THE IMPACT OF CLUSTER COVERAGE ON THE SPI REGION INDEX IN SLOVAKIA

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Abstract: In the article is construction a composite index of social progress for the regions of Slovak Republic, the Social Progress Index. The Social Progress Index is an aggregate index number of social and environmental indicators that capture three dimensions of social progress: Basic Human Needs, Foundations of Wellbeing, and Opportunity. Each of this three dimensions including four components of the Social Progress Index. The main aim of the paper is to construction of the by Social Progress Index for condition of the Slovak regions. This indicator is given in relation to the scope of the cluster in the region. Input indicators included in the Social Progress Index are analyzed using more complex statistical methods. Internal data consistency within each component is verified by Principal Component Analysis. The normalized data are aggregated into a composite indicator and compared.

Keywords: regional policy, cluster, composite indicator, statistical methods.

1 Introduction

The economic development of the Slovak Republic is largely determined by the performance of the regions and the policy of making use of their potential. Effective regional policy requires identification of relevant development factors. An active factor is human resources; passive factors are research, development and innovation, basic infrastructure and services. In addition to the main factors, it is important for the region's development to analyse indicators of economic performance - GDP growth, employment, productivity and assessing their impacts on regional development and growth. Due to the different factors and depending on the starting conditions, the development in the individual regions is different. This is considered an economic and socio-economic problem. This problem impedes development in the economic, social and environmental spheres. The aim of regional policy is to reduce and eliminate these disparities. Reducing disparities is one of the fundamental objectives of the European Union (EU) regional policy.

With the improvement of the socio-economic level of the EU member states related to the development of the various regions also. Achieving this objective is conditional on the level of economic and social development of the member states. This development is, however, between countries at different levels and is determined by the overall situation and the developments in different regions of the member states. The region is seen as a key element in the EU and at the same time an indicator of economic development. At the same time is considered a political, economic, social and cultural unit. (Vojtovič, Krajňáková, 2013)

The uniqueness of the clusters organized on the basis of the regional principle is the uniqueness of the internal environment, the infrastructure, the level of the macro system. This is the region's own, as well as the opportunity to realize its competitive advantages through integration. The cluster acts as a stimulus to economic development. (Krajňáková, 2016)

Activities aimed at improving the prosperity and performance of regions are referred to as regional policy. Regional policy can be defined as a set of objectives, measures and decisions in government activities at the regional level. The priority of regional policy is to ensure the development of the regions and to mitigate major differences in their development. Great emphasis is placed on the efficient use of the region's own resources. The overall economic development of the country is affected by the different socio-economic levels of the regions. Different degrees of regional development stem from inhomogeneous production factories. Regions are also distinguished by the high unemployment rate. (Habánik et al., 2014)

Regional development is defined as a set of economic, cultural and environmental processes and relationships. These relations are taking place in the region and contribute to increasing its competitiveness, economic, social and territorial development. Many authors are currently studying the dynamics of regional development. The first economic models that include the regional development factor are extended versions of neoclassical theories of economic growth. These models assume that free international trade stimulates economic growth and leads to the convergence of economies of mutually trading regions. (Dawkins, 2003)

One of the possibilities of increasing the socio-economic level of the region is to support the development of a predominant sector in the region. Their diversification from one region to another creates a unique environment concentrating businesses of a similar focus. These businesses are trying to exploit the comparative advantages of the region. This creates a network of a range of businesses and organizations linked by specific ties, called cluster. The term cluster is closely related to the theory and practice of regional development. According to Porter (2000), the clusters represent certain geographic concentrations of interconnected enterprises, specialized suppliers, service providers, affiliated companies and institutions (universities, trade unions) in a particular sector (sector) that compete and cooperate with one another. At present, the cluster concept is considered an important regional development element.

