



## ORIGINAL ARTICLE


**Citation:** Dmytrów, K., & Bieszk-Stolorz, B. (2021). Comparison of changes in the labour markets of post-communist countries with other EU member states. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 16(4), 741–764. doi: 10.24136/eq.2021.027

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Article history: Received: 3.04.2021; Accepted: 5.10.2021; Published online: 10.12.2021


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## Comparison of changes in the labour markets of post-communist countries with other EU member states

**JEL Classification:** C38; E24

**Keywords:** *European labour market; linear ordering; Dynamic Time Warping; Ward's method; cluster analysis*

### Abstract

**Research background:** Since 2004, 11 post-communist countries joined the EU. It has helped to strengthen their international competitiveness. This was linked to the implementation of institutional and economic reforms, significant technological changes and improvements in the quality of human capital, as well as fiscal stabilisation policies. These changes affected their situation in the labour market.

**Purpose of the article:** The aim of the study is to assess changes in the situation in the labour market in the EU with particular emphasis on the post-communist countries in the period 2002–2019.

**Methods:** The situation of countries in the European labour market was estimated using the TOPSIS method. A similarity matrix of changes in the composite variable for each country was then constructed using the Dynamic Time Warping method. On its basis, homogeneous clusters of countries were determined using the Ward's method.

**Findings & value added:** Four homogenous clusters of countries were formed. The post-communist ones belonged to two groups. In one, there were two countries — Croatia and Slovakia. The rest of the post-communist countries were in a large cluster, which also included Germany, Malta, Finland, Portugal, France and Belgium. Changes of the situation in the post-communist countries in this group improved very much during the analysed period (this was

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particularly evident for Czechia, Estonia and Poland). It is interesting to investigate whether the reaction of labour markets to changes in the global economic situation in post-communist countries is similar to that in the old EU countries. The similarity of changes can be measured using the DTW method. There is an empirical research gap in this respect. Therefore, the added value is the use of this method in assessing similarities of changes in the labour market situation in post-communist countries in comparison to the Western European ones.

## Introduction

The process of transition from the centrally planned economy into the market one started in Europe in late 1980s. Since then, over a dozen countries began transformation of their economies. Since 2004, until 2013, eleven of them joined the European Union. The largest number of them joined it in year 2004 (Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia). Two countries (Bulgaria and Romania) joined the EU in 2007 and the last one — Croatia — in 2013. The process of transition of their economies was difficult and exhausting for large parts of their citizens. Many branches of the economy collapsed or deteriorated (large parts of heavy industries, mining, shipbuilding or textile industries). It caused changes in employment levels and forms. Previously non-existent, non-standard forms of employment (self-employment, or part-time employment) became more prominent. Although they are much more beneficial for the employer than for the employee, they helped improving the parameters of the labour market, such as decrease of the unemployment rate (Zieliński, 2020).

After thirty years of the transformation process, we can observe the convergence process for the post-communist countries. As previous researchers show, members of the eurozone (Estonia, Latvia, Lithuania, Slovakia and Slovenia) converge faster with the Western European countries than the countries outside the eurozone (with a few exceptions — Czechia converges similarly as the Western European countries, and Greece — similarly to the Eastern European ones) (Monfort *et al.*, 2013). The use of European funds has had a large and positive impact on the convergence of Central and Eastern European countries (and poorer regions of Western European ones) with Western European countries (Jakubowski, 2018). However, differences between EU countries are still noticeable. This situation may also be influenced by the fact that market institutions are not converging within the EU. The differences between these institutions are still significant and they slow down the convergence of labour markets (Obadić *et al.*, 2021). The European labour market is affected by many external factors such as the global economic situation and crises. These factors may affect national economies in different ways. In the case of full convergence

of European labour markets, these influences should be similar and changes in these markets should occur in the same directions. As a result, it would be interesting to check if there is a similarity in the change of the situation in the Central European labour markets with changes of such situation in the Western European economies. Such type of research has not been conducted yet. There is, therefore, a research gap in this area. The empirical added value of our research is the application of Dynamic Time Warping (DTW) method for assessing the similarity of these changes. Therefore, the goal of the research is assessment of changes of situation in the labour market of European Union member states with particular emphasis on the post-communist countries in the period 2002–2019. The first year of the analysis was selected because it was the year when the EU signed the agreement with the first post-communist countries. The 2019 was selected as the final year of the analysis, because it was the last year when the EU consisted of 28 countries, and it was the last year before the outbreak of the Covid-19 pandemic, which complicated the situation in the labour market (see Svabova *et al.*, 2021). The two research hypotheses were set out:

*H1: The situation in the labour markets of the post-communist countries has improved during the whole period.*

*H2: Changes of the situation in the labour markets of the post-communist countries were similar, but at the same time they were different from changes in the remaining EU member states.*

Every year, the situation on the labour market was analysed by using the TOPSIS composite measure. Pairwise comparisons of changes of the situation in the labour market between all countries were made by means of the Dynamic Time Warping (DTW) method. Computed in such a way, distance matrix was then used in the hierarchical clustering, to separate homogeneous groups of countries with respect to changes of situation in their labour markets.

