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## EVALUATION OF SELECTED REGIONAL DEVELOPMENT INDICATORS BY MEANS OF CLUSTER ANALYSIS

*The paper evaluates the development of selected regional development indicators in the regions of Slovak Republic. The authors deal with such selected indicators (due to data availability) as wages, number of SMEs as well as number of entrepreneurs per 1,000 citizens and density of roads using cluster analysis. The aim of this comparison is to establish the similarities between particular Slovak regions in the context of the selected indicators in 2002, 2006, 2011 and 2013.*

*Keywords:* regional disparity; cluster analysis; Slovak Republic.

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## ОЦІНЮВАННЯ ВИБРАНИХ ПОКАЗНИКІВ РЕГІОНАЛЬНОГО РОЗВИТКУ ЗА ДОПОМОГОЮ КЛАСТЕРНОГО АНАЛІЗУ

*У статті проведено оцінювання динаміки вибраних показників регіонального розвитку на прикладі регіонів Республіки Словаччина. Через обмеженість наявних даних використовувалися такі показники: середній рівень заробітної плати, кількість одиниць МСБ та приватних підприємств на 1 тис. населення та щільність автомобільних доріг. Для аналізу даних застосовано кластерний аналіз, що допоміг виявити схожі риси розвитку регіонів Словаччини для окремих років – 2002, 2006, 2011 та 2013.*

*Ключові слова:* регіональні диспропорції; кластерний аналіз; Республіка Словаччина.

*Форм. 5. Рис. 4. Табл. 6. Літ. 37.*

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## ОЦЕНКА ИЗБРАННЫХ ПОКАЗАТЕЛЕЙ РЕГИОНАЛЬНОГО РАЗВИТИЯ ПРИ ПОМОЩИ КЛАСТЕРНОГО АНАЛИЗА

*В статье проведена оценка динамики избранных показателей регионального развития на примере регионов Республики Словакия. В связи с ограниченностью доступных данных использованы такие показатели: средний уровень заработной платы, количество единиц МСБ и частных предпринимателей на 1 тыс. населения и плотность дорожного покрытия. Для анализа данных применён кластерный анализ, который помог выявить схожие черты развития регионов Словакии по отдельным годам – 2002, 2006, 2011 и 2013.*

*Ключевые слова:* региональные диспропорции; кластерный анализ; Республика Словакия.

**Introduction.** One of the basic targets of the European Union (EU) is decreasing regional disparities. The aim of economy policy in many countries is to settle disparities within the country. Achievement of the EU goals means its member countries must identify not only their own shortages but also find suitable solutions and simultaneously overcome social and economic disparities in their regional development. Regional policy and regional development belong to the most important activities of the EU today. The EU enlargement has increased regional disparities among the regions of its member countries. This has also brought new challenges in terms of cohesion policy. At the same time programs supported by structural funds should contribute to strengthening competitiveness of particular regions and economies as a whole. Within the regional EU policy, one of the most important targets has become speeding up the convergence of the least developed regions. Convergence of regional

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disparities is a complex problem for many countries. The important part of regional policy and development is the identification of regional disparities. As shown by the results of scientific research projects VEGA 1/0233/16 and VEGA 1/0953/16 realized at Faculty of Social and Economic Relations (Alexander Dubcek University of Trencin, Slovak Republic) differences in socioeconomic level of individual regions are reduced. Slovak Republic as a member of the EU realizes many projects aimed to decrease regional disparities between European West and Poorer East. This development however is determined by selection and construction of indicators.

**Literature review.** In this paper the authors will be dealing with evaluation of regional disparities which are based upon knowledge of regional policy and regional development. Many national and international authors focus on the importance of regional policy and regional development in various ways: theoretical knowledge in regional development (Blazek and Uhler, 2002; Pike et al., 2008), practical and theoretical issues related to regional development (Tvrdon, et al., 1995; Falt'an and Pasiak, 2004; Benco, 2005; Habanik et al., 2013), issues related to measuring economic effectiveness and economic growth (Solow, 1956; Baumol, 1986; Barro and Sala-i-Martin, 1990), territorial development in terms of region, municipality or country (Hudec et al., 2009), regional development, regional policy, regional growth and regional convergence in the EU context (Armstrong and Taylor, 2000; Cuadrado-Roura et al. 2002; Belajova and Fazikova, 2005; Lipkova et al., 2011; Eckey and Turck, 2007; Gerulova et al., 2010; Ivanicka and Ivanickova, 2007; Monfort, 2008; Huttmanova, 2009; Vyrostova, 2010; Betakova et. al., 2014).

