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Submitted: 10/05/2015 - Accepted: 10/06/2015 - Published: 28/08/2015

## Spatial Analysis of Adults Involvement in Education in Poland

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DOI: 10.26417/ejsr.v3i2.p59-68

### Abstract

Knowledge and competences play an important role in the development of the knowledge-based economy. Therefore, the idea of lifelong learning is a crucial element of development strategies. Various forms of learning may be distinguished, e. g. according to ISCED methodology formal, non-formal, informal and random ones. The participation rates in educational activities differ from country to country. Comparative analyses show that an unfavorable situation in this field can be observed in Poland. Despite many incentives and opportunities for continuous education, the percentage of people participating in trainings is one of the lowest in Europe. A vital question arises whether this issue shows spatial relationships when lower-level (regional) data are taken into consideration. The purpose of this paper is to determine if the educational processes in Poland show regional similarities or dissimilarities. The analysis is performed on the basis of variables characterizing lifelong learning activities at the regional level. Statistical methods taking into account the spatial position of the units are used in order to evaluate spatial relations.

**Keywords:** adult education, lifelong learning, spatial analysis

### Introduction

One of the crucial elements of the knowledge-based economy is the necessity of continuous improvement of skills, competences and knowledge. Lifelong learning process is not very well developed in Poland as compared to many other European

countries. Recent researches depicting the situation (Czapiński & Panek 2013; Grześkowiak 2013; Grześkowiak 2014; Grześkowiak 2015; GUS, 2009) indicate that there are various socio-economic factors associated with the involvement in lifelong learning activities. This paper is focused on another aspect, namely spatial distribution of the participation. Poland is divided into sixteen *NUTS 2* regions called voivodeships and this division is used to analyze spatial relationships. The main objectives of the study are:

- the evaluation of the spatial differentiation of the adults' participation in education,
- the assessment of the regional convergence with regard to the adults' participation in education,
- the detection of spatial patterns of the adults' participation in education.

Chosen spatial data analysis methods as well as some visualization techniques are applied to assess these issues.

### **Data and methods description**

This research is carried out on the basis of several variables characterizing adults' involvement in education in Poland at the regional level. The data come from various sources: Eurostat and Polish nationwide surveys on human capital (*Bilans Kapitału Ludzkiego*). Eurostat presents *Participation rate in education and training (last 4 weeks) by NUTS 2 regions within Labour Force Survey*. This indicator calculated for persons aged 25-64 is used to compare the implementation of the lifelong learning strategic educational objective across European Union countries. The data on it are available from 2001 until 2013 and therefore such a period is included in the analysis. The other data source allows a more comprehensive insight into the educational processes, but for a shorter period of time from 2010 to 2013. The survey on human capital concerns individuals in productive age (i. e. 18-64 for men and 18-59 for women) and includes questions on educational activities in various forms: the formal education, the training and the self-study. In this paper, participation in trainings is treated as a proxy of non-formal education and self-education activities as a proxy of informal education. The participation in the formal education is assessed on the basis of the question whether the respondent is currently taking part in it. The participation in the non-formal and the informal education relates to a declaration for the last 12 months.

Various analytical methods and visualization techniques are applied to assess the spatial differentiation of adults educational involvement. Choropleth maps are used to present the overall situation. The relations and changes of the participation rates in various forms of continuous education are depicted by a graphical presentation named parallel coordinates (see Inselberg, 1995) available by the *parcoord* from *MASS R* package (Venables & Ripley, 2002; Wegman, 1990). The degree of regional diversity in *Participation rate in education and training* indicator is assessed by the

coefficient of variation (CV) and its nonparametric analogy (the interquartile range divided by 2 times median). The regional convergence of lifelong learning participation is evaluated by the analogy with the approach used in the growth studies in which the process of reducing the differences between regions is examined. Two concepts of convergence are frequently considered: beta and sigma convergence (Barro et al, 1991; Sala-i-Martin, 1996). Sigma convergence may be evaluated by the changes of the coefficients of variation (see Trojak & Tokarski, 2013, p. 29).

