DISPARITIES AMONG REGIONS OF THE VISEGRAD GROUP COUNTRIES

Dana JAŠKOVÁ

Abstract

Regional disparities among countries and its measurement is an important topic in the frame of enlarged European Union. We can identify several approaches and methods of measurement and evaluation of disparities between states and regions at Visegrad group countries level. The methods differ in structure of using indicator of disparities and ways of their processing. The aim of the paper is to apply specific model of composite weighted aggregate index of regional disparities in the case of Visegrad group countries. In the theoretical part are briefly described various procedure of construction of Composite Indicator, their advantages and disadvantages. The construction of this aggregated indicator is based on the application of more complex and multidimensional statistical methods.

Key words

Regional disparities, Composite Indicator, multivariate statistical methods

JEL Classification: C34, C52, R23.

Introduction

One of the objectives of the European Union (EU) for increasing competitiveness is to improve the socio-economic level of the regions of its Member States. This is conditional on the level of economic and social development, which varies from one region to another. The region is perceived in the EU as both a major element and an indicator of economic development. The activity of improving prosperity and performance in the regions is referred to as regional policy. By regional policy we mean a set of objectives, tools, methods and measures that lead to reduction of disparities in the socio-economic level of individual regions. The reason for implementing regional policy is the different levels of social and economic development between regions, referred to as regional disparities in the specialist regional literature. Regional disparities create inequalities between individual comparison units. Disparities not only have a purely social and economic dimension, but can be understood more broadly, such as spatial, geographical, political, social, environmental inequalities. Disparities can be both negative and positive; they can be measured by several indicators. In practice, however, the comparison of regional disparities is limited by the availability of suitable data and the methodology of construction of some indicators. The most widely used indicators of regional disparities in practice are: Gross Domestic Product, Gross Value Added, Average Wage in the Region, Unemployment Rate, Infrastructure Level, Foreign Direct Investment Level, Population Data and the like.

The basic idea of the EU and the creation of an integrated European space is to continually increase competitiveness and continuously improve the economic development of a Member State. In the real world, the level of economic, economic and social development in EU countries is not the same. The aim of creating a balanced European area is the relative balance between regions, which is based on the principle of equalizing regional disparities. Knowledge of the economic level of regions and disparities is necessary because of the proposal of further steps for realization of development of individual regions. Regional development is a set of processes that take place within a defined area (region) and contribute primarily to positive changes in its socio-economic situation. The main role of regional development is to reduce regional disparities and promote economic growth with the aim of raising the standard of living of the inhabitants of the region. The definition of regional development is subject to a multidisciplinary (comprehensive) approach. This means combining knowledge from several scientific fields of which regional development is a part. These include: geography, economics, spatial planning, sociology, demography and the like.

This paper focused on Visegrad Group (V4), the Czech Republic, Hungary, Poland and

Slovakia, that belong among the transformed economies of the former Eastern Bloc and whose regions can be generally regarded as less developed when compared with the regions of the traditional EU countries (EU 15). The aim of this paper is to assess the development of disparities among regions of the Visegrad Group countries, to identify the way in which factors determine these disparities. To clarify the social and economic differences between the V4 regions, an aggregated indicator, called the Composite indicator, is applied. The composite indicator design uses more complex multivariate statistical methods.

1. Regional disparities

According to one definition of regional disparities (RD), this term can be understood as distances between regions in abstract metric space. This space can be described by either a selected region descriptor or a set of descriptors, both statically and dynamically. There is large literature on growth processes and with the heavy focus on disparity issue across the European states (Sloboda, 2006). In the previous period, progress was made in the methodology of measuring the dynamics of regional development. RD analysis requires the application of more complex statistical methods. For this reason, there are several universal indicators. We know two basic tools for measuring regional development - static and dynamic (Habánik et al.,2014). Static tools include Composite indicator. Beta and sigma convergence are the most widely used concepts of dynamic analysis.