Regional policy is the integration factor in the system of economy policy at both macroeconomic and microeconomic level by means of its instruments and indicators as well as in the regional economy environment (Habanik, 2011; Habanik and Koiso, 2011; Bucek et al., 2010; Eckey and Turck, 2007; Cuadrado-Roura, 2010). As stated in the Treaty of the Union, European regional policy is mainly about the reduction of disparities among regions in Europe. Thus, European regional policy is focused on the creation of right economic and institutional conditions in a given region for sustainable economic development which creates new economic opportunities and jobs that might increase regional income (Landabaso et al., 2001).

Regional development is conditioned by social and economic environment and the potential of a region in the area of human resources and employment, research and innovative capacity, entrepreneur environment and institutional arrangements, competencies and resource allocation, infrastructure etc. (Armstrong and Taylor, 2000; Pike et al., 2008; Masarova, 2009; Vyrostova, 2010). According to various Slovak and international scientific and specialized sources, disparity within regional development is interpreted as different stages of social and economic development that form inequalities between individual units compared (Eckey and Turck, 2007; Bucek et al., 2010; Cuadrado-Roura, 2010; Mynarzova and Svajdova, 2010; Habanik and Koiso, 2011).

An important aspect of regional policy and regional development is the selection of the criteria for evaluation of regional disparities (Spankova and Grecnikova, 2013; Masarova, 2014). Indicators are values and parameters resulting from measured or estimated data which are intended to demonstrate the changes. Regional development level reached is measured by statistics indicators where we are observing, eval-

uating and analyzing representativeness, verifiability and methodic unity of basis (Koisova, 2013). However, the indicator set deals with the areas of sustainable development, social cohesion and inclusion, economic growth and employment. Unified sustainable development indicator system which would be generally respected does not exist, yet. There have been developed many indicator systems in the world (e.g., by the UNO and also by the EU institutions – eStatistical Office of the European Union – Eurostat, European Environmental Agency (EEA), Organisation for Economic Co-operation and Development (OECD), own systems of particular countries). In the conditions of Slovak Republic the related selection depends on data availability in the databases of statistical offices.

**Problem statement and research objectives.** The authors analyze the selected indicators that may significantly affect the development or attenuation of region. The objective of this paper is to determine development of similarities between Slovak regions in the context of the indicators selected for 2002, 2006, 2011 and 2013 and to evaluate their dynamics.

**Methods.** The article uses the multidimensional statistical method of cluster analysis to analyze hidden relationships involving a broad scale of techniques (Rezankova et al., 2011). By means of this statistic method it is possible to realize the identifying groups of objects that are similar to each other but different from the objects in other groups. Cluster analysis forms clusters based upon similarity within the cluster (in our case regions), as well as the major difference between individual clusters. Cluster analysis is a general logical proceeding formulated as a procedure according to the objects organized into groups by their similarities (or differences). Cluster analysis is a convenient method for identifying homogenous groups of objects called clusters (Mooi and Sarstedt, 2011). A cluster is therefore a collection of objects which are "similar" between them and "dissimilar" in relation to other clusters (Madhulatha, 2012). The results of cluster analysis are recorded in a dendrogram which depicts the created clusters. The distance between objects is expressed by various ways. One of them is the Euclidean distance (Minarik et al., 2013).