Clusters play an important role in the development of individual regions by contributing to increasing their competitiveness. Their importance in regional development lies in particular in increasing the division of labour, increasing migratory flows of workers between enterprises, and the cooperation of enterprises within the department. Clusters are affecting job growth, wage growth, new types of businesses. (Navickas, Vojtovic, Svazas, 2016)

The theme of clusters is still in the interest of experts in several disciplines. In the spotlight is also on components of countries and regions as a tool for increasing the performance and competitiveness of the regions. Regions have different sources of and conditions for the development of a specific industrial sector.
The aim of the article is to identify the social development in the regions of Slovakia by selected social indicators.
On the basis of the aggregate value of the indicator to outline the possible relevance of the existence of clusters in developing the social level of the region.

2 Social progress principles

Regional policy is characterized as a set of objectives, measures and decisions in the development activities of stakeholders (Habánik et al., 2014). Regional development is defined as a system of economic, cultural and environmental processes. These processes take place in the region. Regional development contributes to its competitiveness, sustainable economic, social and territorial development. The region is defined as an administrative unit of the national and local levels. (Cooke, Piccaluga, 2006).

In most studies, the starting inter-comparison is analysis of their economic level. The level is expressed by macroeconomic indicators GDP. (Annoni, Kozovska, 2010) Looking for suitable measures of well-being to assess people´s quality of life is becoming more important on the agendas of government and central institutes of statistics in several countries. An increasing number of programmers are being implemented in European countries. Since its introduction, GDP has been the most widely used indicator of country´s economic performance. However, it is also highly slated as a measure of people´s wellbeing. Indeed, GDP is measure of production, but it ignores the undesirable side effects, such as pollution, environment, which often accompany production growth. But GDP does not include in its

calculation a number of factors which significantly affect people´s quality of life. Included there are, for example, the quality of education, health, care, environment, social relations, personal safety, decent housing. (Ferrara, Nistico, 2015)

The Social progress Index was launched in April 2013 at the 10th annual Skoll World Forum held at the University of Oxford. The European Union Regional Social Progress Index (EU-SPI) was a key project of several European institutions. Index construction was based on Global Social Progress Index developed by the Social Progress Imperative. The Global Social Progress Index has been published in 2014 and 2015 for over 130 countries in the world. The Social Progress Imperative defines concept social progress as the capacity to meet the basic human needs of its citizen. The definition further includes three broad elements of social progress: Basic Human needs Foundations of wellbeing and Opportunity. The *EU-SPI* provides a consistent and comparable measurement of the regions of the EU social and environmental area. The *EU-SPI* is based on a different set of indicators but set of dimensions and components in the same. (Pate, Sweo, 2016)

2.1 Methodology of construction SPI

The indicator can be considered as a special subset of statistical results. A general definition of the concept, which would be applicable in all areas of official statistics, does not exist. There are several approaches to this definition. By the first approach the SPI indicator is characterized as a combination of statistical results using a defined algorithm in the form of derived measurements. The second principles use normative interpretation with the possibility of determines categories. The third principle involves mainly social statistics such as health, education and quality of work. In this sense, indicator includes something wider than is actually measured. The fourth approach is engaged in synthetic indicators. They are formed by combining of individual indicators, while using different methods weighting of each group.

The indicator is a statistical tool that monitors the nature and level of phenomena and processes monitor their development, changes and trends. This results in certain properties of the indicator:

- significant, relevant, understandable,
- transparent,
- analytical,
- complete,
- credible,
- internally comparable,
- externally comparable,
- intertemporal. (Michálek, 2013)

The composite indicator is an indicator that is constructed from sub-indicators. The indicators are often presented in the different units which have different levels and have different variability. (Minařík, 2013)

The *EU-SPI* is composite indicator of fifty social and environmental indicators that capture three dimensions of social progress. There are: Basic Human Needs, Foundations of Wellbeing and Opportunity. Each of these three dimensions is further broken down into four underlying components. The list of these sub-indicators is:

1. Basic Human needs: Nutrition and basic medical care; Water and sanitation, Shelter, Personal safety.
2. Foundation of wellbeing: Access to Basic knowledge, Access to Information and Communications, Health and Wellness, Environmental Quality.
3. Opportunity: Personal Rights, Personal Freedom and Choice, Tolerance and inclusion, Access to Advanced Education.