In this article we follow especially the literature where the Visegrad Group states have been examined. We follow both the classical studies (Nardo et al., 2005; Saisana et al., 2005) and the recent studies (Cuaresma et al., 2014; Zdražil, Kraftová, 2012). The literature provides mixed results on the study of growth disparities – their extent and nature; based on different approaches and its main objectives. Of course, the economic theory says that the effects of economic integration are very ambiguous. However, most authors do agree that the liberalization of the economic environment, in connection with integration, does at least develop the market, and increase pressure to achieve efficiency and higher living standards. Thank to this it can generally be regarded as a beneficial phenomenon. According to some studies the effects resulting from this integration are so unequivocally positive for the participating regions that the fact is indisputable.

The theoretical literature on the development of regional disparities and their relationship to social and economic factors are really wide, even if we are focusing on the Visegrad Group countries and examining the last one or two decades. Smetkowski (2014) underlined that the central and Eastern European countries which became members of the EU have significantly caught up in affluence in relation to the "old" Member States (EU 15). It was a result of a good economic climate until the financial crisis. Kutcherauer et al. (2010) explained that the value of dispersion indicator of regional GDP has fallen down in the whole EU27 within 2001 and 2007.This indicates a convergence process. Regional disparities have grown up in the newest member countries, including countries V4. Koisova (2019) examines regional disparities of V4 countries using the RCI index and the DEA model.

Measurement methods, individual instruments and levels of regional disparities can be classified from different aspects. From the aspect of mathematical difficulty to simple and complicated. By the time to static and dynamic. According to the informative value of deterministic and stochastic, from the material point of view one-dimensional and multivariate. Depending on the number of regions involved in the bi-regional and multiregional analysis. The combination of methods is predominantly used, which provides better opportunities for disparities evaluation (Michálek, 2012).

Several authors recommend using multiple indexes when measuring RD size. It would be best to use a more comprehensive indicator that would be able to capture and describe the widest spectrum of disparities and predict their real level. Summary or complex indicators are simplified models of reality. The construction and consequently the measurement results through these models include some aspect of subjectivity. When selecting indicators, as well as the method of numerical processing (Michálek, 2012; Melecký, 2016).

2. Materials and methods

The analysis of regional differences of V4 countries is evaluated in the paper using an aggregate indicator known as the Composite Indicator (CI). A detailed methodology for its construction was published by the OECD in 2008 (OECD, 2008). The OECD's Handbook on Constructing Composite Indicators (Nardo et al., 2005) describes different methodologies that can be applied to combine varied information in to construction CI. Saisana et al. (2005) describe seven steps in which uncertainties arise in the construction of a composite indicator: selection of sub-indicators, data selection, data editing, data normalization, weighting scheme, weight's values and composite indicator formula. A composite indicator is an indicator that is constructed from several sub-indicators, which are often non-directional, have different levels and variability, and exhibit different degrees of interdependence in pairs. Sub-indicators assess the region from different, often contradictory, perspectives. The composite indicator, constructed from these sub-indicators, should allow a more comprehensive, coherent and synthesizing view of the level of the region. (Minařík, 2013)

Composite indicators which compare region performance are increasingly recognized as a useful tool in policy analysis and public communication. The number of *CI*s in existence around the world is growing year after year. Bandura (2008) cites more than 160 composite indicators.

Despite the growing interest, composite indicators represent a controversial object. The lack of a standard method of calculating it, and in particular the presence of subjectivity involved in the way it is constructed, gives rise to a justified distrust. (Booysen, 2002). Aggregation fulfils the important purpose of comparing several regions. The development of the landscape can be monitored using a composite indicator. CI summarizes and completes the view of such multi-faceted phenomena as human development, social inclusion, knowledge economy, competitiveness. However, the summarizing process inevitably leads to a loss of basic information. If more than one sub-indicator is entering the aggregation, it may happen that the first country is better compared to the two regions and the second country is better than the other. Micklewright (2001) argues that, in the absence of a good composite index, excessive public attention can once again focus on only one or several dimensions, thereby abolishing the original intention to render a multidimensional phenomenon. In fact, this could compromise the credibility of the evaluation of regions.