The article is structured as follows: Introduction section presents the background of the research, its goal and hypotheses. Literature review section presents the research problem in the literature. Section Research methodology presents the description of applied research methods. The Results and discussion section presents the results of the analysis and their discussion. The article ends with the Conclusions section.

## Literature review

Transformation from the centrally planned economy to the market one of former communist European countries was far from uniform across the whole region. Unemployment, which had previously been hidden, emerged. Labour force and employment contracted (Jenkins, 2001). The unemployment rate for the post-communist countries had been increasing since the beginning of the nineties and reached its peak around year 2000 (Shleifer & Treisman, 2014). Particularly bad situation with this regard was in Poland and Slovakia, where the unemployment rates reached the level of 20% (Enderveen & Thissen, 2004). Since then, it began to drop and in the end of second decade of the XXI century the average unemployment rate for the post-communist members of the EU was even lower than for the Western European countries (Bieszk-Stolorz & Dmytrów, 2020). Although at the beginning of the reforms the situation in post-communist economies was in most cases very difficult — eruption of unemployment, collapse of many companies, problems in agriculture, or low quality of governance (Ehrke, 2007), the situation gradually started to improve. It was due to the implementation of institutional reforms (Balcerzak & Pietrzak, 2016a), technological changes, improvements in the quality of human capital (Balcerzak & Pietrzak, 2016b) and policy of fiscal stabilisation (Balcerzak *et al.*, 2016). The accession of new countries to the European Union in 2004 caused mass migration from the post-communist countries to the Western European ones (which opened their labour markets to immigrants). It also helped to reduce specific unfavourable phenomena in their labour markets (such as unemployment rate) (Lemos & Portes, 2008).

Despite the GDP growth in the post-communist countries at the beginning of the XXI century, the unemployment rates were on high levels. At the same time, the employment-relevant component of aggregate demand was too low to significantly reduce the high level of unemployment (Gabrisch & Buscher, 2006). In order to reduce the gap between the situation of the post-communist countries in their labour markets with their Western European partners, the national employment policies were adopted. They assumed, *inter alia*, employment rates at the level of at least 71% (depending on the country), or employment of the elderly people on the level of at least 50% (Lipták, 2013). Changes that occur in the labour markets are also visible in the changes in the structure of employment. When the economy of a country operates in free market conditions, foreign direct investments (FDI) begin to play a much more important role than in the case of the centrally planned one. Thanks to the FDI, multinational corporations (MNC) can enter their economies and act as a competition to the do-

mestic owned firms (DOF). On the one hand, the MNCs are associated with higher employment and higher wages. On the other hand, however, they are associated with higher job insecurity (Beesley, 2020). The inflow of the FDI is probably the most apparent in the field of retail market, on which the share of multinational super and hypermarkets increased up to 50% (Dries *et al.*, 2004). Integration within the EU causes another form of change in the employment structure in the post-communist countries. The share of employment in low-skill industries decreases and share of employment in high-skill ones increases (Crespo & Fontoura, 2007; Havlik, 2005; Gajdos *et al.*, 2020). Structural changes in Central and Eastern European (CEE) countries within more than 20 last years are apparent. The Baltic States tend to reproduce general tendencies in the EU, while Czechia, Slovakia and Slovenia put more stress on reindustrialisation. On the other hand, Romania and Bulgaria are the outliers relying on dominant agricultural sectors (Novák, 2020). As the research of Godlewska-Dzioboń (2020) suggests, in most post-communist European countries the share of employment in the agricultural sector decreases (with the exception of Hungary). The share of employment in the industry sector tends, in most cases to increase, as in the case of the services sector. However, the structure is still much different from the developed EU countries, where the services sector dominates to a much higher degree and the agricultural one has much smaller share.

The Western European countries always acted in the conditions of free market and developed the welfare state economies. The post-communist countries, on the other hand, could not have developed the welfare state yet. However, their lag in welfare state expenditure, as compared to the Western European countries, is not as challenging as their poor performance in meeting new social risks (Toots & Bachmann, 2010). The employees, that suddenly had to act in the free market economy, which has positive aspects (competition, freedom of choice), but also requires activity in participation, increases work-related stress and decreases the perception of safety of employment. However, as the research conducted by Salavecz *et al.* (2010) indicates, impact of work-related overcommitment in post-communist countries was not significantly different than in Western European countries. Despite the improvement of the situation in the labour market, the general assessment of development in most post-communist countries, measured by the World Development Indicators, still falls behind the Western European countries (Pełka, 2019).

Between 2005 and 2018, the countries of the so-called “old” EU maintained leading positions in the competitiveness rankings, but there was also a noticeable increase in the competitiveness of the EU–13 countries. The greatest advancement of these countries was observed in 2018. Research

has shown that from the point of view of the competitiveness of economies, the EU–13 countries are becoming a more homogeneous structure, while the differences in the level of competitiveness of the EU–15 countries are deepening.

