the researcher couldn't determine the means of the principal components, there isn't right the application of the principal components method. If we could that, we determined the means of the components by separating the variables, thus each development factors and success determinants. If we couldn't that, we attempted with the selection of the variables. Thus each development factors and success determinants were marked with right numbers of principal components according to theirs amount of information. 78 variables were entered for the model by the results of the Principal Component Analysis (table 1).

Table 1 **The indicators of the model**

Categories of the pyramid model	*Indicators*
Income level	1. Volume of taxable incomes per one tax-payer 2. Gross income serving as the basis of the personal income tax, per permanent population 3. Earnings from main activity/number of tax-payers 4. Entrepreneurial income/ number of tax-payers 5. Gross Value Added (GVA) per capita
Labour productivity	6. Profit before taxes per employer 7. Gross Value Added per employer 8. Gross income serving as the basis of the personal income tax, per tax-payers
Employment	9. Employment rate 10. Unemployment rate 11. Number of tax-payers per 1000 inhabitants
Global integration	12. Income from export per inhabitants 13. Integration of the trade (export/GDP) 14. Number of foreign tourism nights at public accommodation establishments per 1000 inhabitants 15. Number of domestic tourism nights at public accommodation establishments per 1000 inhabitants
Research and technological development	16. Number of patents between 2000 and 2004 per 10000 inhabitants 17. Number of members of public body of Hungarian Academy of Sciences per 10000 inhabitants 18. R&D units per 100000 inhabintants 19. Number of scientists and engineers per 1000 inhabintants 20. Current R&D expenditures per 10000 inhabintants 21. R&D expenditures per 10000 inhabintants 22. Capital R&D expenditures per 10000 inhabintants
Small and medium-sized enterprises (SME-s	23. Number of active companies and partnerships per 1000 inhabitants 24. Number of active small businesses (10-49 employers) per 1000 inhabitants 25. Number of active corporations with legal entity per 1000 inhabitants 26. Number of active small businesses (10-49 employers) with legal entity per 1000 inhabitants 27. Proportion of partnerships from the active enterprises 28. Owners' equity of the companies per 1000 inhabitants 29. Subscribed capital of the companies per 1000 inhabitants 30. Balance sheet total of the companies per 1000 inhabitants
Foreign Direct Investment	31. Staff number of enterprises with foreign direct investment per 1000 inhabintants 32. Owners' equity of enterprises with foreign direct investment per 1000 inhabintants 33. Foreign direct investment per inhabitant 34. Net revenue of enterprises with foreign direct investment per 1 inhabintant
Infrastructure and human	35. Number of university or college graduate employed per 1000 inhabitants 36. Proportion of leading intellectual employees from the employees

capital	37. 18–X years old population, with at least secondary school general certificate, as a percentage of the same age group 38. 25–X years old population, with university, high school, etc. diploma, as a percentage of the same age group 39. Telephone main lines per 1000 inhabitants 40. ISDN-lines per 1000 inhabitants 41. Number of dwellings built per 1000 inhabitants 42. Number of building permits per 1000 inhabitants
Institutions and social capital	43. Proportion of disability pensioners below retirement age from the 45-59 years old population 44. Annual average internal net migration per 1000 inhabitants, 2000-2004 45. Number of pensioners, retirement provisioners per 1000 inhabitants 46. Active non-profit institutions per 1000 inhabitants 47. Full-time students of higher educational institutions per 1000 inhabitants
Economic structure	48. Proportion of active companies in real estate, renting and business activities from all active companies 49. Proportion of employees in agriculture from all employees 50. Proportion of employees in services from all employees 51. Proportion of non-manual workers from all employees
Innovative activity	52. Registered users of work-place, tertiary educational and other libraries per 1000 inhabitants 53. Number of lecturers of higher education institutions (by seat of institutions) 54. Number of lecturers of higher education institutions (by sections placed out)
Regional accessibility	55. Complex regional accessibility indicator 56. Domestic supplier accessibility indicator 57. Multi accessibility indicator
Skills of work force	58. Employees working at the residence with at least secondary school general certificate per 1000 inhabitants 59. Employees working at the residence with university, high school, etc. diploma per 1000 inhabitants 60. Average number of school grades
Social structure	61. Population aged 60 and over as percentage of permanent population 62. Population aged 0-18 as percentage of permanent population 63. Live births/deaths 64. Vitality index 65. Number of single person households per 1000 inhabitants 66. Share of inhabitants living in settlements with population density over 120 67. Proportion of central settlement's inhabitants from the sub-region's inhabitants
Decision centres	68. The sub-regional proportion of active companies with legal entity with at least 250 employees from the Hungarian data 69. The sub-regional proportion of active companies with legal entity with 50-249 employees from the Hungarian data
Environment	70. Number of discovered publicly indicted crimes 71. Number of economy related discovered publicly indicted crimes 72. Number of places of clubs for the aged providing day-time care per 1000 inhabitants aged 60 and over 73. Percentage of dwellings connected to the public sewerage network
Regional identity	74. Arrivals per 1000 inhabitants 75. Departures per 1000 inhabitants 76. Proportion of employees working at the residence from the daily commuters 77. Proportion of intellectual employees working at the residence from the daily commuter intellectual employees 78. Proportion of daily arrival commuters from the daily departure commuters

