Trend Analysis of the Employment Rate in Slovakia Regions in the Period 2013–2022

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Abstract: *The paper deals with the analysis of the employment rate. The author analyses this indicator in Slovakia regions using the data in the period 2013 – 2022. The analysis of the trend uses relative characteristics of time series analysis – growth rate, and average growth rate. The purpose of the paper is to find out the uniformity, respectively variability of growth rate using absolute geometric deviation and average absolute geometric deviation. The author quantifies absolute changes, relative changes and parallel absolute and relative changes by difference rate.*

The employment rate in the Košice region increased the most in 2022 compared to 2021 by 5.78%. The trend was the most uniform in Bratislava and Prešov regions. When comparing the years 2022 and 2013 using the difference rate, the employment rate in the Žilina region increased the most, absolutely by 15.3 percentage points, relatively by 26.24%, in the case of a combined comparison by 3.5656.

1. INTRODUCTION

The employment rate is one of the basic indicators of labor force statistics. There are several types of employment rates – the employment rate of the population over 15 years of age, the employment rate of the population in productive age, and the employment rate of the population aged 20 – 64.

In the paper, the decision was made to analyze the indicator of the employment rate of the population in productive age, which is calculated as a ratio of the number of employed persons in the age of 15 – 64 to the number of working populations (people in productive age).

Employees in the labor force survey are persons aged 15 and over who work for a public or private employer and who receive compensations in the form of wage or salary, including persons working abroad for up to 1 year and persons commuting to work abroad, persons performing work based on agreements and persons on paid activation work. It can be a full-time or part-time job, permanent, temporary, casual, or seasonal. Helping members of entrepreneurs' households are also included among the employees, who do not receive any salary for their activity. Persons who have a job, but do not work in the observed week due to illness, vacation, regular maternity leave, training, or bad weather, as a result of a strike or lockout, are also considered employees, except for persons on long-term unpaid leave and persons on parental leave (Statistical Office of the Slovak Republic, 2022).

Employment rates are sensitive to the economic cycle, but in the longer term, they are significantly affected by the government's higher education and income support policies and by policies that facilitate the employment of women and disadvantaged groups (OECD, 2023).

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2. METHODOLOGY

The employment rate will be analyzed using the relative characteristics of time series analysis, specifically the growth rate and average growth rate. It is necessary to analyze the stability, uniformity, or variability of growth rates. Appropriate descriptive characteristics are rates of variability – absolute geometric deviation, and average absolute geometric deviation.

- **Absolute geometric deviation ($d_G^{\,i}$)** – compares the trend in two consecutive periods t and $t–1$ to the average trend for the entire time series – to the average growth rate. For the i-th component of the aggregate indicator, the absolute geometric deviation is the ratio of the growth rate and the average growth rate, while the exponent is the ratio of the difference between the growth rate and the average growth rate on its absolute value (Seger et al., 1998):

$$d_G^i = \left(\frac{k_t}{\overline{k}}\right)^{\left(\frac{k_t-\overline{k}}{|k_t-\overline{k}|}\right)} \tag{1}$$

where:

$i=1,2,...,n$ are components of the aggregate indicator,

k_t is the growth rate (Kotlebová & Komara, 2022):

$$k_t = \frac{y_t}{y_{t-1}} \text{ for } t = 2, 3, \ldots , \text{T} \tag{2}$$

$\overline{k}$ is the average growth rate (Kotlebová & Komara, 2022):

$$\overline{k} = \sqrt[T-1]{k_2.\,k_3.\ \ldots\ .k_T} = \sqrt[T-1]{\frac{y_T}{y1}} \tag{3}$$

T is the length of the time series (the number of data),

y_1 is the value of the indicator in the first period,

y_T is the value of the indicator in the last period.

The average growth rate shows an average value for the rate of change over a period of time (typically several years). This rate facilitates comparisons of rates of change for periods of different lengths, for example, comparing annual rates of change (Eurostat, 2023b).

The exponent of absolute geometric deviation can take either the value (+1) or (–1). If $k_t > \overline{k}_t \rightarrow$ exponent $= + 1$, the absolute geometric deviation expresses how many times faster the analyzed indicator developed in the period $t/t–1$ than its average growth. Thus, this period $t / t – 1$ accelerates the growth of the indicator with the size of the deviation, which is equal to the value of the absolute geometric deviation. If $k_t < \overline{k}_t \rightarrow$ exponent $= – 1$, the absolute geometric deviation expresses how many times faster the average growth was than the increase in trend in the period $t / t – 1$. This period slows the trend of the indicator.