The comparative analysis of the situation in the European labour market has been conducted many times in the past. Such an analysis was performed, *inter alia*, by Rollnik-Sadowska and Dąbrowska (2018). Their analysis indicates the importance of the existing labour market policy (LMP) model. Countries with a liberal orientation are less likely to spend on LMP services and activities than countries representing the corporate and Scandinavian model. The employment situation appears to be a more complex relationship resulting from social policy models. Those based on large investments in active labour market policies (Nordic countries) are still the best performers (Dimian *et al.*, 2013, p. 69). The variation in the level of expenditure is also related to the overall level of economic development and has remained consistently low for many years in CEE countries and in Greece. Also, comparison of the general situation in the labour markets for post-communist countries was performed by Rollnik-Sadowska and Jarocka (2021). They assessed the situation in post-communist countries in years 2004–2019. During the whole period Czechia and Estonia were amongst the best performing countries. Slovakia was the country that performed worst, while the situation in Poland has improved the most (it was due to a large decrease in the unemployment rates). Similar analysis was performed by Bieszk-Stolorz and Dmytrów (2020) with similar results obtained. Another example of comparative analysis in the labour market was done in the area of labour market inequality (Jianu *et al.*, 2021). Their results clearly indicate that almost all post-communist countries (with the exception of Slovenia) created a separate cluster with rather unfavourable values of indicators.

Although there are numerous works on comparative analysis of the situation in the labour markets, all of them were done in the static form — the comparison was done for specific years. The dynamics was implemented by presenting comparisons between subsequent years. However, none of these works compared the dynamics of situation in labour markets. Therefore, the present research fills the empirical gap with this respect.

## **Research method**

The research analyses the situation in the labour markets of the EU member states in years 2002–2019. Data referred to all countries that were members

of the EU in 2019. Statistical data was obtained from the Eurostat (<https://ec.europa.eu/eurostat/web/main/data/database>). This is annual data at country level. The situation on the labour market was analysed by means of eight variables:

$x_1$  – registered unemployment rate (share of the unemployed in the number of professionally active persons — %) — *reg\_unemp\_rate*,

$x_2$  – youth unemployment rate (share of the number of unemployed people aged 15–24 in the number of economically active people in this age group — %) — *youth\_unemp\_rate*,

$x_3$  – long-term unemployment rate (share of the number of people unemployed for a period of at least 12 months in the total number of unemployed people — %) — *lt\_unemp\_rate*,

$x_4$  – median unemployment duration (in months) — *med\_unemp\_dur*,

$x_5$  – activity rate (share of the number of economically active people aged 15–74 in the total number of people in this age group — %) — *act\_rate*,

$x_6$  – employment rate (share of employed persons aged 15–74 in the total number of persons in this age group — %) — *emp\_rate*,

$x_7$  – duration of working life (in years) — *dur\_of\_work*,

$x_8$  – age dependency ratio (ratio of the number of people in pre-working and post-working age to the total population) — *age\_dep\_ratio*.

The analysis was carried out for the entire analysed period. Due to the fact that this period covered 18 years, it was decided to present more detailed results for selected 5 years: 2002 — the first year of the analysis, 2004 — the year with the first enlargement of the EU (10 countries), 2007 — year, in which Bulgaria and Romania joined the EU, 2013 — year, when Croatia joined the EU and 2019 — the last year of the analysis. Table 1 presents the basic descriptive statistics (minimum, maximum, mean, median, standard deviation, coefficient of variation and skewness) for above-selected 5 years. Of the analysed variables, the unemployment rates, the median unemployment duration and the activity rate worsened in 2013 (due to the crisis). The values of the remaining variables (with the exception of the age dependency ratio, which is a purely demographic measure) improved throughout the entire analysed period.

The selected variables draw a general picture of the condition of labour market. The choice of variables is always questionable. It would be interesting to conduct a survey based on other labour market characteristics (institutional arrangements, quality of life, cultural factors and others). However, in many cases such data are not available for all EU countries in the Eurostat database. Relevant indicators could be constructed only for selected countries.

The research was conducted by means of methods belonging to three groups:

- linear ordering,
- Dynamic Time Warping (DTW),
- cluster analysis.

Linear ordering methods are used in the multivariate statistical analysis. They change the objects, described by multiple variables into the objects described by means of the composite measure. On the basis of the decision theory, methods such as AHP, ANP, Electre, SAW, COPRAS, or TOPSIS were invented (Podvezko, 2011; Saaty & Ergu, 2015). On the other hand, in the field of multivariate statistical analysis such methods as the composite measure of development (Hellwig, 1972) or Generalised Distance Measure, used as the composite measure of development — GDM (Jajuga *et al.*, 2003) were created. Methods (although not all) from both groups can be used in both multivariate statistical analysis and multiple-criteria decision-making (Wachowicz, 2011).

In the first step of any linear ordering method, the observation matrix is created  $[x_{ij}]$ :

$$[x_{ij}] = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix} \quad (1)$$

where:

$x_{ij}$  value of  $j$ -th variable in  $i$ -th object ( $i = 1, \dots, n, j = 1, \dots, m$ ).

The objects are the countries and the variables — previously described ones, depicting the situation in the labour market.

The second step is determination of the character of the variables. There might be the three types of variables:

- stimulants (the highest possible value of a variable is desired),
- destimulants (the lowest possible value of a variable is desired),
- nominants (specific value of a variable is desired).

