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Contact: mwostieg@ur.edu.pl; Institute of Economics and Finance, University of Rzeszów, ul. Ćwiklińskiej 2, 35-601 Rzeszów

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Małgorzata Wosiek

University of Rzeszów, Poland

 orcid.org/0000-0002-0503-001X

Rural–urban divide in human capital in Poland after 1988

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Abstract

Research background: The subject of the study is the disproportionate development of rural and urban areas in terms of human capital in the context of the convergence process.

Purpose of the article: The main goal of the study is to assess the rural–urban disparities on the educational attainment of the population (adopted as a human capital proxy), based on the example of Poland.

Methods: The Bray-Curtis measure of structures diversity, the Kruskal-Wallis test and regression analysis were applied to investigate the scale and dynamic of the rural–urban educational divide in Poland in the period 1988–2018.

Findings & Value added: The paper emphasizes the aspect of rural–urban differences in the Polish economy and their dynamic nature. Studies have revealed that in 1988–2018, in Poland, the disparity in educational attainment between rural and urban populations was gradually reduced. This process, however, was not accompanied by the reduction of internal educational disparities in the rural space. The study results are helpful in verifying the effectiveness of public funds, allocated in recent years in order to accelerate the multi-functional development of rural areas in Poland and other CEE countries.

Introduction

The disproportionate development of rural and urban areas is a typical feature of national economies, regardless of social, economic, institutional and

historical conditions. The differences observed among countries refer to the depth of the rural–urban divide, as well as the dynamics of its changes. Rural development plays a crucial role in EU cohesion policy, in particular after the accession of Central and Eastern European countries to the EU. As EU allocates significant funds to boost the multi-functional development of rural areas (Bórawski, 2012), the range of rural–urban development disparities is significant for monitoring the fulfillment of social and economic cohesion priorities (Rosner & Stanny, 2017).

In this context, it seems important to find an answer to the question of the effects of the use of public funds, measured by means of the dynamics and scale of reduction of the rural–urban development disparities, including the disparities in the human capital dimension, which is among the most important growth factors in any knowledge-based economy. The significance of the issue is highlighted by the results of previous studies (Glewwe & Kremer, 2006; Raffo *et al.*, 2007; Zhu *et al.*, 2017; Janc & Czapiewski, 2005) that provide evidence for the existence of mutual connections between closing the educational gap and reducing the rural–urban development disparities.

Against this background, the main goal of this research is to assess the rural–urban disparities in Poland on the educational attainment of the population (adopted as a human capital proxy) in the context of the convergence process. The paper contributes to the existing literature in several ways. First, it emphasizes the aspect of rural–urban differences in the Polish economy and their dynamic nature. Moreover, it focuses on the educational dimension of human capital and adopts a research approach that enables simultaneous observation of human capital formation on different levels of formal education. The analyses cover the 1988–2018 period and were performed for urban and rural areas distinguished according to an administrative criterion.

The paper is structured as follows. The first part presents a critical review of the results of previous studies on human capital spatial distribution and development trends in the context of disproportionate rural–urban development. The second part describes the research methods. In the third section, the rural–urban disparities in human capital development in Poland between 1988 and 2018 were analyzed. The fourth part focuses on the internal diversification of urban and rural areas due to education achievements. The paper ends with conclusions containing the most important research findings.

Literature review

In an interdisciplinary approach, human capital is defined as the ‘knowledge, skills, health and competences of an individual which facilitate the creation of individual, social and economic wealth and result from investments made’ (Domański, 1993, p. 19; Bartak, 2018, p. 9). This definition emphasises the human features, which foster personal and social development, alongside economic development.

Human capital is shaped by many different factors throughout life, but a formal education system plays a leading role in the process. Not only does education affect — through the human capital channel — the path of individual development but also contributes to the performance of the economy as a whole (Becker, 1964; Barro & Sala-i-Martin, 2004), including the development of rural areas (Stanny, 2013). Studies also reveal the contextual nature of the benefits of investing in human capital. Benefits are greater where the rate of return on education is higher (Jabłoński, 2016). This usually applies to urban areas where — compared to rural areas — the labour market is more developed, the structure of the economy is more diversified and technologically advanced, social services are more readily available, and the transport and communication infrastructure is more developed (Brasington, 2002; Kochar, 2004).

Studies carried out in different countries, including Poland, unanimously indicate an educational gap between rural and urban areas. Lower educational attainment among the inhabitants of rural areas does not only result from a lower return on educational investment, but also from the relatively higher costs of such activities, e.g. due to the poorer spatial availability of schools, lower income levels or limited access to financial services (Ulubaşoğlu & Cardak, 2007).