Source: own construction

5. Weighting of variables

As mentioned above, the database defined by the variables mainly consists of variables with different units; the potential problems arising from this has been solved with

the help of **standardisation**: the expected value of variables was 0 with their expected variance being 1. Identical variance practically means that all the variables have equal weight in the model. However, the logic of **the pyramid model implicitly requires that the variables affecting the region's competitiveness in different ways and with different relevance should be included in the model with different weight**.

Accordingly we determined the weights of the 78 selected variables. The base of this process was a weighting method, which was published by Porter in the Global Competitiveness Report, one of the most highlighted publications on competitiveness. Porter [27] constructed two sub-indexes. The weights were determined from the coefficients of a multiple regression of the sub-indexes on GDP per capita. The pyramidal model marks the competitiveness by an indicator system, thus we used a complex model. We also defined principal components, as indicators and we attempted for defining the objective weights of those. Our weight system and examination could be an advance in the effort of making commensurable the competitiveness. Opposite of Porters' GDP/capita the pyramid model hasn't metric dependent variable, thus we didn't analyze the causality ([10]). We analyzed the state of the sub-regions.

According to the variables selection method we used the **principal component analysis** to make an **objective weighting system**. The determination of the weights is based on the following train of thought. If we substitute the standardized variables with principal components, the principal components represent the model in reduced dimension. One result of the principal component analysis the values of the communalities. As the communalities practically are coefficients of multiple determinations in a linear regression model, where the dependent variable is the given variable, and the independents are the principal components, the square roots of those are coefficients of multiple correlations. In general the coefficient of multiple correlation quantify the correlation between the effective (empirical) and the estimated values of the dependent variable. Thus it also quantifies the correlation between the dependent variable and the set of independent variables. Especially the coefficient of the multiple correlation means the correlation between the given standardized variable and the set of principal components, which represent the pyramid model. Thus, **the coefficients mean the correlation between the variables and the model**, namely **the weight of the variables**. First time we applied this method for the selected variables, and the second for the categories.

So we determined the weights of the selected 78 standardized variables in the pyramidal model. The variables we could substitute with 12 principal components. Thus the model and namely the competitiveness were marked by 12 components. **The weight of a variable is the square root of the communalities**, which means the correlation between the principal components and the variable, thus the weight of the variable in the pyramid model.

The question of how objective the different weights may be considered also emerges. Or is it possible to measure "subjective" categories in an objective way at all? Obviously, the **weight of the different variables and categories can be objective within the given model** in the sense that their definition – contrary to former surveys – does not include subjective elements ([10]).

We also calculated the value of the *Red* indicator in our study. This indicator is based on the eigenvalues of the correlation matrix. This indicator quantifies **the percentage of collinearity and the proportion of data with a useful content compared to the database of the given size and with minimum redundancy** ([11]). The *Red* quantifies the average correlation of the data of the database, and which can be regarded as the synthetic and normalized indicator.

In the case of the absence of redundancy the value of the above indicator is zero or zero percent, while in the case of maximum redundancy it is one or one hundred percent. The *Red* indicator measures the redundancy of the studied database of the given size. Kovacs proved the value of the *Red* indicator is the quadratic mean of the elements outside the main diagonal of the correlation matrix. The value of the *Red* indicator approximately 0,42. It means that the proportion of data with a useful content is 58%. **So our methods don't draw down significant information loss**.

6. One possible application of the designed method

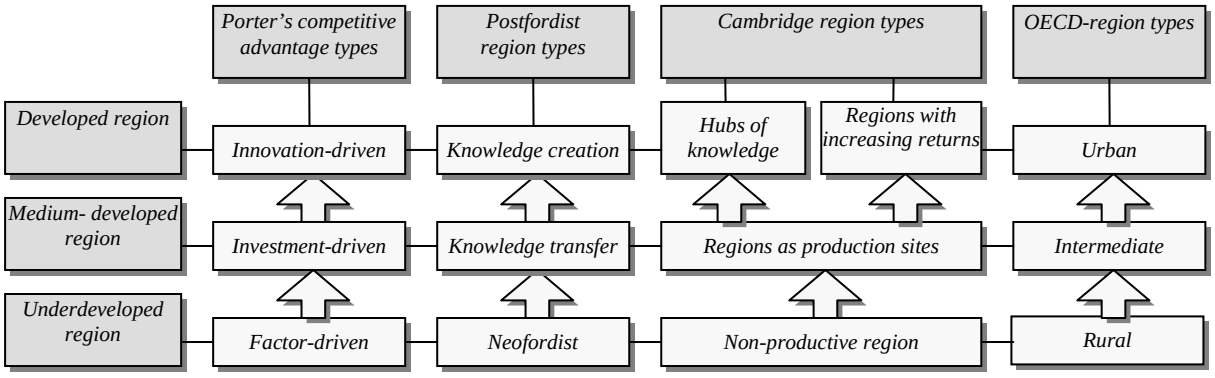
In my paper, I introduce **one possible application** of the designed method, in the framework of which I make an attempt to provide the complex analysis of the competitiveness of 168 Hungarian sub-regions based on the latest available data collected in 2004 as well as formerly compiled information. In the course of the analysis our intention was to proceed as thoroughly as possible, therefore, I examined the same question using **various methods and means**.