In the set of applied in the research variables,  $x_1, x_2, x_3, x_4$  and  $x_8$  are destimulants, and  $x_5, x_6$  and  $x_7$  are stimulants. The third step of every linear ordering method is assigning weights to the variables. We can apply several methods to determine the weights. They belong to two main groups: the statistical and expert ones. The statistical methods can be based on the variability, correlation coefficients (Dmytrów *et al.*, 2019), or Shannon entropy (Lotfi & Fallahnejad, 2010). Among the expert methods, one of the most



important one is the AHP method (Saaty, 1980). Determining the weights by statistical methods would result in different weights each year, making comparisons impossible. On the other hand, setting weights by expert methods would introduce a large degree of subjectivity to this study. To say that some variables here are more important than others is always questionable. Therefore, the study assumed equal weights for all variables.

The fourth step of linear ordering is normalisation of variables. All variables must be normalised in order to remove units and eliminate the differences in orders of magnitude. In the research, one of the quotient transformations was used:

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^n x_{ij}^2}} \quad (2)$$

where:

- $x_{ij}$  value of the  $j$ -th variable in the  $i$ -th object,
- $z_{ij}$  normalised value of the  $j$ -th variable in the  $i$ -th object,
- $n$  number of objects.

Amongst many linear ordering methods, the study uses the well-known TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution). It was invented by Hwang and Yoon (1981). The TOPSIS method has two reference points — the pattern and anti-pattern. In the research, the composite variable obtained by means of the TOPSIS method is calculated every year. Although there are many linear ordering methods, the TOPSIS method was selected due to the fact that it used two reference points, it had a great numerical simplicity and had been widely used in this types of research (Rollnik-Sadowska & Jarocka, 2021).

During the second stage of the research, the previously obtained time series of composite variable are pairwise compared. The aim of the comparison is analysis of similarity of compared time series. It can be done by means of the Dynamic Time Warping (DTW) method. DTW was originally applied for the context speech recognition (Giorgino, 2009). Since then, it was used in many other disciplines such, as finance (Stübinger, 2019), comparison of the COVID-19 dynamics (Landmesser, 2021a; 2021b), dynamics of share prices of energy commodities (Dmytrów *et al.*, 2021), or labour market (Dmytrów & Bieszk-Stolorz, 2019) It is used for estimation of the optimal alignment of timeseries by means of the dynamic programming methods. The alignment between the two-time series is measured by the cost matrix obtained by means of the taxicab geometry (Manhattan distance metric). Optimal alignment between the two-time series is found

by minimising the overall cost amongst all possible warping paths. A  $(N, M)$ -warping path is a sequence  $p = (p_1, \dots, p_L)$ , where  $p_\ell = (n_\ell, m_\ell) \in [1:N] \times [1:M]$  for  $\ell \in [1:L]$ , satisfying the following conditions (Müller, 2007, p. 70):

- Boundary condition:  $p_1 = (1,1)$  and  $p_L = (N, M)$ .
- Monotonicity condition:  $n_1 \leq n_2 \leq \dots \leq n_L$  and  $m_1 \leq m_2 \leq \dots \leq m_L$ .
- Step size condition:  $p_{\ell+1} - p_\ell \in \{(1,0), (0,1), (1,1)\}$  for  $\ell \in [1:L - 1]$ .

$N$  and  $M$  are the lengths of both time series,  $L$  is the length of the warping path. The total cost of warping path between series  $X$  and  $Y$  is defined as follows:

$$c_p(X, Y) = \sum_{\ell=1}^L c(x_{n_\ell}, y_{m_\ell}) \quad (3)$$

where:

$x_{n_\ell}, y_{m_\ell}$  the coordinates of the warping path  $p$ .

The optimal warping path between the series  $X$  and  $Y$  is the warping path  $p^*$  that minimises the total cost amongst all possible paths. This minimal cost is called the DTW distance between series  $X$  and  $Y$  and is denoted by  $\text{DTW}(X, Y)$ :

$$\text{DTW}(X, Y) = c_{p^*}(X, Y) = \min\{c_p(X, Y)\} \quad (4)$$

After comparing every pair of countries, the distance (similarity) matrix is obtained. This matrix is used in the third stage of the research. Although it is possible to measure the distances between time series by means of other metrics (such as Euclidean one), using them calculates distances only between the same periods. The DTW distance allows stretching or compressing compared series locally, which makes it possible to compare time series with various length and takes into consideration the phase shifts. At this stage, the EU countries are clustered with respect to changes of situation in the labour market for the analysed period. It is done by using the hierarchical method of cluster analysis — the Ward's (Ward, 1963). The Ward's method was selected, because it was based on the distance (similarity) matrix. Clusters contain subsets of compared time series. The idea of cluster analysis is having objects within each cluster that are as homogeneous, as possible, with as big distances between the clusters as possible. The distance between the clusters can be measured by different metric than this one used for creating a distance matrix between the objects. Dissimilarity

of clusters on each step are measured by means of the Euclidean metric. The linkage criterion is the unweighted mean:

$$d_{AB} = \frac{1}{n_A n_B} \sum_{x \in A} \sum_{y \in B} d(x, y) \quad (5)$$

where:

$n_A, n_B$  sizes of clusters  $A$  and  $B$ , respectively,  
 $d(x, y)$  distances between objects in clusters  $A$  and  $B$ .