The further part of this paper deals with spatial autocorrelation (association) meaning "the correlation among observations of a single variable (. . .) strictly attributable to the proximity of those observations in geographic space" (Fisher & Wang, 2011, p. 22). Moran's I statistic is applied as a global measure of spatial differentiation (Kopczewska, 2011, p. 72):

$$I = \frac{\sum_i \sum_j w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{s^2 \sum_i \sum_j w_{ij}}$$

and

$$s^2 = \frac{1}{n} \sum_i (x_i - \bar{x})^2$$

where:  $x_i$  - observation in region  $i$ ,  $\bar{x}$  - mean calculated for all regions,  $n$  - number of regions,  $w_{ij}$  - element of spatial weights matrix.

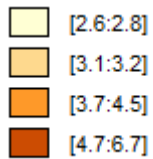
There are various methods of determining the spatial weights and in this paper rook-based first order contiguity approach is used (see Anselin 2004, pp. 106-110). The spatial autocorrelation patterns are visualized by Moran's scatterplot (see Anselin, 1996). Local indicators of spatial association (LISA) are used as a tool for the decomposition of Moran's I statistic and allowing to evaluate the contribution of each region (Anselin, 1995). LISA cluster maps are applied to illustrate significant regions (see Anselin 2004, pp. 140-141).

The analysis are performed with application of R and GeoDa programmes.

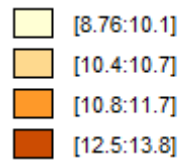
### **Spatial differentiation of lifelong learning participation in Poland**

The distributions of various forms of the lifelong learning process may be compared by the choropleth quartile maps. The situation in 2013 (most recent data) is reflected in Figure 1. The arrangement of colours shows that there are some spatial differences of adult involvement in the educational process. However, patterns vary depending on the form of education.

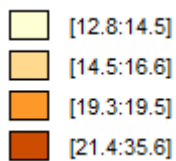
### Education and training (LFS) 2013



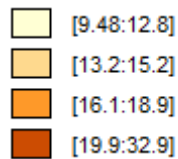
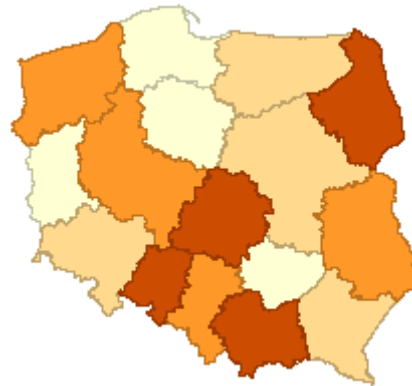
### Formal 2013