Each component is measured through several indicators. One of the main differences with other Wellbeing indexes is that the regional *EU-SPI* includes only social and environmental indicators. Index *EU-SPI* excludes regional GDP or income-based indicators. This is because the main aim is in fact to express social progress directly. By excluding economic indicator, the SPI index can systematically analyses the relationship between economic development (measured for example by regional GDP) and social development.

The Index has been constructed to be relevant and comparable for all the regions. Regional index *EU-SPI* allows regions comparing to any degree of economic levels. Index helps regions with a lower *EU-SPI* learn from regions with higher this Index. All components included in *EU-SPI* will identify significant differences, for example, of access to health care, quality of housing, personal safety, higher education, access to ITC, environmental pollution.

Data source are Eurostat, EU-SILC, European Environmental Agency, The Gallup World Poll, The Quality of Government Institute of the University of Gothenburg and Eurobarometer. 272 EU regions were compared. The study concluded alignment of EU regions at NUTS 2 level by EU-SPI values. Best rated region was the region Övre Norrland in Sweden in 2015 year. Worst rated was region Yugoiztochen in Bulgaria. Of the 272 regions of the Slovak regions placed as follows: Region of Bratislava (181), West Slovakia (229), Central Slovakia (221) and East Slovakia (243). Construction of *EU-SPI* consisted from the following steps:

- selection of observational units,
- checking for statistical internal consistency within each components,
- standardization,
- aggregation,
- computing regional comparison score,
- testing scores and rankings through an extensive robustness analysis.

The achievement of main aim of this paper is basic research of regional differences in the social field of Slovak Regional Social Progress Index (in the next part we will use the abbreviation *S-SPI*). The first analysis was based on data in 2016 and the second for data in 2017. The process design is identical to the steps describe above.

3 Construction of *S-SPI*

This section describes the construction procedure of composite indicator S-SPI. This process is in accordance with the methodology published in document The EU Regional SPI: a measure of social progress in the EU regions, methodological paper. (Annoni, Dijkstra, 2013) The advantage of the summary indicator is a simple comparison of regions. The disadvantage is the different interpretations using different methods. Custom design composite indicator is described in several subsections and steps.

3.1 Selection of observational units

Those requirements must be respected in selection of appropriate indicators. The number of indicators should not be small or too large. Indicators need to be regularly measured and officially published. Index *EU-SPI* was constructed for all regions at the NUTS 2 level. This paper provides a description of the regional *S-SPI* calculated for all NUTS 3 regions in the Slovak Republic (eight self-governing regions). Appropriate division of observational units is fairly debated issue.

3.2 Selection of appropriate indicators

In the design of the *S-SPI* have been 20 indicators. The composite indicator was calculated from data for 2015 and 2017. Selection of appropriate indicators was based on the official availability on NUTS 3 level. Data was retrieved from Slovak Statistical Office, Ministry of Interior and Ministry of Education.

Due to the mutual comparability of the data, they were divided by mid-year population in the region in 2015 or 2017.

At level of self-governing regions, we encounter the problem of missing data in official databases. the literature on the analysis of missing data is extensive and rapid development more comprehensive methods can be found in Little, Rubin (2002). Whenever one or more indicators are observed at the country level only, an imputation method is adopted which imputes data by statistical imputation using available data. The formula for the calculation of the $j-th$ indicator of $r-th$ region $y_{j,r}$ at NUTS 3 level, from y_{nat} at NUTS 1 level is

$$y_{j,r} = \frac{y_{nat}}{\frac{1}{n}\sum_{i=1}^{n}\frac{x_{i,nat}}{x_{i,r}}},$$

where $x_{i,nat}$ is the value of indicator x_i at the county level and $x_{i,r}$ is value of indicator x_i for region r.