## Results and discussion

In the first step of the first stage of the analysis (linear ordering of countries), the coordinates of pattern and anti-pattern for every variable are calculated (Table 2).

The range between the best (pattern) and the worst (anti-pattern) values of variables is in some cases very high. This shows that there is a wide variation in the analysed indicators between the analysed countries. Such situation occurs in the case of the unemployment rate (the worst value is almost 14 times more than the best one). In the case of the unemployment rate among young people, the worst value is over 12.5 times higher than the best one. For the median unemployment duration this disproportion is even larger — over 15 times. On the other hand, for some variables: activity and employment rates this difference is much smaller — the best values are almost 41% and almost 63% higher than the worst ones, respectively. Generally, the best values of variables are for the Scandinavian countries, and the worst — for Greece or new (since 2004) member states.

The TOPSIS method was then applied and the countries were ranked in accordance with the situation in their labour markets. Table 3 presents rankings for previously selected 5 years: 2002, 2004, 2007, 2013 and 2019.

At the beginning of the observation period, amongst the post-communist countries the best position in the labour market was in Hungary (it was ranked 11<sup>th</sup>) and the worst — in Bulgaria (last, 28<sup>th</sup> place). In the middle of the rating were Czechia and Slovenia. The rest of former communist countries were at the end of the ranking. In the year 2004 (first enlargement of the EU) position of most post-communist countries generally did not change much (with the exception of Slovenia, for which it improved by four positions). In 2007 (the second enlargement of the EU and the onset of the global financial crisis), position of the Baltic States improved drastically (especially in cases of Latvia — improve from 19<sup>th</sup> to 6<sup>th</sup> position, and

Lithuania — from 23<sup>rd</sup> to 5<sup>th</sup>), position of Hungary deteriorated (from 11<sup>th</sup> to 19<sup>th</sup> position). In the case of other post-communist countries, their situation did not change much in comparison with year 2004. In 2013 (when Croatia joined the EU and when the second wave of the global financial crisis ended), changes were more visible. Positions of Czechia, Poland and Romania improved drastically (for Czechia from 16<sup>th</sup> to 10<sup>th</sup>, for Poland — from 26<sup>th</sup> to 16<sup>th</sup> and for Romania — from 22<sup>nd</sup> to 12<sup>th</sup>). Slight improvements could be observed for Bulgaria, Estonia and Slovakia, no change for Croatia and Hungary and deterioration for Latvia and Lithuania (in the former case from 6<sup>th</sup> to 18<sup>th</sup> position, while for the latter — from 5<sup>th</sup> to 13<sup>th</sup>). The last year of the analysis brought further improvements in the position of Poland — it was ranked 6<sup>th</sup>, Czechia — 1<sup>st</sup>. The position of Estonia improved to 3<sup>rd</sup>, and Croatia — to 20<sup>th</sup> (from the last but one in 2013). The position of most other post-communist countries returned to more or less the same as at the beginning of the observation period. Summing up, the position of post-communist countries after joining the EU has improved in most cases (Bulgaria, Croatia, Czechia, Estonia, Lithuania, Poland). In the remaining four cases (Latvia, Hungary, Romania, Slovenia and Slovakia), it remained on more or less the same level. Improvements of position of the post-communist countries were achieved at the costs of losing their places in ranking for such countries, as Belgium, Ireland, Greece, Spain, France, Luxembourg, or Portugal.

When we analyse the synthetic situation on the labour market measured by the composite variable, it turns out that during the whole observation period it has improved for all post-communist countries (Figure 1).

The values of the composite variable for all countries at the end of the observation period were higher than at the beginning. However, there are significant differences in its dynamics for various countries. In the case of Poland, the increase in the value of the composite variable was steady during the whole observation period (although it was hardly decelerated during the global financial crisis). The situation of the Baltic states was characterised by significant fluctuations. After rapid initial improvement of the situation (growth of the composite variable) in the first period (until 2007), all three Baltic states noted similar with its scope deterioration during the global financial crisis (2008–2011) and increase (although with much lower rate) after 2012. The situation in Czechia (being always one of the best for the post-communist countries) was steady improving until 2019. For Hungary and Slovenia, the situation in their labour markets undergone mild changes and in the last period it was just a bit better than at the beginning. Similar results were obtained by means of the multidimensional scaling (Bieszk-Stolorz & Dmytrów, 2020). Also, similar results were obtained by