For the complex analysis of the competitiveness of sub-regions I apply **cluster analysis and multidimensional scaling,** two multivariable data analyzing techniques with significantly different logics so that the results produced with one method can be comparable with the results of the other one, ensuring controllability this way. **Strong internal control is an organic part of the analysis**, since results are calculated in various ways to minimize errors of calculation that can occur in the course of the analysis. For example, **I complete cluster analysis** both based on the **78 selected and weighted variables** and the **22 principal components** created in the selection of variables. Furthermore, in multidimensional scaling I will also strive to produce the **widest possible combination** of the results of one-dimensional and two-dimensional analyses in order to achieve the most complex picture on competitiveness.

Cluster analysis

In our former research in 2006, some highlighted region typologies has been surveyed ([15]). The typization of regions is based on different aspects, but **three or four region types** are usually distinguished (figure 2). The above described work in the field of region typization also highlighted that in classifying region types in development phases special attention must be paid to urbanisation, or rather its geographical concentration. Therefore, we also distinguished urban and rural sub-types in three region types.

Figure 4 **Comparison of the results of some highlighted typologies of regions**



Source: [15]

Despite the fact that the vast majority of works developing a typology of regions recognized in reputed professional circles distinguish three theoretical region types, we **may have doubts** whether it is really right to classify the 168 Hungarian sub-regions in three clusters subserviently accepting theoretical guidelines **without reservations**. Especially if we stop to consider what a strong influence the capital sub-region exercises on typology. First, I organized the 168 sub-regions in **three** adequately homogeneous groups, since the majority of works dealing with the typology of regions distinguished three region types.

Subsequently, I studied the results of classifying sub-regions in four or five clusters in order to produce a complex picture about the classification of the given sub-regions based on region types. By doing so I sought an answer to the question of whether it is possible that increasing the number of distinguished clusters within the K-Means clustering method significantly changes the classification of the given sub-regions in the given competitiveness types. If, as a result of our analysis, the answer to this question is yes, then it is not practical to represent the competitiveness of the 168 Hungarian sub-regions in three clusters, but it is advised to include more clusters instead.

Since 93.5% of the sub-regions were not classified differently in the case of three or four clusters, typisation proves more obvious, and **I support relying on classification in three clusters** adding the remark that **the results of the four-cluster method must definitely be considered** in evaluating the competitiveness of the 11 sub-regions that were classified differently by the two methods.

In the case of distinguishing five clusters, **83.4% of the sub-regions can still be clearly linked** to the basic types distinguished in the case of defining three clusters. However, the **drawback** of the method – similarly to the four-cluster method – lies in the fact that it is rather difficult to define the relative position of the two created clusters based on mathematics and statistics, furthermore, cluster 2 is highly **heterogeneous** despite including a small number of elements. Consequently, **I insist on supporting** the clearly definable and interpretable **three-cluster method**, at the same time **noting** that the results of the four- and five-cluster method must be considered in the course of evaluation. A further conclusion deriving from the results of the four- and five-cluster method is that **the competitiveness type of 83.4% of the Hungarian sub-regions may be concerned relatively clear-cut**.

I also examined **whether it makes sense to further increase the number of clusters to be created**. **Based on the result of** the so-called **hierarchical clustering method, it became obvious that in the present case** setting up **more than five clusters is not advised**.

So cluster analysis made possible the organization of the objects in relatively homogeneous groups, although no other data than the Euclidean distance of the given sub-regions from the cluster center can be clearly defined. Both the graphic chart exploring the homogeneity of cluster analysis and the final result of the clustering method fail to produce an answer to the question of which are the sub-regions that were classified to belong in the cluster with relatively weak competitiveness, but compared to their cluster members stand closest to a region type with higher competitiveness. **Consequently, the analyst does not have any information on the relative distance of the given sub-regions either *within clusters* or *among them***.

Multidimensional scaling

This need of information is met by multidimensional scaling that was also performed in various ways. Represented in a two-dimensional space, **two-dimensional scaling** completed based on 78 standardized and weighted variables resulted in a reduced dot-diagram

that displayed the **relative position** of the 168 Hungarian sub-regions in complex terms of competitiveness. After completing two-dimensional scaling, the value of the control indicator of the method qualifies as **excellent**, so the model with a reduced number of dimensions **probably contains all relevant information**.