We selected for dimension Basic Human Needs these indicators: x_1- Mortality rate before age 65 (MR), x_2- Infant mortality (IM), x_3- Beds in health facilities (HF), x_4- Water supply from public water supply (WS), x_5- Sewage treatment (ST), x_6- Living area (LA), x_7- Burdensome cost of housing (BCH), x_8- Number of offenses (NO), x_9- Number of forfeited (NFF), x_{10}- Homicide rate (HR), x_{11}- Number of fires (NF). For dimension of Foundations of wellbeing we selected these indicators: x_{12}- Secondary enrolment rate (SE), x_{13}- Number of posts, x_{14}- Internet at home (IH), x_{15}- Risk of poverty (RP), x_{16}- Life expectancy at birth (LEB), x_{17}- Environmental quality (EQ), x_{18}- Production of pollutant emissions (PPE). In the dimension of opportunity was selected following indicators: x_{19}- Gender gap (GG), x_{20}- Tertiary education attainment (TE). Given the direction, it went into the analysis of eleven positive indicators and nine negative indicators.

3.3 Components internal consistency

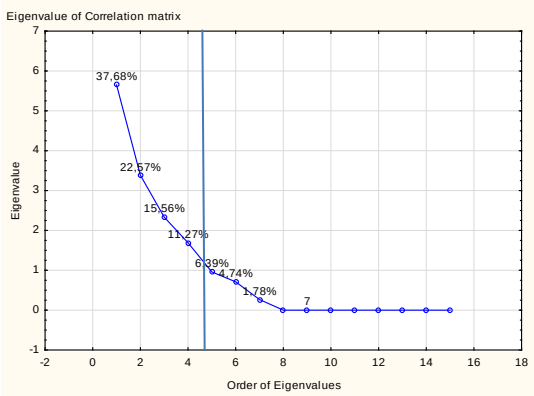
The issue of aggregating indicators into a single composite indicator is an increasingly discussed topic. The aggregation process always implies the choice of weights or use aggregation method. Both issues play crucial role when assessing regional disparities. Internal consistency is verified by classical multivariate method, principal component Analysis (PCA). PCA method is useful statistical technique for finding patterns in data of high dimension. Using method is based on the properties of the correlation matrix of variables. Initial variables will be replaced by smaller number of new variables, called latent variables – the main components. This process consisted of the following three steps.

Step 1: Exploratory analysis
Exploratory data analysis is a critical first step in analysis from an experiment. The purpose of the analysis is to detect the presence of particularities between the data and verify the assumptions for further statistical processing. For this purpose, were calculated descriptive characteristics (mean, variability, asymmetry). By graphical methods we have identified the presence of outliers (Grub´s test), data independence (ACF), homogeneity (Box Plot) and normality (K-S test, N-E test and Lilliefors´s test). In descriptive statistics was calculated Coefficient of variance too. The value of this coefficient was used in subsequent analyses as a decision criterion for the selection of appropriate indicators. This exploratory analysis shows that the data meet the required minimum prerequisites for further analysis. The next step consists of variable´s transformation for some indicators, due to the value of the coefficient of skewness, where the absolute value of this coefficient was higher than value 1.

Step 2: Correlation analysis
After one-dimensional analysis of variables we performed the correlation analysis. For the strong correlation between the indicators we considered while the correlation coefficient applies $|r| > 0{,}9$. These values have been diagnosed by the inverse correlation matrix and subsequent VIF factor. The Variance Inflation Factor (VIF) measures the impact of collinearity among the variables in regression model. If value $|VIF| > 10$, than multicollinearity is high. For further analysis we considered as a key indicator one who had the greatest variability (Coefficient of variation) and seemed to be more appropriate for the description of interregional disparities. The correlation analysis shows that from structure of composite indicator should be removed five indicators: WS, BCH, NO, SE, TE. The further analysis it went fifteen indicators.

Step 3: Principal Components Analysis
Fifteen indicators were analyzed by analysis of PCA. Its aim was identify the key indicators and transform the original data to new latent variables. The suitability of selected indicators was statistically assessed by Kaiser-Meyer-Olkin´s criterion (KMO). KMO test is a measure of how suited your data is for PCA analysis. The test measures sampling adequacy for each variable in the model and for the complete model. Since the covariance matrix is square, we ca calculate the eigenvectors and eigenvalues for this matrix. These are rather important, as tell us useful information about our data. For further analysis we recommend to retain only those components that have their eigenvalue is greater than 1. Subsequently we selected the first fourth components that are explaining 94,34 % of the total variance. This stems from the Kaiser criteria. In another analysis they are preserved only those components that have modified a number greater than 1. (Meloun et al., 2012). Proper selection of components can be assessed according to the Cattell index cart.
From this graph (Figure 1) of eigenvalues, we can identify the main components. The most important components are separated by a vertical line.