Rollnik-Sadowska and Jarocka (2021). They applied the TOPSIS method (but with different set of variables) in assessment of the situation of the CEE countries in their labour markets in years 2004–2019. At the beginning of the research period, the best situation was in Slovenia, Hungary and Czechia and the worst — in Bulgaria, Poland and Slovakia (mostly due to high unemployment rate). In 2019 the best situation was in Czechia, Poland and Estonia and the worst — in Bulgaria, Croatia and Slovakia. Another research by Rollnik-Sadowska and Dąbrowska (2018) confirms that the best situation in the labour markets were in Germany, Denmark, Estonia, Czechia, Luxembourg, the Netherlands, Austria, Sweden, and the United Kingdom. Although that research dates to the year 2015, it confirms the results obtained by the present one, that Czechia and Estonia are amongst the countries with the best situation in their labour markets, similar to this in the Western European ones. For most old Member States (13 out of 15), their situation in the labour market deteriorated or remained at a constant level with high fluctuations (Figure 2). Germany and Finland were the only exceptions. Although the situation in western European countries has worsened or remained unchanged over the long term, and in post-communist countries it has improved, the latter have generally still worse situation than the former. The positive aspect is that this disparity is diminishing. However, the presented results should be referred to the employment efficiency, measured by the Employment Efficiency Index (EEI). The post-communist countries mostly still fall behind the Western European ones. Cultural and political factors dominate over economic factors in shaping the institutional framework of the labour market. The results indicate that labour market institutions are primarily determined by cultural heritage and other formal institutions, meaning that they have deep historical roots (Pilc, 2017).

The time series of the TOPSIS measures calculated for all countries were then compared by means of the DTW method. After pairwise comparisons, the distance matrix was obtained. On its basis, the Ward's method was applied and the dendrogram was obtained (Figure 3).

Four clusters of EU countries were distinguished. Former Eastern Bloc countries were in two of them. Nine of them (Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovenia) was in the largest one, containing also Belgium, Cyprus, Finland, France, Germany, Ireland, Malta and Portugal (total 17 countries). The second cluster (Croatia and Slovakia) consisted only of ex-communist countries. The third cluster (second largest) contained six countries (Austria, Denmark, Luxembourg, the Netherlands, Sweden and the United Kingdom). The last, smallest cluster consisted of three countries — Greece, Italy and Spain. The third cluster can be considered as the one with countries being generally in the best situ-

ation in their labour markets. The two smallest clusters contain countries with generally the worst situation in their labour markets. The worse situation in these countries could be explained by higher unemployment rate, high long-term unemployment rate, long unemployment duration and relatively low employment/activity rate (Žuk & Savelin, 2018). The analysed similarity of countries is based on the composite measure. We can also perform such analysis with respect to particular variables. One of such variables for which such comparison was done, was the unemployed duration. With respect to this variable, Poland created a separate cluster, Slovakia, Romania and Bulgaria were in one cluster with Greece, Italy and the Netherlands. The remaining post-communist countries created one large cluster, which also included the remaining Western European countries (with the exception of Denmark) (Wawrzyniak *et al.*, 2020). The determinants of unemployment duration in Poland were: work seniority, education level, age and type of undertaken job (Batóg & Batóg, 2016). The fact of Slovakia belonging to other cluster than the remaining Visegrad Group countries (Czechia, Hungary and Poland) is also supported by another research, which analysed the relationship between median unemployment duration and unemployment rate. This research indicated that the mutual course of these phenomena (measured by the form of business cycle clock) differed significantly for Slovakia in comparison with the remaining countries (Dmytrów & Bieszk-Stolorz, 2019). Interesting application of the cluster analysis in the European labour market was performed by Jianu *et al.* (2021). They analysed the inequalities in the European labour market. They identified four significantly different clusters in terms of innovation and entrepreneurship potential in EU countries in the context of sustainable development: Central European and Baltic countries, South European countries, West European and Nordic countries, divergent countries (Luxembourg and Ireland). The first cluster includes the post-communist countries (except Slovenia) as well as Greece and Portugal. Slovenia was in the second cluster together with Malta, Cyprus, Spain and Italy.

The conducted analysis shows that during the analysed period (2002–2019) the situation of all post-communist countries in their labour markets has improved, which was the opposite to the situation of most Western European countries. Therefore, the hypothesis H1 was confirmed. If we compare changes of situation in the labour markets of analysed countries, the four homogeneous clusters of countries were selected. The post-communist economies were in two clusters (three countries — Bulgaria, Croatia and Slovakia solely created one and the rest of them were the members of another cluster, along with seven Western European ones), therefore it cannot be stated that changes were similar in all of them. Thus,

the H2 hypothesis has only been partially confirmed. The fact that changes in the situation of Bulgaria, Croatia and Slovakia in their labour markets differed from other post-communist countries mainly resulted from the fact that these countries during the largest part of the observation period had higher unemployment rate, high long-term unemployment rate, long unemployment duration and relatively low employment/activity rate.

## **Conclusions**

The article presents the research regarding the changes in the situation in the labour markets of post-communist members of the European Union.

Analysing changes of the situation in the labour market, two positive conclusions for the post-communist countries can be drawn. The first one is that in all of them this situation improved during the whole period. The second one is that for majority of them, these changes were similar to these in high-developed Western European countries, as Belgium, Germany, Finland, or France.