### Non-formal 2013



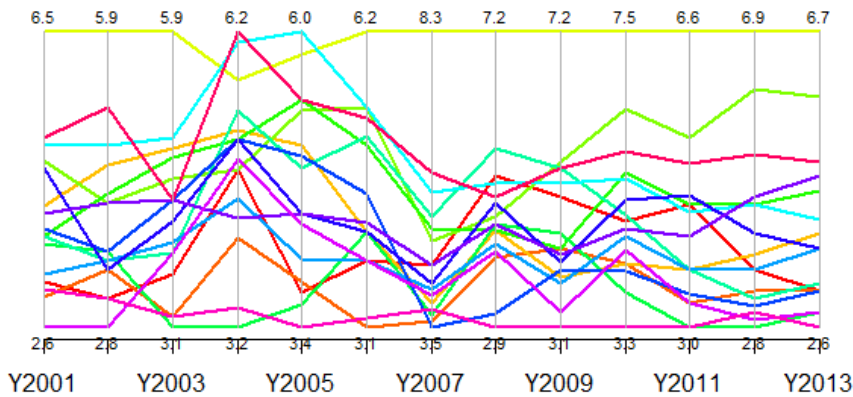
### Informal 2013



**Figure 1. Spatial distribution of participation in educational activities in 2013 by quartiles**

Source: own elaboration based on LFS Eurostat data

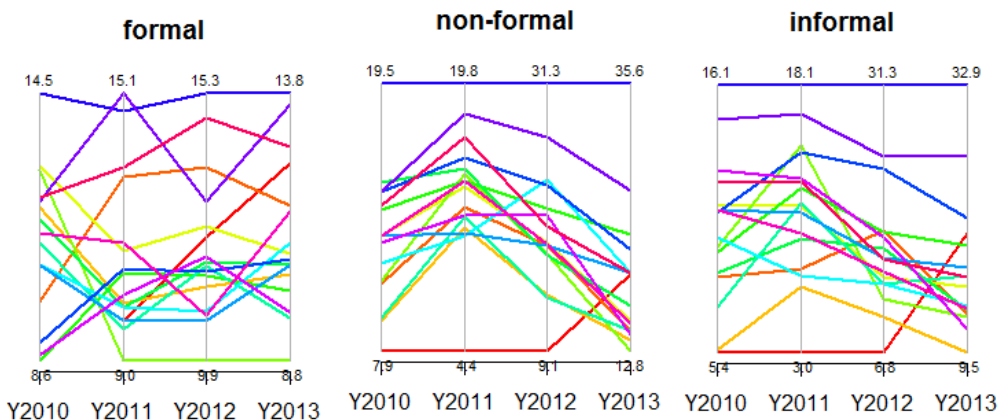
Although the choropleth map presentation is very clear and interesting, its application is a bit limited in the case of longer time series. Hence, a visualization called parallel coordinates is applied in order to compare the course of the phenomena (Figure 2, Figure 3).



**Figure 2. Parallel coordinates presentation of the participation rate in education and training in Polish regions in years 2001-2013**

Source: own elaboration based on LFS Eurostat data

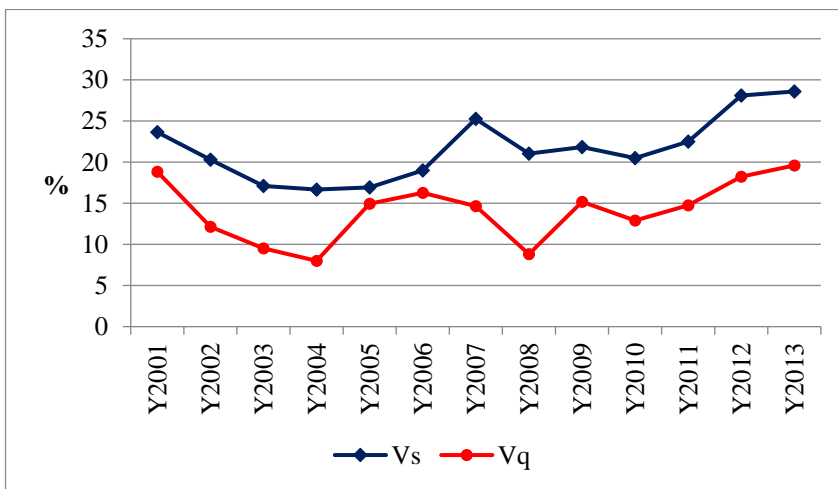
The course of the lines on the graphs indicate that the participation in various forms of education differs from region to region. In some regions, a constant low or constant high level is observed. However, in most regions, the variability of the participation rate is substantial. Spatial patterns are different for various forms of education.



**Figure 3. Parallel coordinates presentation of the participation in various forms of education in Polish regions in years 2010-2013**

Source: own elaboration based on Bilans Kapitału Ludzkiego 2010-2013 data

The variability is assessed by the coefficients of variation compared with the critical value equal to 10%. Assuming this critical value it can be stated that the participation in education and training is characterized by significant regional differences. The coefficients of variation are also the basis for evaluating the degree of the regional convergence. Decreasing values would indicate a diminishing divergence between regions. Figure 4 shows the evolution of the coefficients of variation in the years 2001-2013. Their values do not allow to draw the conclusion that there is the sigma convergence of the Polish regions in the field of lifelong learning. Moreover, the increasing variability since 2010 suggests the divergence in this area.



**Figure 4. Coefficients of variation ( $V_s$ ) and their nonparametric analogies ( $V_q$ ) calculated for the participation rate in education and training in Polish regions in years 2001-2013**

Source: own computations based on Eurostat LFS data

The time series relating to various forms of training include only four years. Such a small number of observations is not sufficient to infer about the convergence.

### Evaluation of spatial autocorrelation

The presence of the spatial autocorrelation of the participation in education and training in the global sense is verified by Moran's I statistics (Table 1). All Moran's statistics values are below zero, demonstrating a negative autocorrelation, but pseudo p-values indicate that the dependences are not significant.