Figure 1 Cattell Index graph



Source: own processing in program Statistica

In terms of further reduction of indicators and finding key indicators are included in the next analysis only those indicators that have a value of the correlation coefficient above 0,7. (Hrach, Mihola, 2006) The values of the correlation coefficients between first fourth factor coordinate with indicators are the basis for further reduction of indicators. Omitted indicators are: x_2, x_{18}. Thirteen other indicators will be used later in the step "Weighting and aggregation" to construct weights for the *S-SPI* composite indicator table.
The results of PCA analysis allows to determine of q-th indicator weight in any time as:

$$w_i = |r_{i,j}|var_j$$

Where $r_{i,j}$ is value of correlation coefficient of the i-th indicator ($i = 1{,}2, \ldots, 13$) of the j-th component. The values of weights are assigned to each indicator are shown in next table (Table 1).

Table 1 Weight of individual indicators

Indicator	Mark	Weight	Indicator	Mark	Weight
MR	x_1	0,30	NP	x_{13}	0,27
BHF	x_3	0,08	IH	x_{14}	0,16

ST	x_5	0,30	RP	x_{15}	0,28
LA	x_6	0,20	LEB	x_{16}	0,30
NFF	x_9	0,15	EQ	x_{17}	0,35
HR	x_{10}	0,32	GG	x_{19}	0,28
NF	x_{11}	0,13			

Source: own research

From the results of the PCA analysis, it is clear that the largest weight is associated with the indicator Environmental quality and lowest weight to indicator Beds in health care. The calculated weight was used for the 2015 indicators also from 2017. Normalization of data is required prior to any data aggregation as the indicators in a data set often have different measurement units. The method Min-Max was used. Using this method, the indicators are normalized to the interval $\langle 0,1 \rangle$. If the indicator is positively oriented, we use the following relationship for region r:

$$I_{i,r} = \frac{x_{i,r} - \min(x_i)}{\max(x_i) - \min(x_i)}$$

and in the case of negative force of $x_{i,r}$, the normalization is realized through the formula:

$$I_{i,r} = \frac{\max(x_i) - x_{i,r}}{\max(x_i) - \min(x_i)}.$$

For calculation of $S-SPI$ was used Additive aggregation method. The composite indicator $S-SPI$ for each region r was finitely calculated by formula:

$$S - SPI_r = \frac{\sum_{i=1}^{n} I_{i,r} w_i}{\frac{\sum_{i=1}^{n}\sum_{r=1}^{m} I_{i,r}}{m}},$$

where w_i is weight of q-th indicator. If $S - SPI_r = 1$, the region is assessed as an average. If $S - SPI_r > 1$ that means the above average appreciation of region, $S - SPI_r < 1$ means, that region is evaluated as a below average. The resulting values of regional $S - SPI_r$ for 2015 and with ranking is in next table.

Table 2 SPI values for regions

Region (r)	$S - SPI_r$	Order
Trenčín (TN)	1,273	1
Bratislava (BA)	1,104	2
Prešov (PO)	1,079	3
Trnava (TT)	1,057	4
Žilina (ZA)	1,036	5
Nitra (NR)	0,894	6
Banská Bystrica (BB)	0,796	7
Košice (KE)	0,760	8

Source: own research

Best rated region was Trenčín, Index $S - SPI_r$ reached around 0,71 better than Bratislava region. It is interesting because the assessment which take into account economic indicators Bratislava region dominates these two regions as only amounted $S - SPI_r$ greater than 1. They can therefore be considered as region with above average $S - SPI_r$. Indicators of quality of lie in these regions are excellent. The second group may include regions of Prešov, Trnava and Žilina. the index value is close 1. These regions can be considered in terms of $S - SPI_r$ for average. The last third group consists of region Nitra, Banská Bystrica and Košice. In these cases, the $S - SPI_r$ is less than 1 and therefore consider them in terms of $S - SPI_r$ as below average.