The guidelines for the pursuit of economic and labour market policies include the need to equalise the level of economic development and, consequently, the labour market in the post-communist countries with the countries of Western Europe. This equalisation should consist in the catching up of developed countries with developing ones. The results of our research indicate that this goal is being achieved as the changes in the situation in the post-communist countries are taking place in the same direction as in Western Europe and at the same time the situation of these countries is improving. The fact that the direction of change is consistent shows that the economies of the post-communist countries are, to a large extent, integrated with Western economies. The policy recommendation is to deepen this integration.

The limitations of our study result from two factors. The first is the fact that we examine the dynamics of changes in the labour market situation and its compliance, while we do not examine the causality of these changes and their direction. The second limitation comes from data availability. It would be interesting to include in the research other indicators such as: institutional arrangements of the labour market, or quality of life. Unfortunately, such data are not available for all countries in the Eurostat database (especially for the entire period under study). Such a survey could be conducted only for selected countries.

The direction of future research will be to analyse changes in the situation of labour markets in EU countries with a particular focus on post-

communist countries during the COVID-19 pandemic. At the time of writing the manuscript, data for the pandemic period were not yet available.

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### **Acknowledgments**

The project is financed within the framework of the program of the Minister of Science and Higher Education under the name "Regional Excellence Initiative" in the years 2019-2022, project number 001/RID/2018/19, the amount of financing PLN 10,684,000.00.

## Annex

**Table 1.** Basic descriptive statistics for years 2002, 2004, 2007, 2013 and 2019

Descriptive statistics	reg_unemp_rate (%)	youth_unemp_rate (%)	lt_unemp_rate (%)	med_unemp_dur (months)	act_rate (%)	emp_rate (%)	dur_of_work (years)	age_dep_ratio
<b>2002</b>								
min	2.60	4.60	16.40	3.80	44.90	52.80	27.50	0.26
max	20.00	41.60	65.50	21.43	69.10	72.20	38.50	0.43
mean	8.71	18.51	41.46	10.38	56.32	61.61	32.86	0.32
median	7.65	15.55	43.30	9.90	55.55	62.00	32.35	0.31
st. dev.	4.79	10.27	15.54	5.29	6.57	5.29	2.92	0.04
CV	55.00%	55.46%	37.47%	50.99%	11.66%	8.59%	8.88%	13.28%
skewness	0.87	0.67	-0.09	0.47	0.20	0.09	0.31	0.87
<b>2004</b>								
min	4.40	7.80	17.80	4.34	46.80	52.10	28.00	0.25
max	19.10	40.10	63.90	19.75	68.70	72.40	38.90	0.43
mean	8.76	19.39	42.14	10.58	56.51	61.87	33.12	0.32
median	7.80	19.15	47.25	10.93	55.60	62.20	32.95	0.31
st. dev.	3.81	7.97	13.43	4.32	5.90	5.13	2.91	0.04
CV	43.50%	41.13%	31.87%	40.85%	10.44%	8.29%	8.79%	12.02%
skewness	1.16	0.55	-0.41	0.20	0.26	0.05	0.22	0.71
<b>2007</b>								
min	3.80	7.50	13.80	2.73	49.70	53.10	28.70	0.24
max	11.10	25.20	74.20	32.66	69.30	72.00	39.80	0.43
mean	6.50	15.08	39.96	9.90	59.05	63.11	33.88	0.31
median	6.30	15.15	43.50	9.53	59.25	63.80	33.75	0.31
st. dev.	1.93	4.93	15.08	6.22	5.50	5.22	3.10	0.04
CV	29.65%	32.68%	37.74%	62.83%	9.32%	8.28%	9.15%	12.32%
skewness	0.50	0.16	0.03	1.65	0.02	-0.13	0.17	0.92
<b>2013</b>								
min	5.20	7.80	18.50	3.69	42.90	55.30	30.30	0.26
max	27.50	58.30	70.20	24.44	65.70	71.50	40.90	0.44
mean	11.16	26.27	44.77	11.01	56.73	63.79	34.79	0.32
median	10.00	23.60	44.95	10.16	56.70	64.45	34.70	0.33
st. dev.	5.47	12.69	12.96	4.77	5.69	4.31	2.77	0.03
CV	49.02%	48.32%	28.94%	43.29%	10.04%	6.76%	7.95%	10.50%
skewness	1.56	1.00	-0.16	0.80	-0.40	-0.26	0.39	1.27
<b>2019</b>								
min	2.00	5.60	14.30	2.91	49.20	57.30	32.00	0.25
max	17.30	35.20	70.10	23.53	68.80	73.40	42.00	0.40
mean	5.96	14.74	35.23	7.80	61.83	65.71	36.38	0.33
median	5.20	12.45	33.25	6.38	62.40	66.35	36.40	0.33
st. dev.	3.23	7.34	13.30	4.68	5.09	4.29	2.62	0.03
CV	54.16%	49.81%	37.76%	59.98%	8.23%	6.52%	7.21%	8.89%
skewness	2.00	1.29	0.68	1.74	-0.70	-0.27	0.26	-0.40