**Table 1. Evaluation of the global spatial autocorrelation of participation in education and training**

Year	Moran's I statistic	p-value*
2001	-0,0283	0,3586
2002	-0,1556	0,3057
2003	-0,2185	0,1538
2004	-0,1058	0,4320
2005	-0,2987	0,0590
2006	-0,2424	0,1259
2007	-0,2205	0,1079
2008	-0,1020	0,4316
2009	-0,1603	0,2727
2010	-0,2115	0,1479
2011	-0,1802	0,2248
2012	-0,2364	0,1219
2013	-0,2388	0,1109

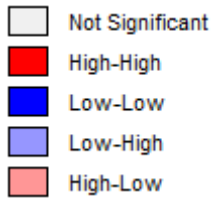
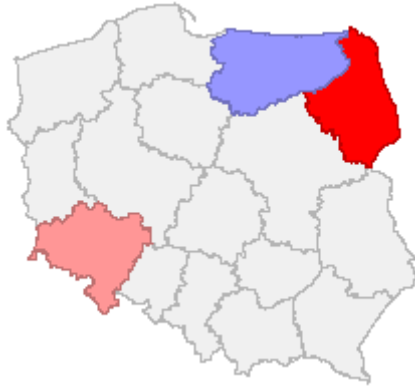
Note: \*pseudolevel calculated by a random permutation algorithm (number of permutations =1000)

Source: own computations based on LFS Eurostat data

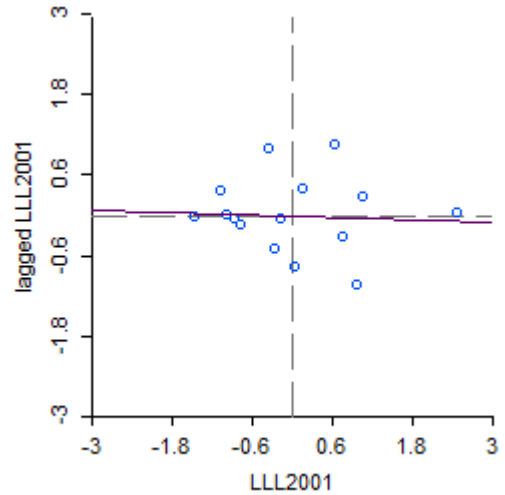
The detailed analysis using LISA reveals locations with significant local Moran statistics. LISA cluster maps and Moran's scatterplots for years 2001 and 2013 are presented in Figure 5. There were three regions with significant local Moran statistics in 2001, each with different characteristics. The Podlaskie voivodeship was characterized by a high participation rate as well as its neighbors. The involvement in education and training was substantially higher in the dolnośląskie voivodeship as compared to the neighboring regions. Poor engagement was observed in warmińsko-mazurskie voivodeship in relation to the contiguous regions. In 2013, the local Moran statistic was significant only in the case of the warmińsko-mazurskie voivodeship, where participation in lifelong learning was again essentially lower than in the neighboring provinces.

### Education and training (LFS) 2001

#### LISA Cluster Map



#### Moran's scatterplot

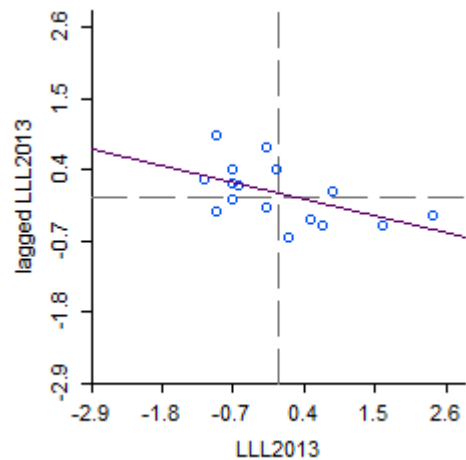


### Education and training (LFS) 2013

#### LISA Cluster Map



#### Moran's scatterplot



**Figure 5. LISA cluster maps and Moran's scatter plots concerning the participation in education and training in 2001 and 2013**

Source: own elaboration based on LFS Eurostat data



The spatial autocorrelation of various forms of education is also considered. The values of the global Moran's statistics and pseudo p-values are shown in Table 2. Certain regularities may be noticed. A positive spatial autocorrelation occurs for the participation in the formal education in all years. The voivodeships with the high rates tend to be close to one another. The same holds for the voivodeships with the low rates. There is no spatial autocorrelation of informal learning. The only significant dependence for non-formal learning is observed in 2011.