E. Koisoa (2013) mentions that the most frequently used rates of similarity are metrics. In particular way, they use geometric representation of the object in space as point. The Euclidean distance is the square root of the sum of squared differences in variables' values (Mooi and Sarstedt, 2011). The most common metric is the Euclidean distance. Let us have two-dimensional space ( $m = 2$ ) and two points  $A = (x_1, x_2)$ ,  $B = (y_1, y_2)$  while Euclid distance between these two points is  $d_{AB}$ . Then the Pythagorean theorem is applied:

$$d_{AB} = \sqrt{(y_1 - x_1)^2 + (y_2 - x_2)^2}. \quad (1)$$

In the case of  $m$  – dimensional space, the Euclidean distance between points

$$A = (x_1, x_2, x_3, \dots, x_m), \quad B = (y_1, y_2, y_3, \dots, y_m) \quad (2)$$

is equal

$$d_{AB} = \sqrt{\sum_{k=1}^m (y_k - x_k)^2}. \quad (3)$$

The squared Euclidean distance is also used:

$$d^2_{AB} = \sum_{k=1}^m (y_k - x_k)^2. \quad (4)$$

An important assumption of cluster analysis is the use of standardised variables. Based on the organisation of objects into clusters, we distinguish hierarchical and non-hierarchical methods of cluster analysis. Hierarchical methods are based on individual objects and by their linking the number of clusters decreases. In this paper, apart from the cluster analysis, we have also used the coefficient of variation to measure disparities.

For evaluation of regional disparities we use the coefficient of variation expressed by the formulas:

$$V_k = \frac{s}{\bar{x}} 100 \text{ (\%)} \text{ or } V_k = \frac{s}{\bar{x}} = \frac{\sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}}}{\bar{x}}. \quad (5)$$

**Key results.** Slovak Republic is the Middle European inland country, with 5410836 citizens (as of 31.12.2012). It is located on the area of 49036 km<sup>2</sup> which means its occupancy density is 110 citizens per km<sup>2</sup>. Bratislava, the capital city, has the population of 415589. Slovakia is divided into 8 administrative regions: BA – Bratislava region, TT – Trnava region, TN – Trenčín region, NR – Nitra region, ZA – Žilina region, BB – Banská Bystrica region, PO – Prešov region, KE – Košice region, with 79 districts and 2890 villages. We have observed similarity, respectively dissimilarity of Slovak regions in the context of the researched indicators for the selected years – 2002, 2006, 2011 and 2013. We have determined the year 2002 as a starting year followed by year 2006 which showed favorable development in the growth rate of Slovak economy but also in other economic indicators. In 2011, in Slovak Republic, the consequences of the economic crisis were abating. 2013 was the last year of the observed period in which statistical data to research the selected indicators were available. We have selected the indicators which should enable us examine disparities in detail and which support economic and social development with regard to their inner potential activation for regional sustainable development in Slovak Republic. Regional disparities will be observing by means of the indicators such as average wage, unemployment rate, number of small and middle-sized companies, number of entrepreneurs, density of road network, highways and high-speed ways. In the paper, we use the data on these indicators provided by the Statistics Office of Slovak Republic.

*The unemployment* is expressed by the indicator of unemployment percentage rate. It indicates what percentage of the total number of economically active population is represented by the unemployed people. The analysis of unemployment as an economic and social phenomenon and of unemployment trends shows is conducted in relation to the period of stabilization and relative economic growth, which followed after the transformation of economic systems in the countries of Central and Eastern Europe. We use the data on unemployment rate provided by the Slovak Statistics Office, Labour force sample survey.

Table 1. **Unemployment rate, %** (Statistical Office of Slovak Republic)

Region	2002	2006	2011	2013
BA	8.6	4.3	5.8	6.17
TT	16.1	8.8	10.6	9.16
TN	11.3	7.1	8.7	10.74
NR	23.8	13.2	12.5	12.52
ZA	17.3	11.8	14.3	12.51
BB	25.2	21.1	17.5	18.26
PO	20.1	18.1	17.8	19.35
KE	24.1	20.3	19.6	17.23

*Wage* is a reward for performance and it depends on quantity, quality, responsibility and social importance of a particular work and it also depends on profession, skills and qualification (Masarova, 2011; Grecnikova et al., 2013). In Slovak Republic, statistical data about average wages by regions are available in the database of the Statistical Office.

Table 2. **Average wages, EUR** (Statistical Office of Slovak Republic)

Region	2002	2006	2011	2013
BA	585	825	1001	1049
TT	414	584	735	745
TN	404	544	687	750
NR	379	511	662	680
ZA	400	546	707	732
BB	386	520	652	706
PO	359	468	608	636
KE	433	595	726	758

*Small and medium-sized enterprises (SMEs)* play an important role in developed market economies because they represent economic subjects which are able to react flexibly to changes in economy. They react flexibly to market demands, contribute to the increase of innovative activities, creation of competitive environment and they are also the most important creator of new job (Okreglicka et al., 2015).