2.1 Properties of composite indicator

The assessment of the social development of the region is diverse, taking into account the purpose pursued, the choice of method and its correct application, as well as the choice of indicators for their evaluation. A key role is played by the way they are integrated into a single indicator and the subsequent correct interpretation of the results. The indicator represents a special subset of the statistical results. The indicator is a statistical tool that monitors the nature and level of phenomena and processes, monitors their evolution, changes and trends. This implies certain characteristics of the indicator: significant, transparent, analytical, complete, credible, internally and externally comparable, inter-temporal. (Michálek, 2014)

These requirements must be respected when selecting appropriate indicators. The number of indicators should be neither small (distorted real situation) nor too large (loss of clarity and transparency of interpretation). Indicators must be regularly measured and officially published. When assessing the development of the region, there is a logical need for an integrated view of the issue under consideration. This is related to the CI design . There are currently several ways to calculate it. One of the most modern approaches is the construction of the so-called BoD - Benefit of the doubt composite indicator (Rogge, 2012; Cherchye et al., 2007). Its construction is using DEA models (Verschelde, Rogge, 2012).

The construction of the CI composite indicator can be described by the following steps:

1. Creation of a theoretical framework
2. Selection and combination of sub-indicators, assessment of their importance and statistical

characteristics, normalization and aggregation of original indicators, determination of their weights
3. Add missing data, multicriteria analysis
4. Stardatization
5. Assignment of weights to a pointer
6. Aggregation
7. Uncertainty analysis
8. Joining the constructed composite indicator with the original indicators, visualizing the results.

Summary indicators have both advantages and disadvantages. The following table briefly summarizes the positive and negative aspects of the aggregated indicators.

Table 1. Positive and negative aspects of the CI

Advantages	*CI* can be used to summarize a complex phenomenon and thus facilitate decision making
	CI may be easier to interpret than the set of indicators used to construct it
	CI makes it easy to compare the performance of a given region over time with other regions
	CI can help simplify the set of indicators while adding new information.
Disadvantages	*CI* may lead to incorrect and non-robust conclusions if it is incorrectly constructed or interpreted.
	The possibilities of simple *CI* interpretation can lead to simplified conclusions, *CI* should be used together with input indicators to more sophisticated conclusions.
	The construction of *CI* involves several decision phases.
	Using weights can be a source of debate.
	The use of *CI* increases the amount of data required because it is necessary to collect data for all input indicators. Missing data reduces the quality of statistical analyses.

Source: Saisana and Tarantola, 2002

Methods for the compilation of aggregate indicators include direct aggregation techniques, methods used for data purification, their modification, statistical processing and control of the results obtained and their presentation. A well-designed aggregate indicator should always include partial trends as well as contradictory developments of individual components and factors. When constructing the composite indicator, it is important to proceed from the correct definition of the measured characteristics and also from the knowledge of the essential links of the problem under investigation (Hrach, Mihola, 2006).

From a mathematical point of view, it is necessary to keep in mind the aggregate indicators that generally apply to all mathematical models. These indicators can never perfectly describe the reality as a whole, they only testify to the part that has been described by the data, and the telling level is always due to the methods used to process the data (Hrach, Mihola, 2006).

2.2 Methods of construction of summary indicator

Methods of construction of aggregate indicator can be divided into statistical-analytical methods, which are focused on the selection of sub-indicators and statistical-descriptive methods, which allow calculation of the aggregate indicator.

The essence of analytical methods is to verify the validity of hypotheses about the significance of individual variables and the suitability of the model in terms of their mutual relations. These methods can be classified as exploratory or extrapolation methods of data analysis.

One-dimensional statistical methods are based on the calculation of basic statistical characteristics, as well as on graphical and tabular representation of data. The basic statistical characteristics provide information on the properties of the population in terms of revealing variability, degree of symmetry and spike, the normality of distribution, and also revealing outliers and suspicious elements in the selection. The identification of outliers is the first impulse to doubt whether the data originates from a normal distribution. This assumption is important, but is often not critical to all methods. Normality can be assessed using graphs and tests.

Multivariate methods do not have predefined hypotheses that would lead to a decision to accept or not. To a large extent, these methods depend on the experience of analysts, expertise

and knowledge of the subject matter. When constructing aggregate indicators, these methods serve to find the optimal number of key indicators. These are cluster analysis, correlation analysis, and major component analysis. The methods of multivariate statistical analysis, which are used to analyse regional disparities, provide us with solutions to the following tasks:

- reduction of excessive number of variables,
- multivariate classification that allows rules to be used to classify objects into one of several group,
- object typology, or ordering or hierarchical sorting into relatively equal groups and determining the order of these groups according to selected criteria.