The results of two-dimensional scaling may be further interpreted and completed if, based on the pyramid model, **we divide the 78 variables in the basic categories representing realized competitiveness and the variables of the basic development factors and success factors**. If we complete one-dimensional scaling separately in the two groups of index-numbers divided this way, then, the logic of the pyramid model leads us to the possibility to define objectively whether a given sub-region assumes a better position in the national hierarchy based on its realized competitiveness or its future development potential.

In general terms, it can be stated that **there is no significant difference** in the realized competitiveness of sub-regions and their development potential – except for the few outstanding cases described. Rankings of basic categories, basic factors and success factors **are in rough correspondence with one another**, which is also justified by the 0.76 value of Spearman's rank correlation coefficient.

At the same time, the technique of one-dimensional scaling implies the possibility of developing a **rank of complex competitiveness** in the event if this operation is not accompanied by significant information loss deriving from excessive fractal reduction. If one-dimensional scaling is completed **jointly for the total of 78 variables** of the basic categories, basic factors and success factors, **it results in the complex competitiveness ranking of the 168 Hungarian sub-regions based on 2004 data**. In the case of the complex competitiveness ranking emerging from the survey, the S-Stress value is 0.1, which may be considered **good**, so **the model with a reduced number of dimensions probably includes all relevant information**.

In harmony with our expectations, Budapest leads the complex competitiveness rank, followed by the Debrecen, Szeged and Pécs sub-regions, whose coordinate based on one-dimensional scaling is approximately half of the Budapest value in numerical terms. However, these coordinates must be interpreted cautiously, since a double coordinate does not mean that the sub-region having such double coordinate assumes double complex competitiveness. In fact, according to the logic of MDS, the produced coordinates **are data interpretable on an interval scale instead of a proportional one**.

Comparing the results of the cluster analysis and the multidimensional scaling

Subsequently, I compared the results of cluster analysis and multidimensional scaling. The three clusters circumscribable in the two-dimensional map **contain the same elements** as the clusters emerging from cluster analysis. Similarly, the four groups circumscribable in the two-dimensional map are also in correspondence with the **four clusters** set up using the K-Means clustering method. **The difficulty** concerning the interpretation of one of the clusters **already outlined in the case of four-cluster analysis** becomes apparent from the graphic chart of two-dimensional scaling. In the event of setting up five clusters, three clusters **could not be circumscribed in a responsible manner**, since their coordinates according to *x* and *y* overlap so much that their graphic distinction could not be carried out with the necessary accuracy.

This survey highlighted the fact that **cluster analysis in itself is not enough for determining competitiveness types**; these can only be defined in a responsible manner by using other methods, as well. The graphic chart of MDS provides excellent help for the

development of a picture on complex competitiveness and the accurate interpretation of the results. Based on the above, it can be clearly stated that in the case of distinguishing three clusters the results of various methods applying different logics produced the most accurate correspondence. Consequently, **I decided to distinguish three competitiveness types** in the end, accepting the recommendations of works dealing with the typology of regions.

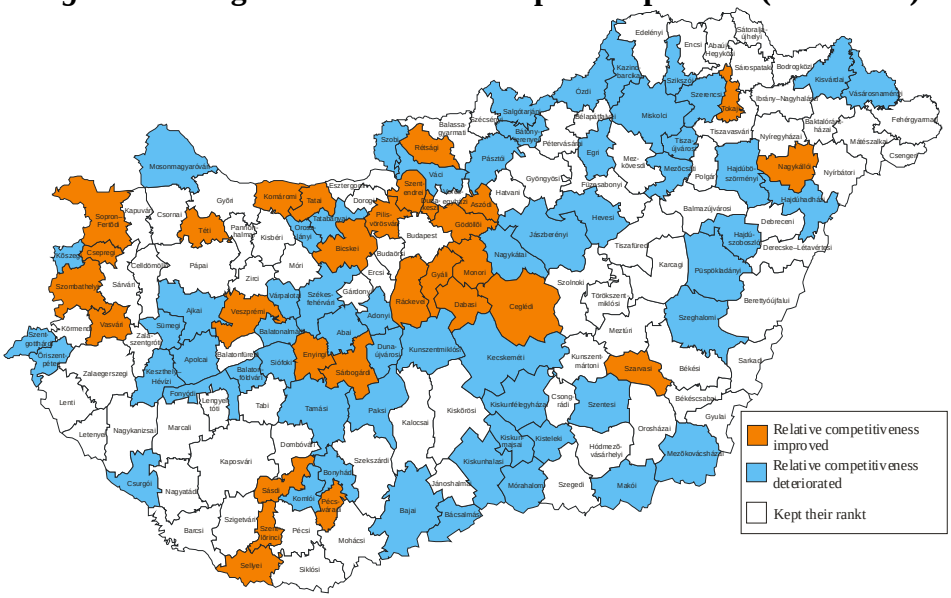
Dynamizing of the model

The model is expected to ensure **comparability in time**, which means that **beyond the relative competitiveness of the different sub-regions, its changes can also be examined** by introducing the latest statistical data to the database consisting of the selected system of index numbers. This aspect assumes importance especially because of regular future surveys; however, taking certain limitations into account, it is also possible to retrospectively map out the competitiveness of the 168 Hungarian sub-regions as well as its changes.

