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The multivariate techniques in evaluation of unemployment analysis of Polish regions

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Abstract
Research background: The labour market situation is considered to be the most widely discussed part of economic development. However, it should be noted that the unemployment situation of young people (aged 15–24 years) in Poland in general terms seems to be problematic. Overall, the unemployment rate among young people in Poland is significantly higher than the overall unemployment rate in the EU. Moreover, the situation varies greatly across the regions.
Purpose of the article: Using multivariate techniques as a theoretical framework, the main goal of the paper is to identify groups of Polish regions that share similar patterns regarding unemployment among young people. To reach this goal, first a set of labour market indicators were selected. Next, the authors compared the labour market situation of young people between the Polish regions in 2005 and in 2014. Finally, the conclusions regarding the conducted analysis are explored.
Methods: The initial calculation is based on the concept of the taxonomic measure developed by Hellwig. The final method used to create clusters of objects (across 16 voivodeships of Poland) is cluster analysis. A segmentation of the voivodeships is observed for the years

2005 and 2014, based on selected indicators to determine the labour market situation. The data was gathered from the databases of the Central Statistical Office of Poland and Eurostat.
Findings & Value added: Through the exploration of the advantages of multivariate methods, the nature of youth unemployment is revealed in more detail. Indeed, dendrogram analysis divided the voivodeships into five groups, which are characterized by similar features associated with the labour market. It was found that the groups which emerged in 2005 have a different composition of regions than in 2014; this difference seems to be connected with the economic crisis.

Introduction

The unemployment rate is an economic indicator that refers to the portion of people who are actively looking for a job and are unable to find work. The unemployment rate is calculated as the percentage of unemployed people in the labour force, while the labour force is the total number of people employed and unemployed. The term "young people" is defined as those aged 15–24 years. The youth unemployment ratio is calculated as the ratio of youth unemployment to the adult unemployment rate. Youth unemployment is often estimated separately because the rate has historically been higher than that for older age groups. In the Eurozone area unemployment among young people (under 25 years) was reported to be approximately 18.6% in December 2016, which is a figure that should cause concern. While Germany has the unemployment rate of around 6%, the rate in countries like Greece, Spain and Italy, is over 40%. Moreover, this phenomenon, which has recently attracted increasing attention, has negatively influenced countries' labour markets at the time of economic crisis. In fact, there is a wide range of both theoretical and empirical literature devoted to the connections between the global economic crisis and labour markets (e.g. Rose & Spiegel, 2011, pp. 309–324; Madianos *et al*., 2014, pp. 34–49; Boeri & Jimeno, 2016, pp. 32–46). However, the rather narrow range of literature regarding youth unemployment has focused on the dispersion of unemployment across Poland's regions during recessions.

In this context, the main aim of this paper is to show the local diversity of the situation on the labour market among the voivodeships of Poland in 2005 (before the economic crisis) and 2014 (under the effects of the crisis). After 2014, by contrast, the economic development was much more divergent across Poland, making it much more difficult to focus on a clear picture of labour market reactions to the initial impact of the Great Recession. The specified period corresponds to the economic crisis, which resulted in a slowdown of economic growth in Poland. In order to contribute to the achievement of this goal, our ambition is to detect the presence of homoge-

neity among different regions based on a multivariate statistical method, namely cluster analysis and Hellwig's method. To the best of our knowledge, a unified framework that jointly considers these two methods is absent from the literature produced to date, and could provide useful indicators for researchers and policy makers. Categorization will be performed using data provided by the Central Statistical Office of Poland and Eurostat.

The paper consists of five main sections. Section 2 focuses on literature data and methodology. In Section 3, the main facts about the specific unemployment situation in Poland are presented, paying particular attention to youth unemployment. The results of the analysis are presented and commented on in Section 4. The main conclusions are presented in Section 5.

Research methodology

The multidimensional nature of the labour market situation entails the use of synthetic indicators to measure its activity level. There are several taxonomic analyses of development concerning the analysis of the labour market available and the most commonly used ones are as follows:

- Hellwig's measure (Jurkowska, 2014, pp. 49–73; Miśkiewicz-Nawrocka & Zeug-Żebro, 2015, pp. 145–161);
- Ward's cluster analysis (Carlsson *et al*., 1993; Drutarovská *et al*., 2016, p. 30) ;
- k-means method (Nadiya, 2008, pp. 28–44; Rollnik-Sadowska, 2016, pp. 80–92);
- Factor analyses (Henkens & Schippers, 2005, pp. 421–433; Cárdenas *et al*., 2015);
- Perkal's index (Stanny, 2010, pp. 103–111);
- Quantitative and qualitative research (Saczyńska-Sokół, 2018, pp. 159–173).

In this paper, however, we limited our discussion to Hellwig's measure and Ward's cluster analysis, because these are widely used data mining methods in the field of economics.