4 Comparison of *S-SPI* indicators between 2015 and 2017

In 2018 year, a similar analysis of the social progress of the regions in Slovakia was carried out. The calculation method of the aggregate index was the same as for two years.

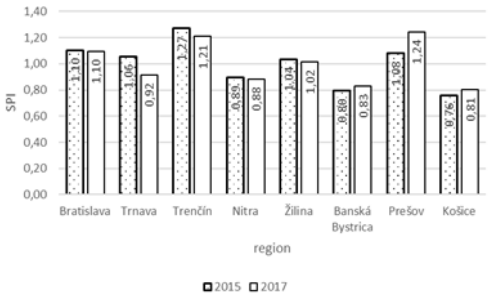
Table 3 The resulting comparison of the regions

Region (r)	$S - SPI_r$	shift	Order	shift
Prešov (PO)	1,243	↑	1	↑↑
Trenčín (TN)	1,210	↓	2	↓
Bratislava (BA)	1,096	↓	3	↓
Žilina (ZA)	1,017	↓	4	↑
Trnava (TT)	0,917	↓	5	↓
Nitra (NR)	0,883	↓	6	
Banská Bystrica (BB)	0,829	↑	7	
Košice (KE)	0,805	↑	8	

Source: own research

From the table it is evident that the region of Prešov increased during the years, the value of the index $S - SPI_r$. From the region's average rating in 2015, the region has been over-rated in terms of the indicators monitored. The Trenčín region is still above average. In 2017 he dropped to second place. The value of the index $S - SPI_r$ has decreased by 0,063. As compared to the fallen region Bratislava and Trnava. The value of the index $S - SPI_r$ in this region in 2017, the region indicates that it is below average. The order of Nitra, Banská Bystrica and Košice has not changed. In the regions of Banská Bystrica and Košice, the value of the monitored index has risen, but these regions are still rated as below average. In the following chart (Figure 2), the calculated index values of $S - SPI_r$ are systematically compared for individual regions in 2015 and 2017.

Figure 2 Comparison of regions in 2015 and 2017



Source: own processing

5 The assessment of social progress for the creation of the cluster

In the introduction, the impact of cluster coverage in the region on its socio-economic development was described. In the year 2018 in the Slovak Republic there were 20 clusters. The highest number of clusters is in Košice region (5), the lowest in Trenčín, Banská Bystrica and Prešov (2). According to Havierniková (2016), the placement of cluster from a point of view of typology corresponds with economic structure of regions. Slovak cluster typology is using clustering in two groups of cluster: technological and tourism. However, it seems more appropriate to proceed on the following division of clusters: tourism cluster, cluster of information and communication technologies, existing industrial clusters, and creative and cultural industries cluster. Particularly creative and cultural clusters represent a certain impetus in the future to increase social progress in the region.

6 Conclusions

The official site of the Institute of Social progress is imperative from the perspective of the order of the countries in the year 2018 $EU-SPI$. The highest value of $EU-SPI$ reached Norway, and the highest was rated by the pillar of the Basic Human Needs. Slovakia placed 35 spot with a high score for a Basic Human Needs, but a very low score of Opportunity dimension (0.65). For comparison, in the year 2017 has been the highest-rated country Denmark and Norway was rated as the third best. This year the Slovak republic ended on 30 sites. The aim was to assess the contribution of the regions of Slovakia, between 2015 and 2017 years, from the point of view of social development. The social aspect was just concerned with the

calculation of $EU - SPI$.bIn each of the years analyzed had been drawn up to the order of NUTS level 3 regions of Slovakia. All available indicators recommended by the EU institutions in the SPI calculation were taken into account. Based on the clusters in these regions, efforts have been made to find the cluster's impact on the social development of the region. To better evaluate the impact, it would be useful if the cluster's scope was differentiated into subgroups. There is also a lack of official information on the functioning of these subgroups.

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