Table 3. **Number of SMEs per 1000 inhabitants**  
(Statistical Office of Slovak Republic)

Region	2002	2006	2011	2013
BA	25.94	43.83	69.52	78.29
TT	8.74	13.92	21.24	24.11
TN	8.46	14.76	19.16	21.36
NR	6.93	11.69	20.11	24.42
ZA	8.82	13.22	19.93	23.76
BB	8.21	13.27	18.76	50.50
PO	6.79	11.56	17.31	19.77
KE	8.75	13.27	18.49	20.77

*Numbers of SMEs and entrepreneurs* are the indicators of entrepreneurial activities in a particular region. One more indicator is the number of small and medium-sized enterprises and the number of traders. It is about the enterprises with the number of employees between 0 and 249. In the analysis, it is necessary to calculate this indicator per 1000 inhabitants due to size differences of particular regions in SR.

Other researched indicator is *road infrastructure*. J. Masarova (2009) defines road infrastructure as a network of terrestrial communications which enable connection of two or more locations and serves for personal and cargo transportation. Road infrastructure includes all roads and communications and also equipment and constructions, objects and products which are located on them and are needed to ensure secure, speedy, continuous and economic traffic. Most frequently road transportation is divided into road, local and purpose-built communications. We consider road infrastructure to be an important indicator of regional development (Masarova and Koiso, 2011). In the analysis, we work with two indicators such as roads density in km to 1000 km<sup>2</sup> and density of highways and high-speed roads in km to 1000 km<sup>2</sup>. Road network on the regional level consists of highways, high-speed roads and roads of 1st, 2nd and 3rd class. We pay special attention to the highest level of roads such as highways and high-speed roads. For better understanding, it was necessary to calculate these indicators per 1000 km<sup>2</sup>.

Table 4. **Density of roads, km per 1000 km<sup>2</sup>** (Statistical Office of Slovak Republic and Road Database of Slovak Road Headquarters)

Region	2002	2006	2011	2013
BA	388	390	394	391
TT	470	470	471	469
TN	413	416	420	416
NR	403	403	410	409
ZA	290	293	300	298
BB	334	337	339	338
PO	343	344	352	351
KE	353	352	352	352

Table 5. **Density of highways & speedways, per 1000 km<sup>2</sup>** (Statistical Office of Slovak Republic and Road Database of Slovak Road Headquarters)

Region	2002	2006	2011	2013
BA	50.19	52.14	55.33	54.41
TT	21.70	22.45	22.55	22.54
TN	14.69	17.43	20.79	19.86
NR	2.95	3.41	10.72	9.98
ZA	6.73	7.22	12.82	12.4
BB	1.17	8.21	10.44	10.96
PO	2.09	3.40	9.84	9.84
KE	0.82	4.35	4.38	6.6

Before the examination of regional disparities' evolution in the case of regional development of Slovak Republic by means of cluster analysis, we realized the analy-

sis the development of variation coefficient for the particular researched indicators for the years 2002, 2006, 2011 and 2013. The lowest disparities in the development of particular indicators were unambiguously identified in 2013, while 2006 was the most critical year. From the indicators perspective, the biggest decrease in disparities was in density of highways and speedways per 1000 km<sup>2</sup>. It decreased from 126.3 to 79.34.

Table 6. The development of variation coefficient, authors'

Year	2002	2006	2011	2013
Unemployment rate	31.35	44.76	33.9	32.96
Average wages, EUR	15.67	17.78	15.55	15.44
Number of SMEs per 1000 inhabitants	57.58	60.28	65.13	59.45
Density of roads, km per 1000 km <sup>2</sup>	13.96	13.76	13.37	13.31
Density of highways & speedways, per 1000 km <sup>2</sup>	126.3	104.75	81.93	79.34

In the next part of the paper we present the most important results obtained though cluster analysis in the observed periods. In 2002, two main clusters can be seen: first is represented by the Bratislava region where almost none of the indicators shows similarity with the ones of other regions. The second is formed by indicators of other Slovak regions. This cluster is formed by other regions of SR and we identified the biggest similarity in the regions of Kosice, Banska Bystrica, Presov, Nitra, Trencin and Trnava. We can see that in this cluster Kosice stands separately.