Cluster analysis is one of multidimensional methods that allows observations to be classified into groups. Cluster analysis techniques include several different algorithms, which can be broadly divided into two methods: hierarchical and non-hierarchical. Dendrograms are often used to aid visualization in the form of a tree showing the linkages between observations. In order to group the voivodeships into clusters, a hierarchical Ward's algorithm based on a squared Euclidean distance has been chosen.

This method is the most highly recommended one due to the efficiency criterion of presenting the actual data structure (see Mačerinskienė & Aleknavičiūtė, 2017, pp. 573–592; Trapczyński *et al*. 2016)

Next, in the current research, the concept of taxononomic measure proposed by Zdzisław Hellwig (Hellwig, 1968, pp. 307–326) is used. This is a commonly applied method in spatial economic research that allows the researcher to produce a synthetic measure d_i, which takes into account the impact of many indicators on socio-economic development. The main advantages of Hellwig's method are its methodological simplicity and the flexibility of its application (see Balcerzak, 2016, pp. 11–27; Pietrzak & Balcerzak, 2016).

The description of a set of objects can be presented in the X matrix as follows:

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

where:
x_{ij} – the j-th characteristics of the i-th object and $i = 1,2, \dots, n; j = 1,2, \dots, m$.

Next, the values of the characteristics X_j are standardized according to the formula:

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{S_j}, \quad i = 1, \dots, n; \; j = 1, \dots, m. \quad (2)$$

where:
x_{ij} – the output value of j-th feature in the i-th object,
z_{ij} – the standardized value of j-th feature in the i-th object,
$\bar{x}_j$ – the arithmetic mean of the j-th feature,
S_j –the standard deviation of the j-th features.

In the next stage, with application of constant reference, it is established that an abstract object P_0 with coordinates $(z_{01}, z_{02}, \dots, z_{0m})$, can be determined using the following equations (see Wierzbicka, 2018, pp. 123–139; Balcerzak & Pietrzak, 2017, pp. 5–18; Balcerzak & Pietrzak, 2016, pp. 66–81):

$$z_{0j} = \begin{cases} \max\limits_{i} z_{ij}\ , & \text{when } X_j \text{ is a stimulant} \\ \min\limits_{i} z_{ij}\ , & \text{when } X_j \text{ is a destimulant} \end{cases} \quad (3)$$

The distance from a given pattern is estimated with the following equation:

$$D_{i0} = \sqrt{\sum_{j=1}^{m}\left(z_{ji} - z_{0j}\right)^2}, \quad i = 1,2,\dots,n;\ j = 1,2,\dots,m. \quad (4)$$

Finally, the value of development measure is calculated:

$$d_i = 1 - \frac{D_{i0}}{D_0}, \quad (5)$$

where $D_0 = \overline{D_0} + 2S_0$, and $\overline{D_0}, S_0$ are given with the following formula:

$$\overline{D_0} = n^{-1}\sum_{i=1}^{n} D_{i0},\ \ S_0 = \sqrt{n^{-1}\sum_{i=1}^{n}(D_{i0} - \overline{D_0})^2}, \quad i = 1,2,\dots,n. \quad (6)$$

The aim of this paper is to use cluster analysis and Hellwig's synthetic measure to create a new perspective for discussing differences and similarities of youth unemployment in the regions of Poland.

The analysed data are obtained from the databases of the Central Statistical Office of Poland and Eurostat. Indicators which determined the situation of young people in Poland for two different years — 2005 and 2014 were selected. Statistical calculations were performed using SPSS statistical software, version 22. Calculations using multivariate techniques are based on information about territorial division, employment status and age groups, which are as follows:

- Territorial division – Greater Poland, Kuyavian-Pomeranian, Lesser Poland, Łódź, Lower Silesian, Lublin, Lubusz, Masovian, Opole, Podlaskie, Pomeranian, Silesian, Podkarpackie, Świętokrzyskie, Warmia-Masurian, West Pomeranian,
- Employment status – employed, unemployed,
- Age groups – 15–24 years, 25–54 years, 55–64 years.

The starting point of the analysis were indicator data for the labour market and wages. The selection of the variables is based on the conducted literature review devoted to the determinants of labour market and unemployment (Boeri & Jimeno, 2016, pp. 32–46; Jindrová & Vydrová, 2012, pp. 165–172). Firstly, the character of variables (stimulant, destimulant) and pattern object values were determined. The initial set of potential diagnostic variables includes six indicators of the structure of unemployment by age, education, work experience and other measures of unemployment. To the final set of variables which are characterized by high spatial variability with low correlation within the selected variables (Cheba & Szopik-Depczyńska, 2017, pp. 487–504), 6 diagnostic variables were selected (see Table 1). All of the variables were standardized by means of unitization with zero minimum.Note that variables X_1 — X_3 and X_5 act as destimulants, while the other two variables are stimulants. The stimulants are numbers whose bigger values indicate a higher level of progress of a given phenomenon, while the destimulants are diagnostic characteristics whose smaller values signify a higher level of development (Bąk, 2014, pp. 134–145).