In our analysis, we compared the competitiveness types of the different sub-regions in 1998 and 2004. We studied which are the sub-regions whose competitiveness changed so much in the examined two years that their position assumed in clustering was also modified. Looking at the period between 1998 and 2004, only **ten sub-regions were found** whose ranking in clusters based on complex competitiveness changed by 2004 compared to its state in 1998.

The closed logical method describable by the objective selection and weighting process of indicators based on the pyramid model of competitiveness also offers a chance to complete an annual assessment of the changes in the relative competitive position of Hungarian sub-regions**.**

Figure 5 **Changes in the relative competitive position (1998-2004)**



Source: own construction

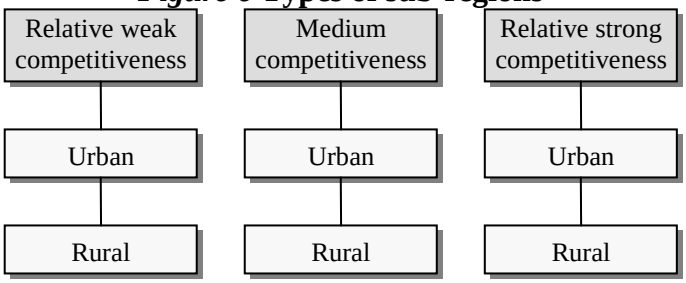
Annual one-dimensional scalings as the sub-regional comparison of the complex competitiveness rankings help identify the sub-regions that assumed worse ranking (or in other words, whose relative competitiveness deteriorated), the ones that achieved better position (whose relative competitiveness improved) and the ones that kept their rank in the two examined years (figure 5).

Based on the Euclidean distance of the final cluster centers, it must be underlined that **in 1998 three clusters were situated closer to one another that in 2004**. Between 1998 and 2004, the distance of the cluster with relatively weak competitiveness and the one with medium competitiveness did not change significantly, however, the Euclidean distance between the clusters of the sub-regions with medium competitiveness and the ones with relatively strong competitiveness grew significantly, and the same happened in the case of the clusters of sub-regions with relatively weak competitiveness and the ones with relatively strong competitiveness. **This observation, in a way, proves the increase of spatial inequalities**. This recognition not only shows the growth of spatial inequalities, but also confirms the fact that the cluster of **Budapest** with relatively strong competitiveness **underwent much more dynamical development** in the examined period **than the sub-regions constituting the other two clusters**.

Urban-rural dimension

Responding to the challenges of the spatial organizing forces, empirical analysis is complemented by **a typology along the urban-rural dimension** that differentiates the competitiveness types based on their critical mass necessary for their development potentials ([19], [20]). Major approaches in the typology of regions highlight the fact that, in the course of analyzing regional competitiveness, **special emphasis must be placed on the "*critical mass*" present in the region**, or in other words, the urban or rural character of the region. In harmony with this challenge, **the second step** of the present research **makes an attempt to further differentiate the picture** on regional competitiveness developed in the first step based on whether the sub-regions classified in the given region type are considered urban or rural (figure 6).

Figure 6 **Types of sub-regions**



Source: own construction based on Lengyel – Lukovics (2006)

It can be stated that the approaches examining urban-rural distinctions are similar in the respect that urban regions are predominantly **regions of large towns** where **significant population concentration** may be observed ([5]). Departing from this, the traditional approach expects sub-regions called urban to have a number of population that reaches a critical mass. Based on international recommendations, this can be approached with three indicators:

1. **The number of population in the center of the sub-region at the end of the examined year**: based on ESPON, the community strategic guidelines between 2007 and 2013 and the recommendations of OMB it should reach 50 000 persons.
2. **The proportion of inhabitants living in settlements with a population density of more than 120** in the examined sub-region should be at least 75%.
3. **The population rate of the sub-regional center** in the population of the sub-region should not be lower than 75%.