The statistical-descriptive methods allow the compilation of an aggregate indicator using aggregation techniques and an analytical-hierarchical process that is based on different ways of determining weights for individual sub-indicators in aggregating them. The starting point of all these methods is the matrix of entities (municipality, region, state) and their indicators. The aggregate indicator may be produced in a weighted and unweighted form. (OECD, 2008)

2.3 Construction of the composite indicator

The following methods can be used to normalize input indicators: Normalisation based on interval scales, Standardisation z-scores, Min-Max, Distance to a reference, Indicators above or below the mean, Methods for cyclical indicators and Percentage of annual differences over consecutive years.

We can define the weight in the context of composite indicator creation as a value that expresses the relative importance of the indicator in comparison with others. The determination of the weights of the indicators involved in the composite indicator can be accomplished by several methods. They can be divided into two groups. The first group consists of subjective decisions. This includes the following methods: Expert decision, Scoring method. The disadvantage of these weighting methods is, above all, a high degree of subjectivity, which is based on personal perception of preferences.

The second group consists of methods that are based on an accurate (objective) assessment of the weights of the original indicators. The following 7 methods are used in the analysis of regional disparities ($v = 1, \dots, 7$):

1. Equal weighting (EW)
2. Principal component analysis (PCA)
3. Benefit of the doubt (BOD)
4. Unobserved components models (UCM)
5. Budget allocation process (BAP)
6. Analytic hierarchy process (AHP)
7. Conjoint analysis (CA)

There is no uniform approach for aggregating individual indicators into one aggregate indicator. Saisana and Tarantola (2002) list several basic types of aggregation techniques that they consider to be the basic methods of aggregation. These methods are divided according to the way of inclusion of sub-indicators into the calculation into linear, geometric and multicriteria. Aggregation methods also vary. While the linear aggregation method is useful when all individual indicators have the same measurement unit, provided that some mathematical properties are respected. Geometric aggregations are better suited if the modeller wants some degree of non-compensability between individual indicators or dimensions. The MCA method is recommended in the case when highly different dimensions are aggregated in the composite, as in the case of environmental indices that include physical, social and economic data.

The following table (Table 2) shows the compatibility between the different methods of aggregation and weighting:

Table 2. Compatibility between methods of aggregation and weighting

Weighting methods	Aggregation methods		
	Linear	Geometric	Multicriterial
EW	+	+	+
PCA/FA	+	+	+
BOD	+ (Min-Max)	-	-
UCM	+	-	-
BAP	+	+	+
AHP	+	+	-
CA	+	+	-

Source: Saisana and Tarantola, 2002

3. The research results and discussion

As a reference point for the analysis we chose regions at the NUTS II level, since NUTS II is the default level at which EU regional policy is implemented (European Commission, 2015). Within the Visegrad Group countries we are therefore working with a sample of 37 NUTS II regions, 8 of which are Czech (CZ1 – CZ8), 8 Hungarian (H1 – H8), 17 Polish (PL1 – PL17), and 4 Slovak (SK1 – SK4). Socio-economic disparities are characterized by some selected official indicators. For this analysis, it was selected 9 indicators that represent the most frequently indicators used in Cohesion Reports, some of them represent the EU Structural indicators. The reporting period was 2014 and 2017. Some important indicators (e.g. GDP) are not yet officially published in 2018. Indicators characterizing the socio-economic level of the region are given in the following table.

Table 3. Socio-economic indicators

Type of disparities	Indicator	Label
Economic disparities	Gross domestic product	1GDP
	Gross fixed capital formation	2GFCF
	Income of households	3IH
	Human Resources in Science and Technology	4HRTS
	Employment in technology and knowledge-intensive sectors	5ETKI
Social disparities	Employment rates (% of population aged 15-64)	6ER
	Employment rate of woman (% of woman population aged 15-64)	7ERw
	Unemployment rate (% of population aged 15-64)	8UR
	Long-term unemployment - 12 months and more (% of population)	9LUR

Source: Own research

The input data were subjected to statistical analysis. Data consistency and multicolinearity were excluded. Given the different unit of data examined, they were normalized by the Min-Max method, in the case of a positive scope, according to the relation:

$$I_{i,t} = \frac{y_{i,t} - y_{min}}{y_{max} - y_{min}}$$

and in the case of the negative scope of the indicator according to the relation:

$$I_{i,t} = \frac{y_{max} - y_{i,t}}{y_{max} - y_{min}}$$

where $y_{i,t}$ is value of i-th indicator in year t $(2014;2017)$, y_{max} is a maximal value of i-th indicator and y_{min} is a minimal value.