Statement of the problem and research tasks

The history of Polish youth unemployment in the period before 2008 significantly differs from the wider picture of the EU. Poland entered the twenty-first century with a youth unemployment rate of almost twice the EU average: in the first quarter of 2000 it reached almost 35%. Between 2002 and 2003 it was almost 43%. After 2004, the unemployment rate began to fall until the figure reached its lowest point at the end of 2008, when it fell to 17%. Since then, the unemployment rate has continued to grow; this is presented in Figure 1.

The main driver of Polish unemployment cross-country divergence is youth unemployment. Figure 2 plots the unemployment rate over the 2000–2014 period for three age groups. As Figure 2 illustrates, the highest level of unemployment is experienced by young people. Youth unemployment rates at the national level have experienced considerable turbulence. The unemployment rates within other age groups are much more stable. Since 2006, the unemployment rate among young people has declined by about 10%, and it is still twice as high compared to those of other groups. As shown in Figure 2, the recession affected youth unemployment rates earlier than it affected other age groups; this is indeed the group most affected by the economic crisis.

Table 2 shows the changes among the investigated factors in 2005 and 2014, which are the main unemployment facts that influenced our analysis. We observe a significant decrease in almost all chosen variables, namely X_1, X_2, X_4, X_5. In the next section, however, we will investigate the influence of these changes across the regions in Poland.

Some of the reasons for the large number of unemployed people under the age of 25 are connected with the specific conditions of the country, namely, the differences in employment policy, the education system and economic performance between EU Member States. However, there are factors that contribute to high rates of youth unemployment that are present throughout the EU. The obvious reason for the large number of unemployed young people is the latest crisis, which caused a slowdown in economic growth and a tightening of the labour market.

Moving on to the literature that deals with the consequences of the recession, Boeri and Jimeno (2016, pp. 32–46) have documented connections between the financial crisis and labour market results. Additionally, there are also countries and regions with a high degree of unemployment rate dispersion within the Eurozone area in this period. This increase in dispersion is also noticeable when we consider youth unemployment in several countries and it is considered to be a result of the Great Recession and the Eurozone crisis (Boeri & Jimeno, 2016, pp. 32–46). European labour market reactions to the crises were also reported by Masson and Krillo (2011, pp. 38–102), Eamets (2013, p. 4).

The rise in youth unemployment in Poland and increasing levels of European unemployment dispersion across countries and regions are two facts that give us the motivation required to analyse the situation. In order to pursue these problems, the paper proceeds to develop an analytic framework for identifying groups of Polish regions that share similar patterns regarding unemployment among young people.

The results

In order to compare the labour market situation of young people between the Polish regions in 2005 and in 2014, we implemented a two-step procedure. Firstly, we used the concept of the taxonomic measure to arrange the items being studied in a linear manner from the best to the worst. In addition, we classified the Polish regions according to their labour market performance, using cluster analysis methods. Similar results were obtained in both classifications for the years 2005 and 2014.

Hellwig's method allowed us to build a synthetic measure d_i taking into account cumulative impacts on the development of socio-economic indicators characterizing many different aspects of this development. The closer the value of d_i is to 1, the better the situation was in the region. On the other hand, the closer the value of d_i is to 0, the worse the situation in the voivodeship was, according to the variables adopted in the study.

According to the results presented in Table 3, there is a high diversity for the different provinces with respect to the synthetic measure. For a group of provinces characterized relative to each other, the best situation on the labour market in 2014 occurred in the Lower Silesian and Masovian regions. The lowest synthetic measure value was obtained for Lublin and Świętokrzyskie voivodeships. Both of these voivodeships stand out from the others in terms of the values of the measure. This means that in these voivodeships we have to deal with the worst situation with regard to youth participation in the labour market from the viewpoint of the adopted diagnostic features. Positive changes in the labour market were observed at the Silesian voivodeship where the dynamic of the changes reached the highest level (from 8th position to 5th). It may be stated with certainty that the situation in the labour market has worsened in the Opole voivodeship (falling from 5th to 8th position). Also, a decrease by one position was observed for the Masovian, Greater Poland and Lublin voivodeships. The process of arranging the regions showed that seven of them (Pomeranian, West Pomeranian, Lubusz, Łódź, Warmian-Masurian, Podlaskie and Lesser Poland) occupied the same position with regard to the value of d_i. For most voivodeships, the synthetic measure was above average.

In order to create groups of voivodeships which are similar in terms of the structure of the labour market, a hierarchical cluster analysis has been used. The composition of clusters in the year 2005, is shown in Table 4, while the data concerning the year 2014 are provided in Table 5. A detailed description of the clusters in 2005 and 2014 is presented in Table 6 and Table 7. A dendrogram analysis for 2005 is shown in Figure 3, while the 2014 analysis is shown in Figure 4. The territorial distribution of the clusters produced by the analysis is presented in Figure 5.