Studies also indicate that the scale of educational disproportions between rural and urban areas changes with the level of social and economic development and is higher in developing and transforming countries (Glewwe & Kramer, 2006). Hence, the issue of educational diversification between rural and urban areas is widely discussed in the literature, especially for the reference group of economies (Zhu *et al.*, 2017; Amini & Nivorozhkin, 2015; Agrawal, 2014).

In international comparisons, the educational dimension of human capital is assessed mostly by the average years of schooling. Additionally, the percentage of people with secondary/tertiary education, enrolment rates or PISA-test results are used. Educational inequality is measured by:

- the educational GINI coefficient for years of schooling (Castelló & Doménech, 2002; Agrawal, 2014; Shukla & Mishra, 2019),
- the standard deviation of years of schooling (Gregorio & Lee, 2002; Shukla & Mishra, 2019; Senadza, 2012),
- the ratio of rural to urban average years of schooling (Ulubaşoğlu & Cardak, 2007).

The main focus of the research is to answer the question of how educational inequality evolves over time, how it is generated and how it relates to other economic variables (e.g. economic growth, income inequality etc.).

Studies on rural–urban educational differences in Poland tend to focus on the internal development problems of rural areas, and the urban context functions as a measure of comparison (Halamska *et al.*, 2017; Kamińska, 2016; Bański, & Czapiewski, 2009). The studies indicate the important role of education in increasing the economic potential of rural areas (Janc & Czapiewski, 2005). The significance of education, however, is lower than that of economic and financial factors (Stanny, 2013).

Regarding the Polish economy, the research methods often involve multi-dimensional comparative analyses (Rosner & Stanny, 2014; Klonowska-Matynia, 2017), in which the educational context is among other human capital indicators, next to such aspects as entrepreneurship or health. The cognitive value of such research consists in demonstrating the multi-dimensional nature of human capital and the internal diversification of rural space due to human capital endowment, but it is poorly aimed at monitoring human capital accumulation at each stage of the educational process. In filling this research gap, this paper emphasizes the aspect of rural–urban diversification in Poland and its dynamic character. Moreover, a different research approach is applied, enabling the simultaneous observation of human capital formation at different stages of formal education.

Research methodology

This paper was made under the assumption that the following hypotheses would be verified:

H1: *The changes in the spatial distribution of human capital between rural and urban areas in Poland after 1988 were of a convergent nature.*

H2: *The changes in the spatial distribution of human capital within rural/urban areas in Poland after 1988 were convergent.*

A starting point for the analyses is a data matrix X , which characterizes the population's educational attainment:

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

where:

- a x_{ij} observation is the share of the j -th feature ($j=1,2,\dots,m$) in the structure of the i -th object ($i=1,2,\dots,n$) in period t ($t=1988, \dots, 2018$), and falls within the $[0,1]$ range. In the present study, a x_{ij} observation applies to: a) the share of people aged 15 or above who have completed a specific level of formal education: tertiary (x_{i1}), secondary (x_{i2}), basic vocational (x_{i3}), primary (x_{i4}) and incomplete primary (x_{i5}); b) poviats¹ or voivodeships are the objects (i);
- for a particular object: $\sum_{j=1}^m x_{ij} = 1$.

The data matrix X is the basis for the calculation of the Bray-Curtis (BC) structures diversity measure in period t (De Benedictis & Tajoli, 2007):

$$BC_{ik,t} = \frac{\sum_{j=1}^m |x_{ij,t} - x_{kj,t}|}{\sum_{j=1}^m (x_{ij,t} + x_{kj,t})} \quad (2)$$

where:

x_{ij} – as above. The reference object (k) includes: a) average values in Poland, b) average values of Polish urban areas, and c) average values of Polish rural areas in period t .

The Bray-Curtis semi-metric has the advantage of relatively high ability to distinguish differences in the distribution of the structures of individual objects (Młodak, 2006, pp. 54–59). It falls within the $[0,1]$ range, where lower values mean a higher similarity of objects.

Delimitation of rural areas was carried out based on an administrative criterion. The analyses covered rural areas (rural communes and rural areas of urban–rural communes) and urban areas (urban communes and urban areas of urban–rural communes) within different territorial arrangements: at the local level (poviats) for the years 1988 and 2011 (data from the National

¹ Powiat is part of a voivodeship (NUTS-2). It is the second-level unit of local administration in Poland, equivalent to a county or district (formerly NUTS-4) in other countries. A powiat is sub-divided into communes.