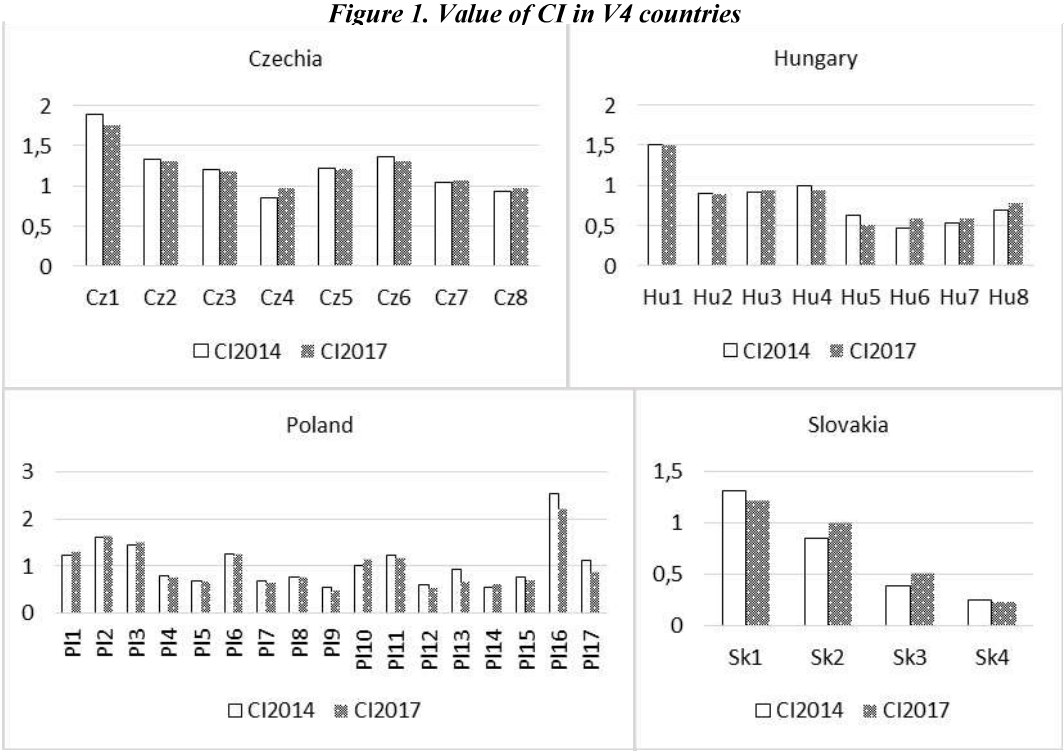
The first EW method was used to determine the weights of each indicator. Using equal weighting method, the equal weight is calculated for each indicator by formula $w_{1,i} = \frac{1}{Q}$, where $Q$is number of indicators. In this case there is a risk that pillar with more indicators will have a higher influence in the composite indicator. But in our case is only one pillar. The main strength of the method is the simplicity.

The principle of using the above method was that the values of the indicator were compared with each other I. The worst region was assigned a value of 0 and the best value was 1. In most countries, the capital was the best region in all respects. Subsequently, a composite indicator C_t^r was calculated for each region *r* in year *t* using a linear aggregation method based on the following formula:

$$C_t^r = \frac{\sum_{i=1}^{n} I_i^t \cdot w_{1,i}}{\frac{\sum_{i=1}^{n}\sum_{t=1}^{T} I_i^t w_{1,i}}{R}},$$

The composite indicator takes values around 1. A value greater than 1 characterizes an above-average region. Value less than 1 below average region. In the following graph, in four figures, there is a comparison of regions within the country in 2014 and 2017.