Cluster 1 (2005) — Łódź, Greater Poland, Kuyavian-Pomeranian, Lubusz

This cluster is characterized by the lowest level of unemployed persons without internship, and the lowest percentage of unemployed persons with higher education.

Cluster 2 (2005) — Lower Silesian, Silesian, Pomeranian, Lesser Poland, Masovian

This cluster is characterized by high levels of unemployment among the highly educated, although there are a lot of vacancies which are being regularly taken and the average salary in this cluster is the highest. Since the cluster includes five of the 16 voivodeships, the situation regarding unemployment among people with higher education and a lack of jobs for them was important for Poland.

Cluster 3 (2005) — Opole, West Pomeranian, Lublin

The lowest indicator of unemployment among young people is a characteristic of this group. The rate of unemployment among people with higher education is almost twice as low as it is for cluster 2, but it stands at the highest level compared to clusters 1, 4, 5.

Cluster 4 (2005) — Podkarpackie, Warmian-Masurian, Podlaskie

Being the cluster which is characterized by the highest rate of unemployment in the age group of 15–24, it has the lowest level of job vacancy rate The voivodeships in this cluster include the lowest levels of monthly average gross salary.

Cluster 5 (2005) — Świętokrzyskie

The single voivodeship in this cluster is characterized by the greatest number of unemployed persons attributable to one offer, as well as the highest level of unemployment among people without experience.

Cluster 1 (2014) — Opole, Kuyavian-Pomeranian, Pomeranian, West Pomeranian

It includes four voivodeships which are characterized by the lowest percentage of unemployed people with higher education, as well as by the lowest percentage of unemployed persons without internship.

Cluster 2 (2014) — Silesian, Greater Poland, Lower Silesian, Lubusz

This group consists of four voivodeships. Compared with the first cluster, it has lower indicators of participation of unemployed people in the age

group of 15–24 years. This cluster is characterized by the lowest number of unemployed persons attributed to one offer and by participation of unemployed persons without internship.

Cluster 3 (2014) — Podlaskie, Podkarpackie, Świętokrzyskie

Among all of the clusters, this one is next to the first one in terms of the participation of unemployed persons in age of 15–24 years, without internship and with high education.

Cluster 4 (2014) — Warmian-Masurian, Lublin

A defining characteristic of the cluster is a lower monthly average gross salary than any other cluster. This cluster shares similar problems with cluster 3 when it comes to youth unemployment. It is in second place with a higher level of unemployed persons without internship. Even though these indicators in the cluster are slightly better than they are in the third cluster, this does not affect the size of the average salary.

Cluster 5 (2014) — Łódź, Lesser Poland, Masovian

This cluster shares similar characteristics with cluster 2 when it comes to unemployed persons in the age bracket of 15–24 years. It has the highest monthly average gross salary, despite the average values of other indicators.

To sum up, cluster analysis and the use of Hellwig's method have allowed us to examine the Polish unemployment situation with regard to groups of regions according to their youth labour market performances. The analysis of statistical data for the years 2005 and 2014 has led to interesting results. According to the selected indicators of the market, it may be observed that advanced regions proved to be more homogenous. The clusters with the highest numbers of voivodships are those with a good or at least a moderately good situation, in the sense of the synthetic variable, although their number has changed over time.

Discussion

The division of Poland into geographic regions is commonly used to assess the level of development in the various areas. First of all, it enables evaluation of socio-economic conditions (Gawroński *et al*., 2014). Information

about problematic regions occurrence is useful while preparing regional programmes and development strategy (Wysocki, 2010).

It can be concluded that application of taxonomic development measures based on two different diagnostic methods provides non-identical results in the ranking of voivodships. The conclusions that result from comparing of both method can be as follows. The Hellwig taxonomy is for sure less time-consuming than the cluster method. In recent years, an interesting direction of development of the taxonomy measure was made by Antczak (2013, pp. 37–53) and Pietrzak (2014, pp. 181–201). The clusters profiles obtained for each dimension allows important insights that could not be made if a simple variable analysis was performed. Although the map being a picture of performed cluster procedure result is easy to interpret, it is difficult to prepare. The results obtained confirm the observations of other authors (see White, 2016, pp. 404–422; Pietrzak & Balcerzak, 2016; Ciżkowicz *et al*. 2016, pp. 487–519). The results of the investigation may be the starting point for feedback analyses and the foundation for decision making in the labour market field.

Conclusions

The concept of youth unemployment as it is dealt with in this paper covers the problems encountered by young people below 25 years of age. Using multivariate techniques as a theoretical framework, the main goal of the paper was to identify groups of Polish regions that share similar patterns regarding unemployment among young people. The results of the analysis show that the methods used are suitable for inter-regional comparisons on the basis of the labour market. This paper presents data mining methodology, in particular, cluster analysis and Hellwig's methods, which allowed us to divide the 16 voivodeships into five groups, characterized by similar features associated with the labour market. The measures provide a way of grasping the changes between the years 2005 and 2014 in the labour market situation in the Polish regions. Based on this analysis, we may conclude that the labour market in Poland is considerably regionally structured. In the case of Poland, cluster analysis shows the division of the country into five groups which are homogenous in terms of unemployment and described by multiple characteristics at the same time.