In the event that **at least one** of the above criteria is met, we can talk about an urban region in Hungarian sub-regional terms. However, we should not forget about today's ruling

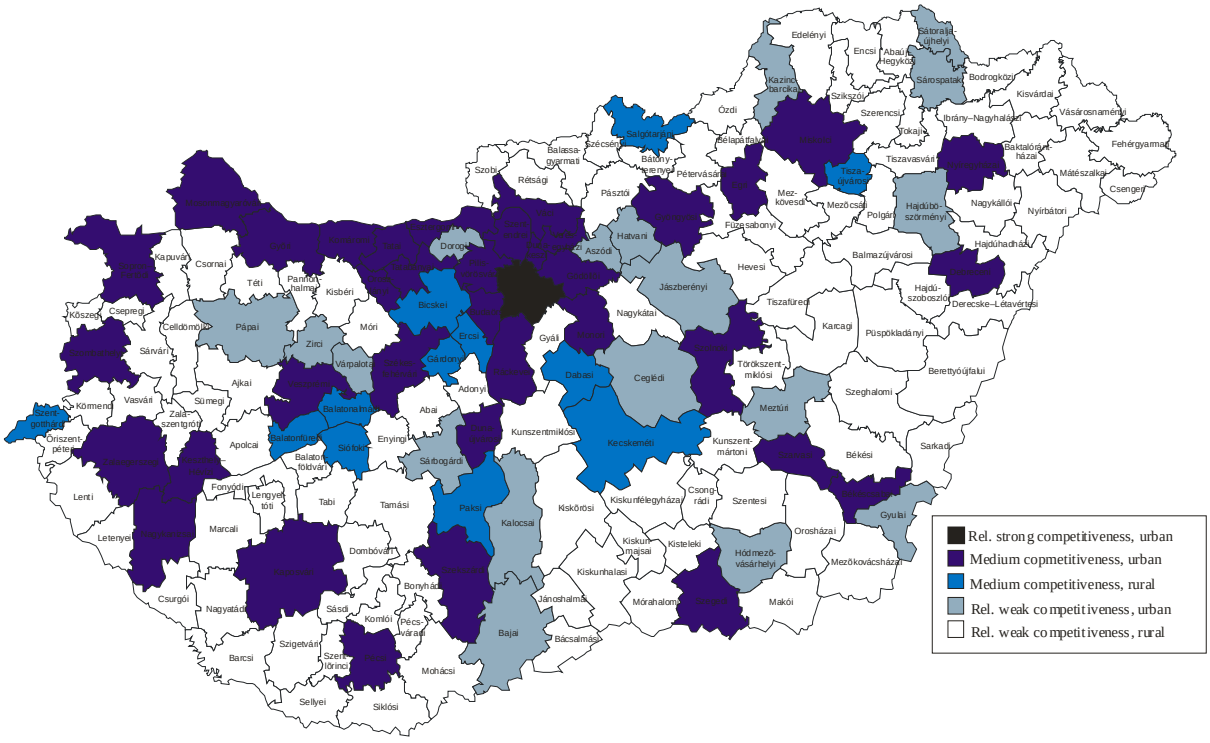
tendency, or in other words, **the challenges of knowledge-based economy**. In fact, in a region it is not only population concentration in the classical sense that can represent the critical mass necessary for urban regions, but also the knowledge produced in the given sub-region. The most important depositaries of creating new knowledge are higher education institutions, whose presence in a given sub-region can also be interpreted as a type of critical mass. All this is in line with Malecki's idea, according to which competitiveness is basically determined by the presence of a critical mass of institutions ([17]).

4. On the basis of this, beyond the fulfillment of one of the three indicators defined above, I also consider sub-regions **with a higher education institution** to be urban in line with the implied criteria of the knowledge-based economy.

7. The compatitiveness of the Hungarian sub-regions

In the empirical application of the developed method, I classified Hungarian sub-regions in competitiveness types with the help of multivariable data analysis methods. In the course of developing a typology of the sub-regions in terms of complex competitiveness, I applied cluster analysis as well as one- and two-dimensional scaling performing the analyses in various different ways. Since the various techniques using methods with different logics led to the same result, it is probable that the competitiveness of Hungarian sub-regions could be mapped realistically. **Based on this, it makes sense to suppose that the applied theoretical model and the methodology based on it are suitable for making regional competitiveness measurable**. In the efforts to make regional competitiveness measurable, maybe choosing, objectively selecting and attempting to weight the variables relying on the pyramid model as a logical frame meant a step forward.

Figure 7 **The typology of the Hungarian sub-regions**



Forrás: Own counstruction

Among Hungary's sub-regions, the analysis distinguished **1 urban sub-region with relatively strong competitiveness**, **36 urban sub-regions with medium competitiveness**,

12 rural sub-regions with medium competitiveness, 18 urban sub-regions with relatively weak competitiveness and 101 rural sub-regions with relative weak competitiveness. It can be said about the spatial concentration of competitiveness and urbanization that – based on the data compiled in 2004 – the only urbanized sub-region of the capital with relatively strong competitiveness is surrounded by the ring of sub-regions with medium competitiveness, 90% of which are urban. Furthermore, the urban sub-regions with medium competitiveness are on one hand the sub-regions of the chief towns of counties (with the exception of Salgótarján) and the sub-regions of large towns. Sub-regions with medium competitiveness (urban and rural alike) are concentrated in the vicinity of developed Western centers and highways. Beyond this, it can also be stated that a concentration of sub-regions with medium competitiveness can be found in the North-Western and Central regions of the country, while sub-regions with weak competitiveness are situated in the zones along the Northern and Eastern country borders (figure 7).