Figure 1. Value of CI in V4 countries



Source: Own processing

In each V4, country is the highest ranked region per capita. (Cz1, Hu1, Pl16, Sk1). The highest value of the *CI* composite indicator is in the Warszawski stoleczny - Pl16 region (the capital of Poland), $CI_{2014}^{Pl16} = 2{,}55$ a $CI_{2017}^{Pl16} = 2{,}25$. The worst rated V4 region, in terms of the composite indicator, is the Eastern Slovakia region – Sk4, $CI_{2014}^{Sk4} = 0{,}25$ a $CI_{2017}^{Sk4} = 0{,}24$.

In the Czech Republic, the highest ranked region is Prague – Cz1, $CI_{2014}^{Cz1} = 1{,}89$, $CI_{2017}^{Cz1} = 1{,}76$. The worst is region Northwest – Cz4, $CI_{2014}^{Cz4} = 0{,}93$, $CI_{2017}^{Cz1} = 0{,}98$. Two regions are rated below average; the other six regions are above average. There is not much difference between regions, which means the homogeneity of the NUTS 2 regions.

Of the eight Hungarian regions, the best-ranked region is the capital city of Budapest

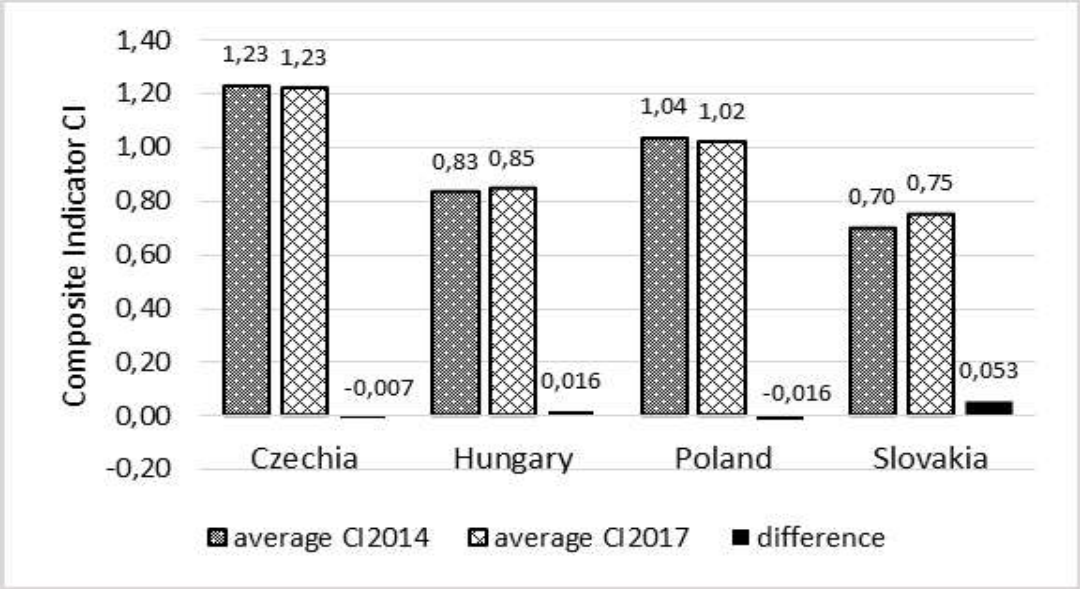
$CI_{2014}^{Hu1} = 1{,}51$ $CI_{2017}^{H1} = 1{,}50$. The worst rated region is Észak-Magyarország – Hu6, $CI_{2014}^{Hu6} = 0{,}48$ $CI_{2017}^{H1} = 0{,}59$. Unlike the Czech Republic, the difference between the best and worst regions is almost 1.

In Poland, the region of the capital is highly above average. *CI* is very high, also in comparison with other capitals of the V4 countries. Of the 17 Polish regions, 9 regions were rated below average. This shows the inhomogeneity of the Polish regions, at the NUTS 2 level. The worst rated region is Warminsko-Mazurskie – Pl9, $CI_{2014}^{Pl9} = 0{,}53$, $CI_{2017}^{Pl9} = 0{,}50$.