This paper also has some important policy implications. Namely, the results could help decision makers to identify regional similarities/dissimilarities in the Polish labour market. The lack of stability in the labour market in the form of visible differences occurring in clusters re-

quires special attention from the ruling elites, who ought to take joint steps aimed at reducing the number of the unemployed young people. The state should actively contribute to reducing disparities between the regions. The main justification for the need for such a policy is to achieve equality of opportunity of development between the regions. The high level of regional diversity discriminates against people living in regions with high unemployment rates among young people and low per capita incomes. Their chances to pursue their aspirations in life are significantly lower than those of residents in wealthier areas. Furthermore, the findings of this paper may help to generate new ideas concerning which factors should be prioritized regarding equal opportunities for all young people in education and in the labour markets of the different regions of Poland.

References

Antczak, E. (2013). A spatial taxonomic measure of development. *Wiadomości Statystyczne*, *7*.

Balcerzak, A. P. (2016). Multiple-criteria evaluation of quality of human capital in the European Union countries. *Economics & Sociology*, *9*(2). doi: 10.14254/2071-789X.2016/9-2/1.

Balcerzak, A. P., & Pietrzak, M. B. (2016). Quality of institutions for knowledge-based economy within new institutional economics framework. Multiple criteria decision analysis for European countries in the years 2000–2013. *Economics & Sociology*, *9*(4). doi:10.14254/2071-789X.2016/9-4/4.

Balcerzak, A. P., & Pietrzak, M. B. (2017). Digital economy in Visegrad coutnries. Multiple-criteria decision analysis at regional level in the years 2012 and 2015. *Journal of Competitiveness, 9*(2). doi:10.7441/joc.2017.02.01.

Bąk, I. (2014). Influence of feature selection methods on classification sensitivity based on the example of a study of Polish voivodship tourist attractiveness. *Folia Oeconomica Stetinensia*, *13*(2). doi: 10.2478/foli-2013-0017.

Boeri, T., & Jimeno, J. F. (2016). Learning from the great ivergence in unemployment in Europe during the crisis. *Labour Economics*, *41*. doi: 10.1016/j.labeco .2016.05.022.

Cárdenas Hurtado, C. A., Hernández Montes, M. A., Gorron, T., & Edwar, J. (2015). A statistical analysis of heterogeneity on labour markets and unemployment rates in Colombia. *Desarrollo y Sociedad*, *75.*

Carlsson, F., Johansson, M., Petersson, L. O., & Tegsjö, B. (1993). *Creating labour market areas and employment zones*. Umeå University.

Cheba, K., & Szopik-Depczyńska, K. (2017). Multidimensional comparative analysis of the competitive capacity of the European Union countries and geographical regions. *Oeconomia Copernicana, 8*(4). doi: 10.24136/oc.v8i4.30.

Ciżkowicz, P., Kowalczuk, M., & Rzońca, A. (2016). Heterogeneous determinants of local unemployment in Poland. *Post-Communist Economies*, *28*(4). doi: 10.2139/ssrn.2646569 .

Drutarovská, J., Kovacova, J., Pechová, H., & Podmajerská, K. (2016). Analysis of women's status in the labor markets of countries in the European Union 1. *Journal of International Women's Studies*, *17*(1).

Eamets, R. (2013). Labour market and labour market policies during great recession: the case of Estonia. *IZA Journal of European Labor Studies*, *2*(1).

Gawronski, K., Prus, B., & Soltysik, S. (2014). Analysis and evaluation of the conditions of socio-economic development of the Podkarpackie Voivodeship. *Infrastruktura i Ekologia Terenów Wiejskich*, *4*(2).

Hellwig, Z. (1968). Application of the taxonomic method to the typological division of countries due to the level of their development and the resources and structure of qualified personnel. *Przegląd statystyczny*, *4*.

Henkens, K., Remery, C., & Schippers, J. (2005). Recruiting personnel in a tight labour market: an analysis of employers' behaviour. *International Journal of Manpower*, *26*(5). doi:10.1108/01437720510615116.

Jindrová, A., & Vostrá Vydrová, H. (2013). Modelling dependence indicators of labor market using advanced statistical methods. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, *60*(4). doi: 10.11118/actaun20 1260040165 .

Jurkowska, B. (2014). The federal states of Germany – analysis and measurement of development using taxonomic methods. *Oeconomia Copernicana*, 5(3). doi: 10.12775/oec.2014.019 .

Mačerinskienė, I., & Aleknavičiūtė, R. (2017). National intellectual capital influence on economic growth in the European Union countries. *Equilibrium. Quarterly Journal of Economics and Economic Policy, 12*(4). doi: 10.24136/eq. v12i4.30.