The absolute geometric deviation expresses how many percentage points the increase (decrease) between the period (t) and $(t – 1)$ contributed to the average increase (decrease) by one percentage point in the entire observed period. Low deviations from the average growth rate mean a steady trend of the indicator. When evaluating the trend of a certain indicator in the entire time series, it is possible to find out the periods in which the indicator deviated the most from the average trend and focus a more detailed analysis on these periods.

- **Average absolute geometric deviation ($\overline{d}_G$)** – it is calculated as the geometric mean from the absolute geometric deviations (Hindls et al., 2018):

$$\overline{d_G} = \sqrt[n]{\prod_{i=1}^{n} d_G^i} = \sqrt[n]{\prod_{i=1}^{n} \left(\frac{k_t}{\overline{k_t}}\right)^{\left(\frac{k_t - \overline{k_t}}{|k_t - \overline{k_t}|}\right)}} \tag{4}$$

The larger the average absolute geometric deviation, the more significant fluctuations existed compared to the average trend in individual periods.

Simultaneous absolute and relative changes will be quantified using **the difference rate**. This rate is a combination of absolute and relative comparison. We calculate it based on the formula (Hindls et al., 2000):

$$R(y) = \left(\frac{y_k}{y_j}\right)^{(y_k - y_j)} \tag{5}$$

whereas:

$$\left(\frac{y_k}{y_j}\right) = I(y) \tag{6}$$

$$(y_k - y_j) = d(y) \tag{7}$$

where:

   k is the compared situation of variable y (most often it is the value of y in period t),
   j is the basis for comparing the variable y (most often it is the value of y in the period (t-1) or 0).

For practical applications, the logarithmic form is used because *R(y)* can take on astronomical values (Hurbánková & Sivašová, 2018):

$$\ln R(y) = d(y) \cdot \ln I(y) \tag{8}$$

where:

   d(y) is the absolute change of the analyzed indicator *y*,
   I(y) is the relative change of the analyzed indicator *y*.

These rates will be applied to the data on the employment rate of the population in productive age in the regions of Slovakia.

3.   RESULTS AND DISCUSSION

Data for the analysis of the employment rate in the regions of Slovakia were obtained from the website of the Statistical Office of the Slovak Republic for the years 2013 – 2022. They are listed in Table 1.

From Table 1, we can see that the ratio of employees in productive age and the number of populations in productive age in Slovakia varied from 59.9% to 71.3% during the entire monitored period. The analyzed indicator was higher than the national average in Bratislava, Trnava, Trenčín and Nitra regions.

The rate of employment in the Slovak Republic is comparable to that of developed EU countries significantly lower (EU-27 at the level of 74.6% in 2022) (Eurostat, 2023a). Quite high there are also disproportions between the Bratislava region (79.5%) and three least developed regions (Prešov, Košice, Banská Bystrica 65.0 – 68.5%). This regional difference is observed within the entire observed period.

Table 1. The employment rate in % in Slovakia regions in the period 2013 – 2022

Region	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Bratislava	70,6	70,9	71,5	74,9	75,2	76,2	77,1	75,4	78,5	79,5
Trnava	64,5	64,7	67,0	70,1	70,1	68,8	70,1	70,3	72,7	74,3
Trenčín	61,1	63,1	64,4	67,0	69,3	71,0	71,0	70,3	72,8	73,2
Nitra	60,3	62,1	63,0	65,3	67,5	68,6	69,3	68,5	72,3	72,6
Žilina	58,3	59,0	62,4	64,5	65,7	67,2	68,5	67,5	70,9	73,6
Banská Bystrica	58,0	58,6	61,8	63,1	64,5	66,5	67,7	67,4	66,2	68,5
Prešov	55,6	56,5	57,1	59,4	61,2	63,1	63,8	62,0	63,4	65,0
Košice	54,3	56,4	58,2	58,8	59,8	62,3	62,9	62,1	62,3	65,9
Slovak Republic	59,9	61,0	62,7	64,9	66,2	67,6	68,4	67,5	69,4	71,3

Source: Statistical Office of the Slovak Republic, 2023.