In Slovakia, four regions were evaluated at the NUTS 2 level. The highest rated region is Bratislava – Sk1, $CI_{2014}^{Sk1} = 1{,}31$, $CI_{2017}^{H1} = 1{,}23$. The worst rated region is Eastern Slovakia. As mentioned, this region is the worst rated region of all V4 regions.

The following graph shows the V4 countries compared to each other. For each country, the average *CI* value for all regions is expressed in both years and the difference between these values is expressed.

Graph 1. Comparison of V4 countries using average CI

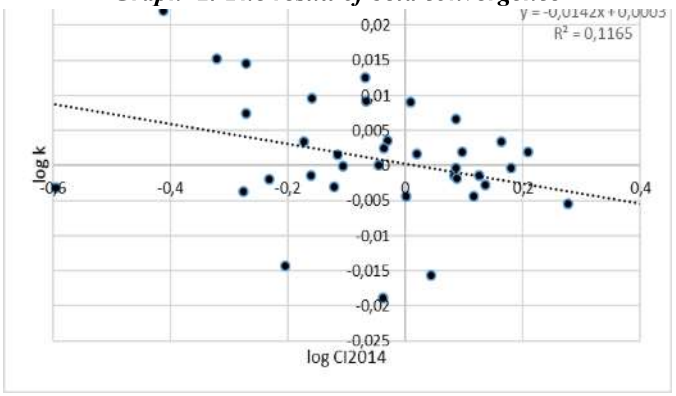


Source: Own processing

The best-rated country is the Czech Republic, while the assessment of its regions shows homogeneity. The average appreciation in 2014 and 2017 is approximately the same, above average in time. Poland is also on average, although there has been a slight decline over the period under review. Below-average V4 countries are Hungary and Slovakia. For these countries, there has been a slight increase in three years. The GDP indicator is very important for economic comparison of the V4 countries. The highest average value for all V4 regions in Poland is € 24186, followed by the Czech Republic € 19582, Slovakia € 1902, and Hungary's € 13193 is the worst in 2017. Hungary and Slovakia are lagging behind the Czech Republic and Poland in all monitored indicators in the period under review.

The reduction of regional disparities is finally analysed by beta convergence. The process of convergence means reducing the differences between objects over time. Under the concept of beta convergence, less developed regions are growing faster than developed ones. The subject of the research is the situation in 2014 and the situation at the end in 2017. The dependence of the growth coefficient k on the initial value CI_{2014} is examined. The result of the analysis is on the following chart.

Graph 2. The result of beta convergence



Source: Own processing

Obviously, over time, regional disparities are diminishing, as the regression coefficient is negative. Statistically, however, the linear regression is not significant as the coefficient of determination is $R^2 = 0{,}1165$. It can therefore be concluded that regional disparities between V4 regions do not diminish.

Conclusion

Nowadays, regional policy, European integration, cohesion policy and regional development are often deceptive expressions mainly in the context of the development of countries that are members of the European Union and countries whose priority is to continuous increase the political, social, economic and environmental level of their own regions. The priority of European integration is continually reducing disparities at the level of economic regions and to enable residents, businesses and others to participate in the benefits that the European Union has achieved in building a common area. The main problem of the European Union is regional disparities concerning differences in elementary economic indicators, competitiveness of economies and business entities. Following the accession of 10 countries to the European Union in 2004 and the subsequent accession of two Balkan countries in 2007, the size of the European market as well as its population has increased considerably. This has doubled the differences.

Regional disparities are evaluated in this article using an aggregate indicator, the composite indicator CI. The composite indicator is constructed from nine simple indicators. With a single value, one can comprehensively look at the position of the region in terms of several socio-economic aspects. The best-rated regions were the capitals of the V4 countries. Warszawa, the worst score in the Eastern Slovakia region, achieved a very high score. These results are generally known. Dynamic analysis was performed using the beta convergence method, subsequently. The analysis does not imply a reduction in regional disparities between the regions of the V4 countries.

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Contact

Dana, Jašková, RNDr., PhD.
Department of Economy and Economics,
Faculty of Social and Economic Relations,
Alexander Dubček University of Trenčín
Študentská 3, 911 50 Trenčín, Slovakia,
e-mail: dana.jaskova@tnuni.sk