Madianos, M. G., Alexiou, T., Patelakis, A., & Economou, M. (2014). Suicide, unemployment and other socioeconomic factors: evidence from the economic crisis in Greece. *European Journal of Psychiatry*, *28*(1). doi: 10.4321/S0213-61632014000100004.

Masso, J., & Krillo, K. (2011). Mixed adjustment forms and inequality effects in Estonia, Latvia and Lithuania. *Work Inequalities in the Crises, Edward Elgar, ILO*. doi: 10.5848/ilo.978-9-221248-86-6_3.

Miśkiewicz-Nawrocka, M., & Zeug-Żebro, K. (2015). Assessment of the risk of unemployment in Polish voivodships in 2005–2012. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie*, *940*.

Nadiya, D. (2008). Econometric and cluster analysis of potential and regional features of the labour market of Poland. *Ekonomia. Rynek, Gospodarka, Społeczeństwo*, *21*.

Pietrzak, M. B (2014). Taxonomic measure of development (TMD) taking into account spatial dependencies. *Przegląd Statystyczny, 61*(2).

Pietrzak, M. B., & Balcerzak, A. P. (2016). A spatial SAR model in evaluating influence of entrepreneurship and investments on unemployment in Poland. In M. Reiff & P. Gezik (Eds.). *Proceedings of the international scientific conference quantitative methods in economics multiple criteria decision making XVIII*. Vratna: Letra Interactive.

Pietrzak, M. B., & Balcerzak, A. P. (2016). Assessment of socio-economic sustainability in new European Union members states in the years 2004–2012. In M. Papież & S. Śmiech (Eds.). *The 10th professor Aleksander Zelias international conference on modelling and forecasting of socio-economic phenomena. Conference proceedings*. Cracow: Foundation of the Cracow University of Economics.

Rollnik-Sadowska, E. (2016). Young people in the European Union labour market. *Latgale National Economy Research*, *1*(8). doi: 10.17770/lner2016 vol1.8.1482 .

Rose, A. K., & Spiegel, M. M. (2011). Cross-country causes and consequences of the crisis: an update. *European Economic Review*, *55*(3). doi:10.1016/j.euro ecorev.2010.12.006.

Saczyńska-Sokół, S. (2018). Supporting NEETs — challenges facing labor market institutions in Poland. *Oeconomia Copernicana*, *9*(1). doi: 10.24136/oc. 2018.009.

Stanny, M. (2010). Spatial diversification of the balance on the labour market in rural areas in Poland. *Bulletin of Geography. Socio-economic series*, *14*. doi: 10.2478/v10089-010-0018-x.

Trapczynski, P., Jankowska, B., Dzikowska, M., & Gorynia, M. (2016). Identification of linkages between the competitive potential and competitive position of SMEs related to their internationalization patterns shortly after the economic crisis. *Entrepreneurial Business and Economics Review*, *4*(4). doi: 10.15678/ EBER.2016.040403.

White, A. (2016). Informal practices, unemployment, and migration in small-town Poland. *East European Politics and Societies*, *30*(2). doi: 10.1177/08883 25415602056 .

Wierzbicka, W. (2018). Information infrastructure as a pillar of the knowledge-based economy — an analysis of regional differentiation in Poland. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, *13*(1). doi: 10.24136/eq.2018.007.

Wysocki, F. (2010). Taxonomic methods in recognizing economic types of agriculture and rural areas. *Wydawnictwo Uniwersytetu Przyrodniczego w Poznaniu, Poznań*, *108*.

Annex

Table 1. Diagnostics variables for the purpose of describing youth unemployment

Variable	Description of diagnostic variables
X_1	participation of unemployed persons in age group of 15-24 years in the total number of unemployed
X_2	participation of unemployed persons without internship in the total number of unemployed
X_3	participation of unemployed persons with higher education in the total number of unemployed
X_4	job vacancy rate
X_5	number of unemployed persons attributable to one offer
X_6	the monthly average gross salary in relation to the national average

Source: own calculations based on Eurostat (2017).

Table 2. Specification the investigated factors

Variables	2005	2014	Growth Rate (in %)
X_1	774 575	347 325	-55.16
X_2	656 600	315 400	-51.96
X_3	152 400	225 441	47.93
X_4	66	50	-24.24
X_5	158	46	-70.89
X_6	4439.76	6516.26	46.77

Source: own calculations based on Eurostat (2017).