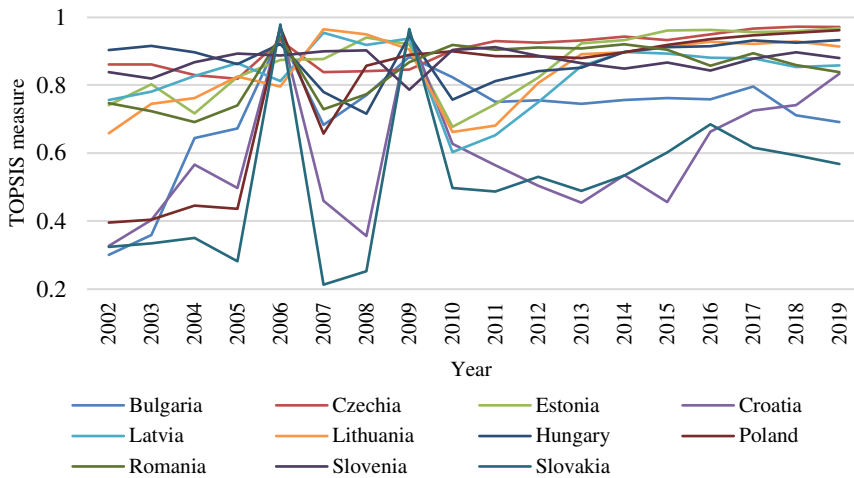
**Table 2.** Pattern and anti-pattern coordinates

	reg_unemp_rate (%)	youth_unemp_rate (%)	lt_unemp_rate (%)	med_unemp_dur (months)	act_rate (%)	emp_rate (%)	dur_of_work (years)	age_dep_ratio
Country/ year	Czechia 2019	Netherlands 2002	Denmark 2009	Denmark 2008	Sweden 2019	Denmark 2008	Sweden 2019	Romania 2009
pattern	2.0	4.6	9.5	2.26	73.4	69.8	42.00	0.21
Country/ year	Greece 2013	Greece 2013	Slovakia 2006	Slovakia 2007	Malta 2004	Greece 2013	Hungary 2002	France 2013
anti-pattern	27.5	58.3	76.3	34.61	52.1	42.9	27.50	0.44%

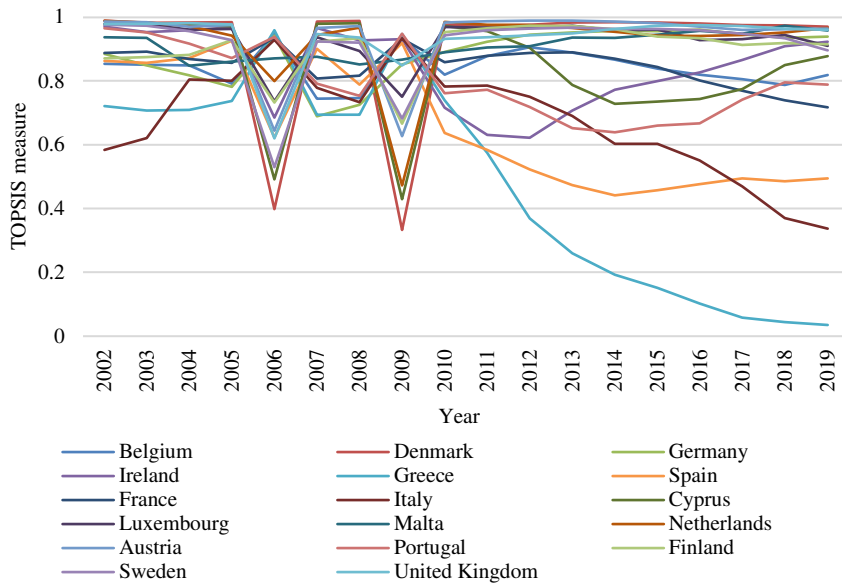
**Table 3.** Rankings of countries with respect to their situation in their labour markets for years 2002, 2004, 2007, 2013 and 2019

Country	2002	2004	2007	2013	2019
Belgium	17	15	21	15	21
Bulgaria	28	25	25	21	24
Czechia	16	17	16	10	1
Denmark	1	1	1	2	2
Germany	13	19	24	7	9
Estonia	21	22	14	11	3
Ireland	8	7	3	22	11
Greece	22	23	23	28	28
Spain	15	12	12	26	26
France	12	13	17	14	23
Croatia	26	26	27	27	20
Italy	24	20	20	23	27
Cyprus	6	3	2	20	17
Latvia	19	18	6	18	18
Lithuania	23	21	5	13	13
Luxembourg	4	6	9	3	14
Hungary	11	10	19	19	10
Malta	10	16	15	9	8
Netherlands	2	4	8	6	4
Austria	3	5	4	1	5
Poland	25	27	26	16	6
Portugal	9	9	18	24	22
Romania	20	24	22	12	19
Slovenia	18	14	13	17	16
Slovakia	27	28	28	25	25
Finland	14	11	11	4	12
Sweden	7	8	10	5	15
United Kingdom	5	2	7	8	7

**Figure 1.** Changes of situation of post-communist European countries in their labour markets in years 2002–2019



**Figure 2.** Changes of situation of Western European countries in their labour markets in years 2002–2019



**Figure 3.** Dendrogram of EU countries with respect to similarity of time series of situation in their labour markets