**Table 2. Evaluation of the global spatial autocorrelation of participation in various forms of education**

Form	Year	Moran's I statistic	p-value*
formal	2010	0,2765	0,0190
	2011	0,4284	0,0040
	2012	0,2361	0,0420
	2013	0,2458	0,0320
non-formal	2010	0,0545	0,1909
	2011	0,1995	0,0320
	2012	-0,1237	0,3676
	2013	-0,0168	0,3427
informal	2010	-0,0422	0,4296
	2011	-0,1228	0,3786
	2012	-0,0522	0,4286
	2013	-0,0619	0,4396

Note: \*pseudolevel calculated by a random permutation algorithm (number of permutations =1000)

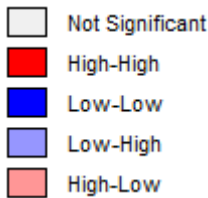
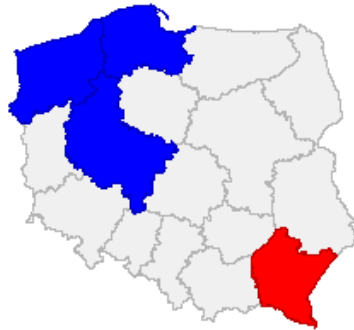
Source: own computations based on Bilans Kapitału Ludzkiego 2010-2013 data

Some interesting detailed results are obtained by the application of LISA and presented on the cluster maps in Figure 6 and Figure 7.

There are four regions characterized by a significant local Moran's statistics in 2013 if the participation in formal learning is taken into account. Three of them, i. e. the zachodniopomorskie, the pomorskie and the wielkopolskie voivodeships have a low level of the educational engagement and the same regularities are present in the contiguous regions. The opposite situation is observed in the podkarpackie voivodeship where the high participation rate is accompanied by the high involvement in the neighboring provinces.

### Formal 2013

#### LISA Cluster Map



#### Moran's scatterplot

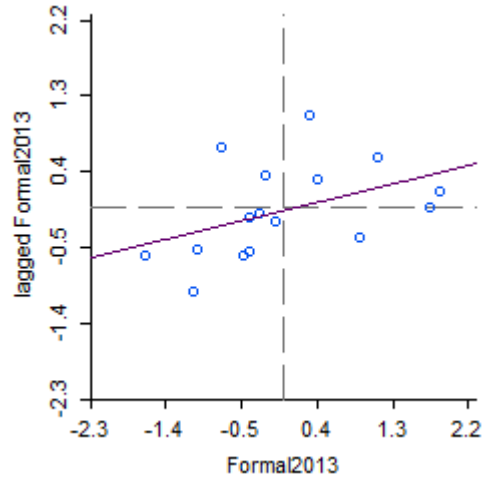
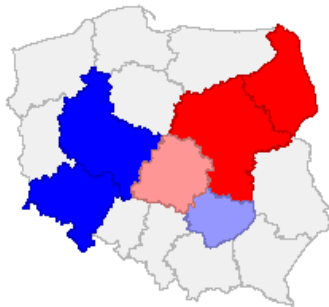


Figure 6. LISA cluster map and Moran's scatter plot for formal education participation in 2013

Source: own elaboration based on Bilans Kapitału Ludzkiego 2011 and 2013 data

### Non-formal 2011

#### LISA Cluster Map



#### Moran's scatterplot

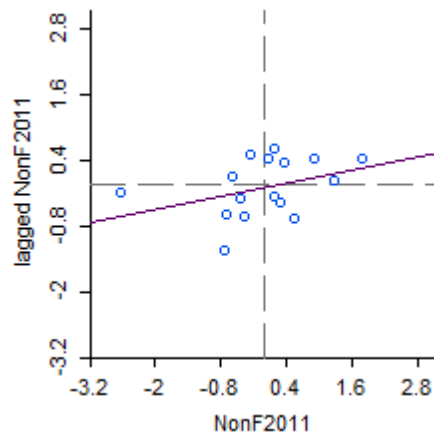


Figure 7. LISA cluster map and Moran's scatter plot for non-formal education participation in 2011