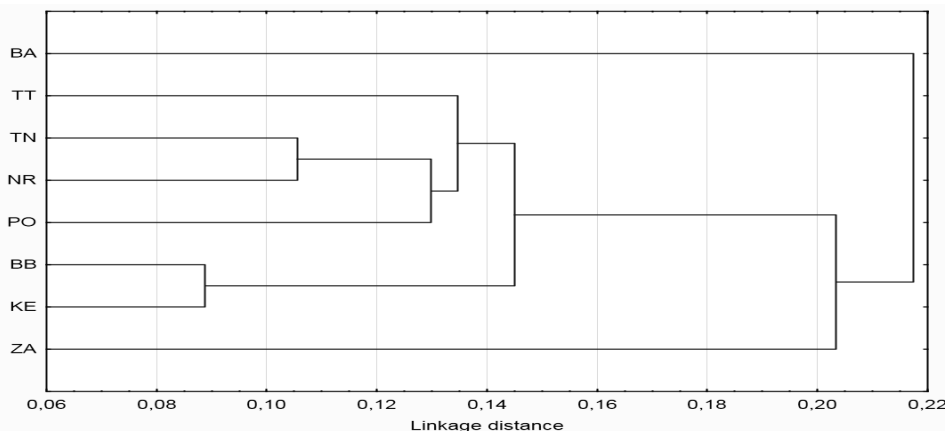


Figure 1. Cluster analysis of regional development of the selected indicators, 2002, own elaboration in "Statistica"

The cluster analysis dendrogram for 2006 proves similar development as in 2002, when two basic clusters were created. Again, one cluster is formed by separately standing Bratislava Region which differs significantly from other regions and reaches considerably better results in the observed indicators as compared to other regions of the SR.

In 2011, the first cluster was changed for the first time. This cluster is now formed by Bratislava and Zilina Regions. Better position of Zilina occurred due to

positive development in the number of traders per 1000 inhabitants and the number of SMEs, and better highways and high-speed ways density.

In 2013 the regions were again divided into 2 clusters which consisted of 4 regions: the first cluster was formed by Bratislava, Zilina, Banska Bystrica and Kosice. The increase in the number of SMEs from 18.76 in 2011 to 50.50 per 1000 citizens in 2013 contributed to propitious development in Banska Bystrica. The second cluster consisted of the regions Trnava, Nitra, Trencin and Presov. Trnava and Nitra showed the greatest similarity in this cluster. However, it is interesting that Trencin region reported the biggest similarity with Presov in that year. In Trencin region all the indicators were developing unpropitiously except the number of SMEs per 1000 citizens and the average wage.

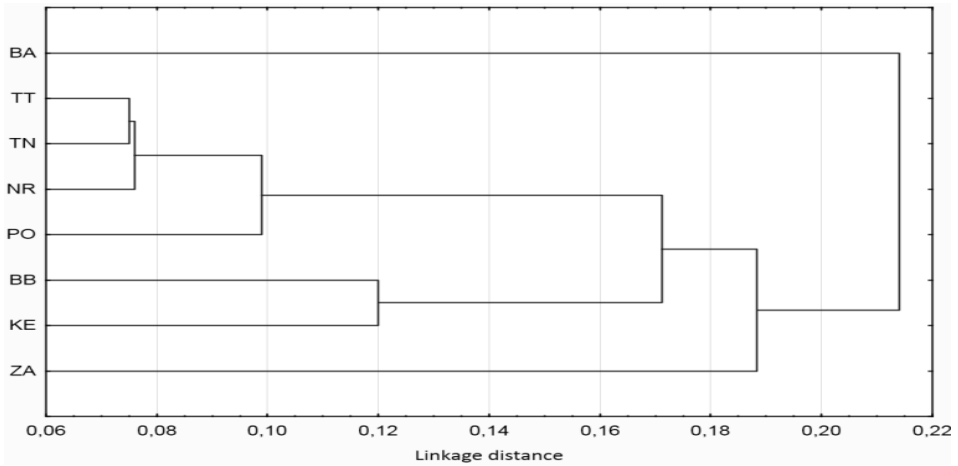


Figure 2. Cluster analysis of regional development of the selected indicators, 2006, own elaboration in "Statistica"