8. Summary

Following its research objective, the paper sought an answer to the fundamental question of how **the measurement and typisation of competitiveness in local units could be achieved by minimizing the analyst's subjectivity**, and this way promoting the development of **spatial situation analyses with development purposes**. While answering this question, I introduced a possible method that analyzes the complex competitiveness of the different spatial units in a closed logical system.

In the model developed by the paper and built on the standard definition of competitiveness and the pyramid model unfolding it, the major role in selecting potential indicators was assumed by economical considerations and a deeper understanding of the concept of competitiveness as well as the experiences of the indicator set outlined in the 13 international and 17 Hungarian studies analyzed. The selection of indicators occurred based on the communalities and loading variables of principal components analysis, while weighting was based on the roots of the communalities of principal components analysis. Obviously, the weight of the different variables and categories may be considered objective within the given model in the sense that the definition of these – contrary to former surveys – does not contain subjective elements.

The paper concentrated on analyzing the competitiveness of local units; however, the developed method is naturally suitable for analyzing the competitiveness of spatial units (counties, regions, countries) with higher agglomeration level, as well. Nevertheless, it is highly important that concerning any examined indicator, the spatial units of higher agglomeration levels are highly heterogeneous, therefore, the lower agglomeration level we choose as the object of our analysis, the more accurate picture it produces of the real situation of the given region.

By choosing the basic unit of the analysis, I responded to the global tendency and challenge of **upvaluing the local level** that is parallel with globalization and becomes increasingly apparent in developed countries. The primary reason of upvaluing the local level lies in the fact that **real economic effects and long-term competitive advantages obviously manifest in the local unit**. It is well-known that the long-term competitive advantages of global companies are concentrated in their regional base, that is, in a local unit, exploiting its potentials. Consequently, the economic sectors of local units exposed to global competition show strong specialization, what is likely to lead to different development paths in the different local units depending on the region types circumscribable along specialization.

These – highly complex – spatial processes must be assessed as accurately as possible on the local level, as well.

I have observed that international competitiveness studies **mostly deal with the national and regional level**, **while the international literature includes a relatively small number of analyses on the competitiveness of local units**. After an international review, I examined and evaluated the methodology and system of indicators in development and competitiveness reports competed at the national sub-regional level focusing on which elements of these could be adopted for a competitiveness report and situation analysis for development purposes conducted at the level of local units. Upon reviewing national surveys, I concluded that **so far, at the level of sub-regions, mostly development surveys have been completed in the national literature**, while the number of competitiveness analyses is much smaller.

In my opinion, **one potential strength of the paper** lies in the fact that it conducts both the selection and weighting of the indicators forming the basis of the competitiveness study completed at the level of local units and creates the typology of sub-regional competitiveness relying on the results of hard statistical methods, therefore, **it manages to minimize the distorting effect of the analyst's subjectivity** in the system. Due to meeting the 18 criteria established for the circumstances of modeling, **it is possible to apply the developed method as the basis of a regional monitoring system**, helping to monitor the changes in spatial processes.

We believe that the analyzed subject area offers an excellent opportunity **to continue the research**, since according to our expectations, the competitiveness analysis of local units will gain increasing focus in the future. Developing the model introduced in the paper as well as conducting the empirical analysis raised a series of further questions and challenges that proposed a wide perspective of continuing the present research.

Naturally – as already mentioned in our paper – relevant literature tends to treat local units in theoretical works as **nodal regions,** the dimensions of which must be judged based on the intensity of economic interdependencies. On the basis of the methodology introduced in the paper, it would also be **interesting to analyze the competitiveness of local units defined by real workforce catchment areas** in Hungary. The National Regional Development and Spatial Planning Information System (Hungarian abbreviation: TeIR) publishes certain data also on the level of **settlements**, so it would be possible to create almost any spatial examination units from these data by aggregating the data of neighboring locations. Consequently, after the assessment of real workforce catchment areas, studying the **micro-regions within sub-regions** (especially in heterogeneous ones) and defining and analyzing dynamically changing town catchment areas even crossing county borders also become possible.

In the paper, the output of the analysis was the complex typology of Hungarian sub-regions based on competitiveness; nevertheless, the limitations of space **did not allow for a detailed analysis of the different types**. Continuing the research would offer a nice opportunity for a deeper analysis and explanation of **the classification of the different sub-regions based on competitiveness types**. One highly useful next step of the research could be analyzing the values of the **78 unstandardized basic data based on types** and calculating the most important positional and calculated averages for each indicator. According to my expectations, it would lead to **an exact definition** of the most important features of the different competitiveness types. Should such attempt result successful, it would provide actual support for explaining the classification of the examined units based on competitiveness

types, and therefore, similarly to the basic model, **subjectivity would be minimized** in the analyst's evaluation.