Table 3. Polish regions arranged according to Hellwig's measure in the years 2005 and 2014

Voivodeship	d_i in **2005**	Voivodeship	d_i in **2014**
Masovian	0.632	Lower Silesian	0.656
Lower Silesian	0.629	Masovian	0.62
Pomeranian	0.554	Pomeranian	0.51
West Pomeranian	0.485	West Pomeranian	0.503
Opole	0.479	Silesian	0.465
Lubusz	0.471	Lubusz	0.461
Łódź	0.444	Łódź	0.443
Silesian	0.415	Opole	0.436
Greater Poland	0.347	Kuyavian-Pomeranian	0.427
Kuyavian-Pomeranian	0.326	Greater Poland	0.414
Warmian-Masurian	0.282	Warmian-Masurian	0.329
Lesser Poland	0.258	Lesser Poland	0.216
Podlaskie	0.155	Podlaskie	0.173
Podkarpackie	0.149	Podkarpackie	0.09

Table 3. Continued

Voivodeship	d_i in **2005**	**Voivodeship**	d_i in **2014**
Lublin	0.106	Świętokrzyskie	0.076
Świętokrzyskie	0.025	Lublin	0.058
Arithmetic average	0.360	Arithmetic average	0.367
Standard deviation	0.186	Standard deviation	0.190

Source: own calculations based on Eurostat (2017).

Table 4. Distribution of Polish regions by clusters in 2005

2005				
1	**2**	**3**	**4**	**5**
Łódź	Lower Silesian	Opole	Podkarpackie	Świętokrzyskie
Greater Poland	Silesian	West Pomeranian	Warmian-Masurian	
Kuyavian-Pomeranian	Pomeranian	Lublin	Podlaskie	
Lubusz	Lesser Poland			
	Masovian			

Source: own calculations based on Eurostat (2017).

Table 5. Distribution of Polish regions by clusters in 2014

2014				
1	**2**	**3**	**4**	**5**
Opole	Silesian	Podlaskie	Warmian-Masurian	Łódź
Kuyavian-Pomeranian	Greater Poland	Podkarpackie	Lublin	Lesser Poland
Pomeranian	Lower Silesian	Świętokrzyskie		Masovian
West Pomeranian	Lubusz			

Source: own calculations based on Eurostat (2017).

Table 6. Cluster description in 2005

Year	**2005**				
Cluster	**1**	**2**	**3**	**4**	**5**
participation of unemployed persons in age of 15-24 years, %	22.5	22.2	19.67	24.33	24
participation of unemployed persons without internship, %	20.25	23.2	21	26.67	29
participation of unemployed persons with higher education, %	4.5	17	8.67	6.33	8
job vacancy rate, %	66	73.2	62.33	51.33	57
number of unemployed persons attributable to one offer	159.25	116.2	251.33	408.67	1070
the monthly average gross salary (PLN)	3397.16	4424.18	3325.02	3162.91	3208.39
Number of voivodeships in cluster	4	5	3	3	1

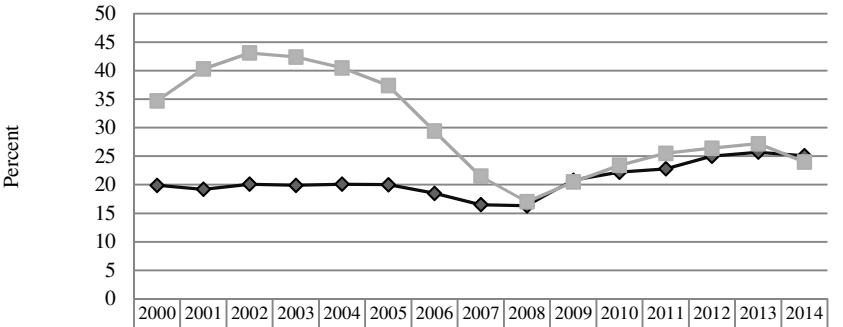
Source: own calculations based on Eurostat (2017).

Table 7. Cluster description in 2014

Year	**2014**				
Cluster	**1**	**2**	**3**	**4**	**5**
participation of unemployed persons in age of 15-24 years, %	16	15	18.53	18	15
participation of unemployed persons without internship, %	15.5	15	21.67	21	17
participation of unemployed persons with higher education, %	9	11.25	14.33	12	12.67
job vacancy rate, %	55	56	29.33	35	52
number of unemployed persons attributable to one offer	43	27	103.67	78	61
the monthly average gross salary (PLN)	5186.82	5513.26	4949.3	4740.23	6002.67
Number of voivodeships in cluster	4	4	3	2	3

Source: own calculations based on Eurostat (2017).

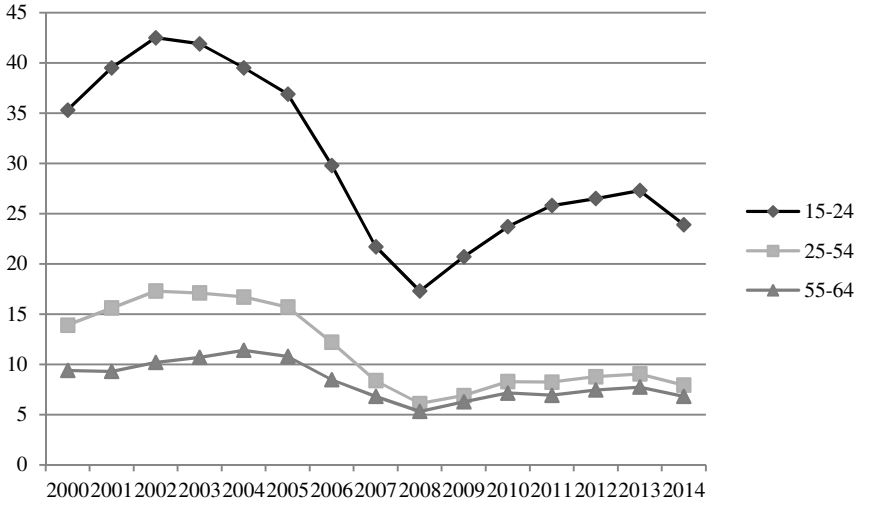
Figure 1. Youth unemployment in the European Union and Poland between 2000 and 2014