The highest values of the employment rate were recorded in Bratislava region during the entire monitored period (the highest value was recorded in 2012 – 79.5%), and the lowest in Prešov and Košice regions (the lowest value was in 2013 in Košice region – 54.3%). We can also see this in Figure 1.
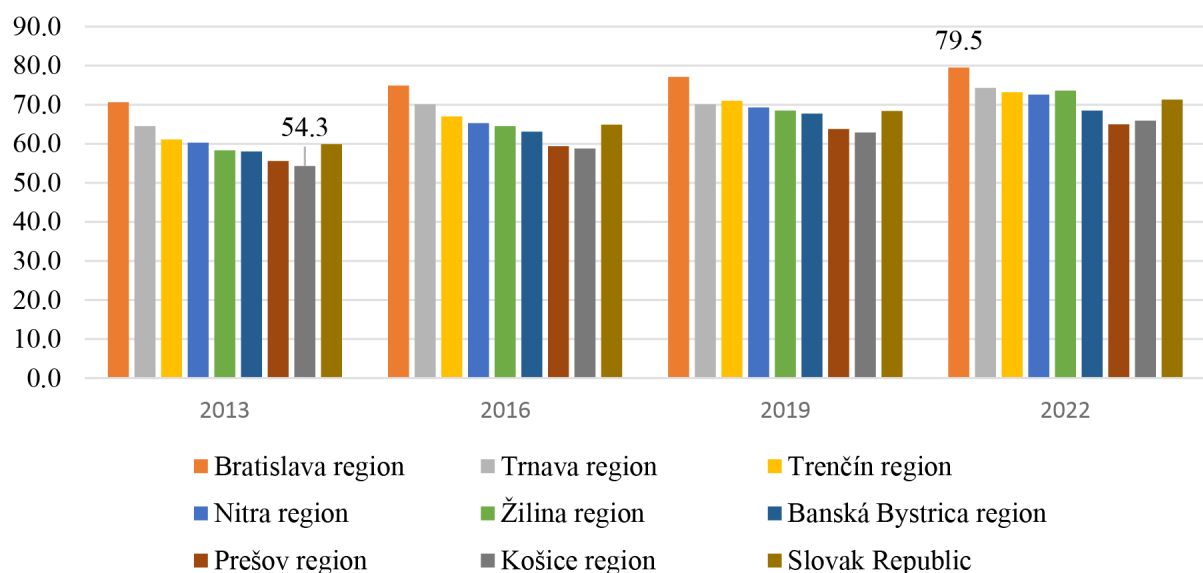
Figure 1. The employment rate in % in Slovakia regions
in the years 2013, 2016, 2019 and 2022
Source: Own processing

Table 2 shows the calculated growth rates and average growth rates, which we will use when calculating the absolute geometric deviation and the average absolute geometric deviation.

Based on the data in Table 2, we can state that during the entire monitored period, the employment rate in the Košice region increased the most in 2022 compared to 2021 by 5.78%. It decreased in almost all regions in 2020 compared to 2019 (except for the Trnava region), the most

in Prešov region by 2.82%. It was caused by the COVID-19 pandemic. Analyzed indicators for the Slovak Republic recorded the highest increase in 2016 compared to 2015 – by 3.51%, the decrease was found only when comparing the years 2020 and 2019 – a decrease of 1.32%. On average, the lowest annual increase was recorded in the Bratislava region, by 1.19%, and the highest in Žilina region by 2.36%. The average annual employment rate in Slovakia grew by 1.95%.

Table 2. Growth rates and average growth rates of the employment rate in Slovakia regions in the period 2014 – 2022

Region	2014/2013	2015/2014	2016/2015	2017/2016	2018/2017
Bratislava	1,0042	1,0085	1,0476	1,0040	1,0133
Trnava	1,0031	1,0355	1,0463	1,0000	0,9815
Trenčín	1,0327	1,0206	1,0404	1,0343	1,0245
Nitra	1,0299	1,0145	1,0365	1,0337	1,0163
Žilina	1,0120	1,0576	1,0337	1,0186	1,0228
Banská Bystrica	1,0103	1,0546	1,0210	1,0222	1,0310
Prešov	1,0162	1,0106	1,0403	1,0303	1,0310
Košice	1,0387	1,0319	1,0103	1,0170	1,0418
Slovak Republic	1,0184	1,0279	1,0351	1,0200	1,0211

Source: Own calculations

Continuation of the table 2

Region	2019/2018	2020/2019	2021/2020	2022/2021	Average
Bratislava	1,0118	0,9780	1,0411	1,0127	1,0119
Trnava	1,0189	1,0029	1,0341	1,0220	1,0142
Trenčín	1,0000	0,9901	1,0356	1,0055	1,0182
Nitra	1,0102	0,9885	1,0555	1,0041	1,0187
Žilina	1,0193	0,9854	1,0504	1,0381	1,0236
Banská Bystrica	1,0180	0,9956	0,9822	1,0347	1,0168
Prešov	1,0111	0,9718	1,0226	1,0252	1,0157
Košice	1,0096	0,9873	1,0032	1,0578	1,0196
Slovak Republic	1,0118	0,9868	1,0281	1,0274	1,0195

Source: Own calculations

The highest fluctuations compared to the average trend occurred in the Košice region by 1.80 percentage points, on the contrary, the smallest in Bratislava and Prešov regions, by 1.35 percentage points, where the development was the most uniform. Average deviations of 0.92 percentage points were found for the entire Slovak Republic (see Table 3).