References

[1] EC (1999): *Sixth Periodic Report on the Social and Economic Situation and Development of Regions in the European Union*. European Commission, Luxembourg.

[2] EC (2004): *A new partnership for cohesion - Third Report on Economic and Social Cohesion*. European Commission, Brussels.

[3] EC (2006a): *The Growth and Jobs Strategy and the Reform of European Cohesion Policy. Fourth Progress Report on Cohesion*. European Commission, Brussels.

[4] EC (2006b): Council Decision of 6 October 2006 on Community strategic guidelines on cohesion (2006/702/EC). *Official Journal,* L 291/11, Luxembourg.

[5] ESPON (2005): *Urban-rural relations in Europe*. European Spatial Planning Observation Network, Luxembourg.

[6] Gardiner, B., - Martin, R., - Tyler, P. (2004): Competitiveness, Productivity and Economic Growth across the European Regions. *Regional Studies*, 9, 1045-1067. o.

[7] Garlick, S. (2003): *Growth and Competitiveness in the Gippsland Region: Performance and Determinants 1984 – 2000*. Regional Knowledge Works, Sydney.

[8] GHK (2005): *Long-Term Economic and Employment Strategy for the Black Country*. West Midlands Regional Assembly, Birmingham.

[9] LDY (2006): *The Northern Way: Quality of Place - The North's Residential Offer*. Llewelyn Davies Yeang, London.

[10] Kovács, P. – Lukovics, M. (2006): Classifying Hungarian Sub-regions by their Competitiveness. "*Globalization Impact on Regional and Urban Statistics"* SCORUS 25th Conference on Urban and Regional Statistics and Research, Wroclaw.

[11] Kovács, P. – Petres, T. – Tóth, L. (2005): A New Measure of Multicollinearity in Linear Regression Models. *International Statistical Review* (ISR), 3, 405-412. o.

[12] Lengyel I. (2003): *Verseny és területi fejlődés: térségek versenyképessége Magyarországon*. JATEPress, Szeged.

[13] Lengyel, I. (2004): The Pyramid Model: Enhancing Regional Competitiveness in Hungary. *Acta Oeconomica*, 3, 323-342. o.

[14] Lengyel, I. (2005): On the interpretation of territorial competition and competitiveness. In Horváth, Gy. (ed): *Competitiveness of the Hungarian Regions and Places in the European Economic Space*. Centre for Regional Studies, Hungarian Academy of Sciences, Pécs, 37 o. (megjelenés alatt).

[15] Lengyel, I. – Lukovics, M. (2006): *An Attempt for the Measurement of Regional Competitiveness in Hungary*. "Enlargement, Southern Europe and the Mediterranean" 46th Congress of the European Regional Science Association, Volos, 29 o. Downloadable: http://www.ersa.org/ersaconfs/ersa06/papers/350.pdf

[16] Lengyel I. - Rechnitzer J. (2000): A városok versenyképessége. In Horváth Gy. – Rechnitzer J. (szerk.): *Magyarország területi szerkezete és folyamatai az ezredfordulón*. MTA RKK, Pécs, 130-152. o.

[17] Malecki, E. J. (2002): Hard and Soft Networks for Urban Competitiveness. *Urban Studies*, 5-6, 929-945. o.

[18] Martin, R. L. et al (2005): *A Study on the Factors of Regional Competitiveness*. A final report for The European Commission DG Regional Policy. University of Cambridge, Cambridge.

[19] OECD (2001): *Rural regions in EU – exploring differnces in economic development*. Organisation for Economic Co-operation and Development, Paris.

[20] OMB (2000): Standards for Defining Metropolitan and Micropolitan Statistical Areas. *Federal Register*, Office of Management and Budget, No. 249, 82228-82238. o.

[21] Parkinson, M. et al (2004): *Competitive European Cities: Where do the Core Cities Stand?* Office of the Deputy Prime Minister, London.

[22] Parkinson, M. et al (2005): *State of the Cities. A Progress Report to the Delivering Sustainable Communities Summit.* Office of the Deputy Prime Minister, London.

[23] Parkinson, M. et al (2006): *State of the English Cities.* Office of the Deputy Prime Minister, London.

[24] Pike, A. et al (2006): *New horizons programme, The economic viability and self-containment of geographical economies: A framework for analysis*. Office of the Deputy Prime Minister, London.

[25] Porter, M. E. (1990): *The Competitive Advantage of Nations*. The Free Press, New York.

[26] Porter, M. E. (1998): *On Competition*. The Free Press, New York.

[27] Porter, M. E. (2003): Building the Microeconomic Foundations of Prosperity: Findings from the Microeconomic Competitiveness Index. In *The Global Competitiveness Report 2002-2003*. World Economic Forum, Geneva, 23-45. o.

[28] Worldbank (2000): *Cities in Transition. World Bank Urban and Local Government Strategy*. World Bank, Washington.