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
EU	19.9	19.2	20.1	19.9	20.1	20	18.5	16.5	16.3	20.8	22.2	22.8	25	25.7	25.1
Poland	34.7	40.3	43.1	42.4	40.5	37.4	29.4	21.5	17	20.5	23.4	25.5	26.4	27.2	24

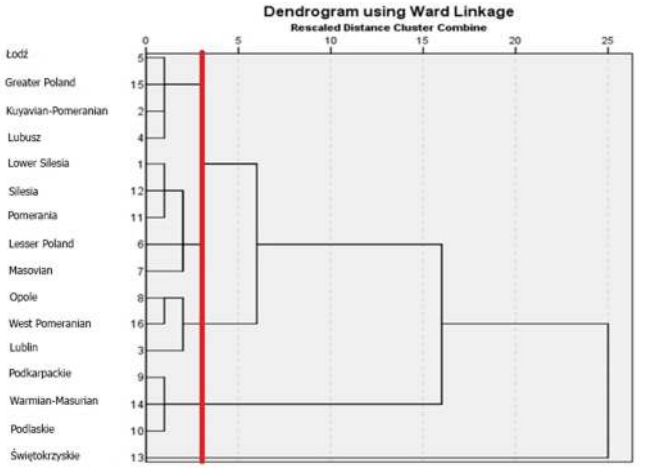
Source: own calculations based on Eurostat (2017).

Figure 2. Unemployment rate by age group in Poland between 2000 and 2014



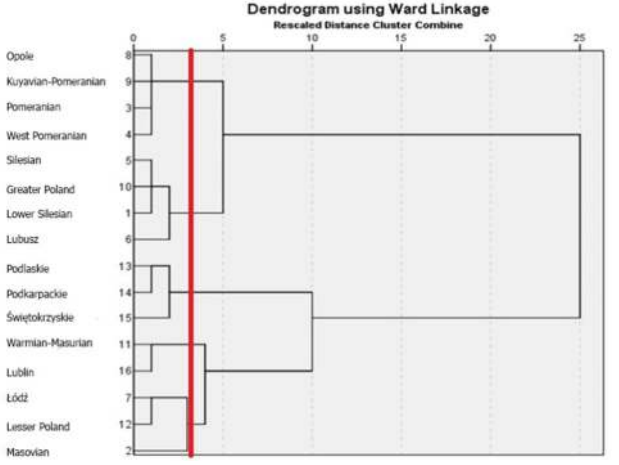
Source: own calculations based on OECD Statistics.

Figure 3. Dendrogram clustering of the Polish regions with respect to selected young people's labour market indicators in 2005



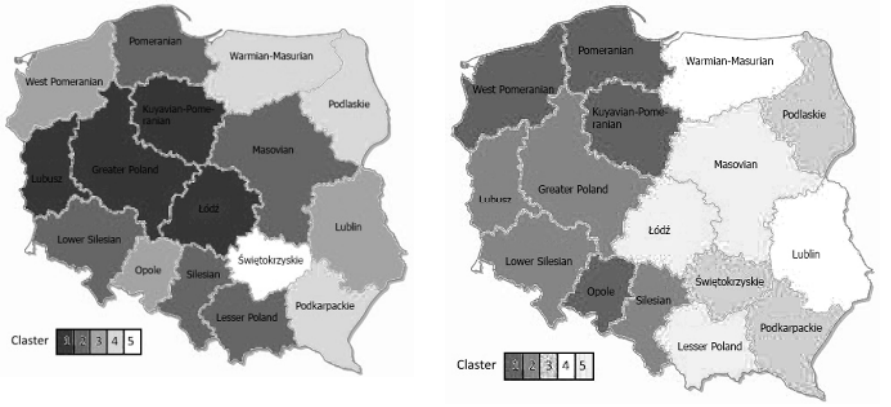
Source: own calculations based on Eurostat (2017).

Figure 4. Dendrogram clustering of the Polish regions with respect to selected young people's labour market indicators in 2014



Source: own calculations based on Eurostat (2017).

Figure 5. Groups of the voivodeships distinguished on the basis of cluster analysis in 2005 (on the left) and in 2014 (on the right)



Source: own calculations based on Eurostat (2017).