The difference rate will be applied to the most recent period and the oldest period. It will be used to compare the employment rate in 2022 versus 2013 in terms of absolute, relative, and combined absolute and relative comparison.

Based on the difference rate calculated in Table 4, it can be stated that in 2022, compared to 2013, the employment rate increased the most in the Žilina region, absolutely by 15.3 percentage points, relatively by 26.24%, in the case of a combined comparison by 3.5656. The analyzed indicator grew the least in the Bratislava region, absolutely by 8.9 percentage points, relatively by 12.61%, and by a combination of absolute and relative comparison by 1.0567. In the Slovak Republic, the share of employees in productive age and the number of populations in productive age increased absolutely in 2022 compared to 2013, absolutely by 11.4 percentage points, relatively by 19.03%, and using the combined comparison, it was an increase by 1.9861.

Table 3. Absolute geometric deviations and average absolute geometric deviations
of the employment rate in Slovakia regions in the period 2014 – 2022

Region	2014/2013	2015/2014	2016/2015	2017/2016	2018/2017
Bratislava	1,0090	1,0048	1,0338	1,0092	1,0000
Trnava	1,0127	1,0194	1,0300	1,0158	1,0350
Trenčín	1,0122	1,0003	1,0197	1,0138	1,0042
Nitra	1,0088	1,0063	1,0153	1,0126	1,0045
Žilina	1,0141	1,0306	1,0072	1,0075	1,0033
Banská Bystrica	1,0082	1,0353	1,0023	1,0035	1,0121
Prešov	1,0013	1,0068	1,0224	1,0126	1,0133
Košice	1,0166	1,0100	1,0113	1,0047	1,0196
Slovak Republic	1,0012	1,0082	1,0152	1,0005	1,0016

Source: Own calculations according to (1)

Continuation of the table 3

Region	2019/2018	2020/2019	2021/2020	2022/2021	Average
Bratislava	1,0015	1,0361	1,0275	1,0005	1,0135
Trnava	1,0030	1,0130	1,0180	1,0061	1,0170
Trenčín	1,0203	1,0304	1,0150	1,0147	1,0145
Nitra	1,0105	1,0328	1,0339	1,0166	1,0157
Žilina	1,0068	1,0414	1,0235	1,0115	1,0161
Banská Bystrica	1,0006	1,0232	1,0371	1,0158	1,0153
Prešov	1,0063	1,0470	1,0050	1,0076	1,0135
Košice	1,0120	1,0349	1,0185	1,0353	1,0180
Slovak Republic	1,0076	1,0331	1,0084	1,0077	1,0092

Source: Own calculations according to (1), (4)

Table 4. Difference rate of the employment rate in Slovakia regions
in the year 2022 compared to 2013

Region	d(y)	I(y)	lnR(y)
Bratislava	8,9	1,1261	1,0567
Trnava	9,8	1,1519	1,3862
Trenčín	12,1	1,1980	2,1863
Nitra	12,3	1,2040	2,2833
Žilina	15,3	1,2624	3,5656
Banská Bystrica	10,5	1,1810	1,7471
Prešov	9,4	1,1691	1,4683
Košice	11,6	1,2136	2,2459
Slovak Republic	11,4	1,1903	1,9861

Source: Own calculations according to (8)

4. FUTURE RESEARCH DIRECTIONS

The current results may form a basis for further research realized on data for districts of Slovakia.

5. CONCLUSION

Based on the analysis of the employment rate of the population in productive age, we came to the following conclusions:
• over the entire monitored period, the employment rate in the Košice region increased the most in 2022 compared to 2021 by 5.78%;

- the highest decrease of the analyzed indicator was recorded in the Prešov region in 2020 compared to 2019 when the employment rate decreased by 2.82%;
- on average, the indicator grew the most in Žilina region by 2.36% and the least in Bratislava region by 1.19%;
- the highest deviations compared to the average growth rate occurred in Košice region by 1.80 percentage points, the lowest in Bratislava and Prešov regions, by 1.35 percentage points;
- when comparing the years 2022 and 2013 using the difference rate, the employment rate in the Žilina region increased the most, absolutely by 15.3 percentage points, relatively by 26.24%, in the case of a combined comparison by 3.5656;
- the analyzed indicator grew the least in 2022 compared to 2013 in the Bratislava region, by 8.9 percentage points, relatively by 12.61%, and a combination of absolute and relative comparison by 1.0567.

Acknowledgment

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