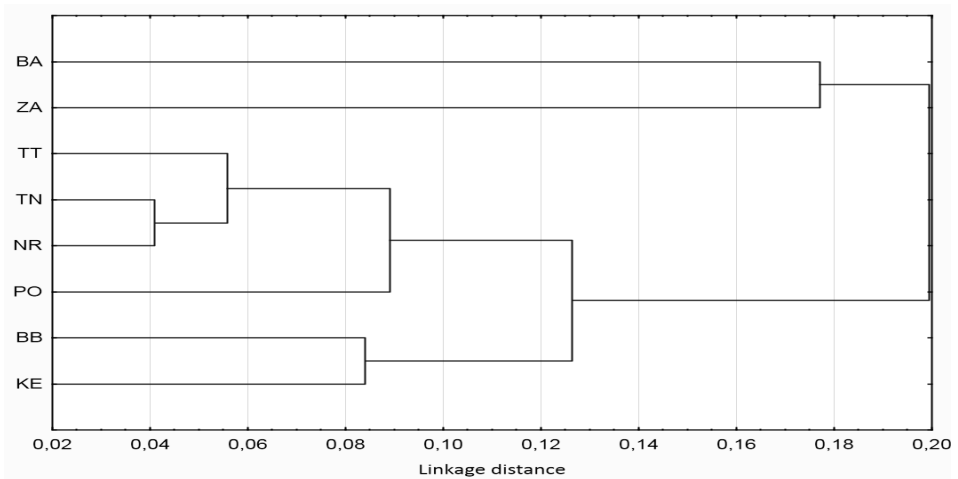


Figure 3. Cluster analysis of regional development of the selected indicators, 2011, own elaboration in "Statistica"



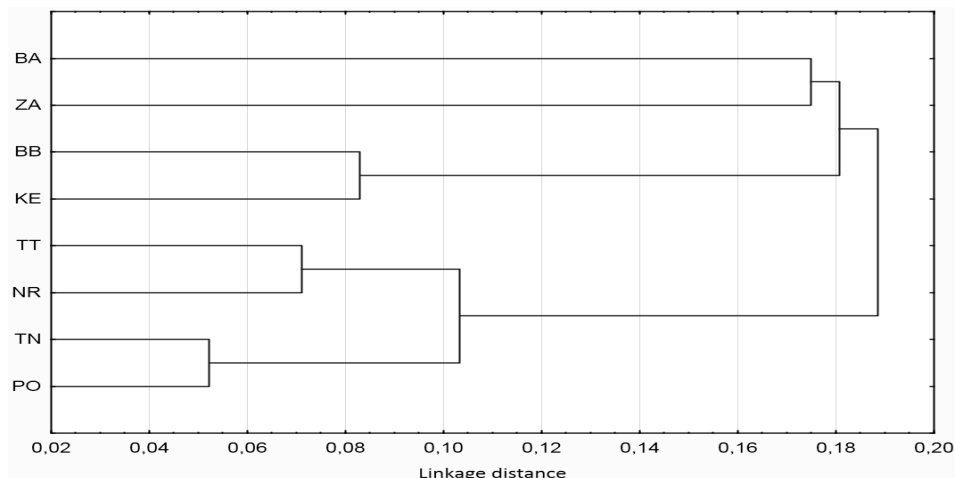


Figure 4. Cluster analysis of regional development of the selected indicators, 2013, own elaboration in "Statistica"

**Conclusion.** The paper shows the results of the analysis of regional disparities evaluated on the basis of the selected indicators within Slovak regions. We have compared the years 2002, 2006, 2011 and 2013. The most interesting development of regional disparities was registered in 2013 when 8 regions of Slovak Republic formed two big clusters. The regions of Kosice and Banska Bystrica have approximated Bratislava. The second cluster was formed by the regions Trnava, Nitra, Trenčín and Prešov. In 2013, we observed an unambiguously positive development of regional disparities in SR regions. Such a development has been also confirmed by disparities analysis by means of the variation coefficient which points out to the lowest disparities in the development of particular indicators.

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