Source: own elaboration based on Bilans Kapitału Ludzkiego 2011 and 2013 data

Six regions are distinguished if the spatial distribution of the participation in non-formal education in 2011 is evaluated by the local Moran's statistics. All types of spatial dependences are represented: high values in the regions and high values in the neighboring regions (podlaskie and mazowieckie voivodeships), low values in the regions and low values in the neighboring regions (dolnośląskie and wielkopolskie voivodeships), high value in the region and low values in the neighboring regions (łódzkie), low value in the region and high values in neighboring regions (świętokrzyskie).

## Conclusions

There is a spatial differentiation in terms of the adults' activities in the field of the continuous education in Poland. The levels of participation rates vary across regions. In recent years, there was no evidence of regional sigma convergence in this aspect. Spatial autocorrelation was detected in some cases. A distinct positive relationship was found in the case of participation in formal education in years 2010-2013. Regions of high and low degree of adults' involvement in this form of education tend to form clusters. The spatial dependencies for the other forms of lifelong learning are not significant in the sense of spatial autocorrelation with the exception of non-formal education in 2011.

## References

- [1] Anselin, L. (1995). Local indicators of spatial association-LISA. *Geographical analysis*, 27 (2), pp. 93-115.
- [2] Anselin, L. (1996). The Moran scatterplot as an ESDA tool to assess local instability in spatial association. *Spatial analytical perspectives on GIS*, 111, pp. 111-125.
- [3] Anselin, L. (2004). *Exploring spatial data with GeoDaTM: a workbook*. Urbana, 51, 61801.
- [4] Barro, R. J., Sala-i-Martin, X., Blanchard, O. J., & Hall, R. E. (1991). Convergence across states and regions. *Brookings papers on economic activity*, pp. 107-182.
- [5] Czapiński, J. & Panek, T. (eds.). (2013). Social diagnosis 2013. Objective and subjective quality of life in Poland. *Diagnoza Społeczna 2013. Warunki i Jakość Życia Polaków, Contemporary Economics*, Vol. 7, pp. 1-491.
- [6] Fischer, M. M., & Wang, J. (2011). *Spatial data analysis: models, methods and techniques*. Springer Science & Business Media.
- [7] Grześkowiak, A. (2013). Statystyczna analiza aktywności edukacyjnej osób dorosłych w Polsce, *Ekonometria*, 2 (40), pp. 22-35.
- [8] Grześkowiak, A. (2014). Self-learning as a method of improving skills by adult Poles - evidence from non-metric survey data, [in:] *Proceedings of the 12th International Academic Conference*, IISES, Prague, pp. 486-495.
- [9] Grześkowiak, A. (2015). Wielowymiarowa analiza uwarunkowań zaangażowania Polaków w kształcenie ustawiczne o charakterze

pozaformalnym. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu* (forthcoming).

- [10] GUS. (2009). *Kształcenie dorosłych*. Warszawa.
- [11] Inselberg, A. (1985). The plane with parallel coordinates, *The Visual Computer*, 1. 2, pp. 69-91.
- [12] Kopczevska, K. (2011). *Ekonometria i statystyka przestrzenna z wykorzystaniem programu R CRAN*. Warszawa: CeDeWu Wydawnictwa Fachowe.
- [13] Sala-i-Martin, X. X. (1996). The classical approach to convergence analysis. *The economic journal*, pp. 1019-1036.
- [14] Trojak, M. , Tokarski, T. (eds. ). (2013). *Statystyczna analiza przestrzennego zróżnicowania rozwoju ekonomicznego i społecznego Polski*. Kraków: Wydawnictwo Uniwersytetu Jagiellońskiego.
- [15] Venables, W. N. & Ripley, B. D. (2002). *Modern Applied Statistics with S*. Fourth edition. Springer.
- [16] Wegman, E. J. (1990). Hyperdimensional data analysis using parallel coordinates. *Journal of the American Statistical Association* 85, pp. 664–675.