Census), and at the regional level (voivodeships, NUTS-2) for the 1995–2018 period (data from Labour Force Survey; LFS). All data were provided by the Central Statistical Office of Poland (CSO; Local Data Bank).

The impact of the place of residence on the level of the educational attainment of the population was verified statistically by means of the Kruskal-Wallis test.

In order to evaluate the internal diversification of rural and urban areas with regard to the inhabitants' educational attainment:

- a regression analysis was used. An equation verifying the σ -convergence type (Barro & Sala-i-Martin, 2004) was applied:

$$sd(x_{ij,t}) = \alpha_0 + \alpha_1 t \quad (3)$$

where:

$sd(x_{ij,t})$ – standard deviation in the share of people with specific educational attainment living in a rural (urban) area in Poland in period t . A negative value of the α_1 parameter means that the dispersion in the share of the population with a completed specific level of formal education in rural (urban) areas decreases over time. For all levels of educational attainment, the $sd(x_{ij,t})$ data have a normal distribution, as indicated by the Shapiro-Wilk test ($p > 0.10$).² The log transformation, however, was applied to the dependent variable, as a White-test indicated violations of the linearity assumption. Additionally, in order to address the first-order autocorrelation problem, the FGLS (feasible generalized least squares) estimators were used.

- the clustering of poviats (based on comparative classification using a median) was performed (Strahl, 2006). Six types of rural (urban) areas were distinguished according to similarities in the share of inhabitants with a specific level of formal education. The first group includes poviats in which the values of the x_{i1} and x_{i2} variables³ were greater than or equal to the median, while for x_{i3} – x_{i5} ⁴, they were lower than or equal to the median. The second group covers poviats where four out of five features satisfied the abovementioned conditions. Likewise, the fifth group includes poviats with only one feature meeting the median criterion, while in the sixth group none of the features satisfied the conditions. The grouping results were verified using the Kruskal-Wallis test.

² The only exception is x_{i2} (the share of people with secondary education) ($p=0.03$).

³ Higher values of the x_{i1} and x_{i2} variables indicate a higher level of human capital.

⁴ Higher values of the x_{i3} – x_{i5} variables suggest a lower level of human capital.

It should be noted that this study has focused on the quantitative aspects of human capital and neglects the quality of education (due to the limited availability of data). It was assumed, though, that quantitative indicators can reflect the general trends in the educational differences between rural and urban populations. Thus, the obtained research results allow the verification of the research hypotheses.

Results

Rural–urban educational disparities in Poland

Over the entire study period (1988–2018), rural areas in Poland exhibited a less favourable population structure by educational attainment than urban areas (Figure 1). In rural areas, the percentage of people with tertiary or secondary education was lower and, consequently, the share of people with vocational and primary education was higher. At each level of formal education, the differences between the rural and urban areas were statistically significant, which was confirmed by the results of the Kruskal-Wallis test ($p < 0.001$) (except for vocational education in 1988, $p = 0.44$).

Despite the fact that the rural–urban differences persisted between 1988 and 2018, similar processes in human capital development were taking place in rural and urban areas. They involved an increase in the percentage of people with tertiary and secondary education, with a simultaneous decrease in the share of people with primary or incomplete primary education. Discrepancies occurred only in the share of inhabitants with vocational education: while their share in the structure of the urban population dropped from 25% at the beginning of the 1990s to 19.8% in 2018, an increase was observed in rural areas from 24% in 1988 to 30.5% in 2018. As a result, the differences between rural and urban areas relating to vocational education after 1988 have become statistically significant (Kruskal-Wallis test, $p < 0.001$). Furthermore, the ratio of rural–urban differences at this level of education increased from 1.04 in 1988 to 1.54 in 2018 (Table 1, Figure 2). In the case of inhabitants with primary or lower education, the rural–urban disproportions increased from 1.78 in 1995 to 1.90 in 2006 to become stable around 1.88 after 2006.

Differences were also observed in the dynamics of the abovementioned processes. More intense investments in the formal education of the rural population made it possible to reduce the educational gap between the rural and urban areas: for tertiary education from 81% in 1988 to 52% in 2018, and for secondary education from 59% in 1998 to 16% in 2018 (Table 1,

Figure 2). As a result, a persistent downward trend in the rural–urban educational gap, in terms of tertiary and secondary education, was clearly visible.

A comprehensive approach to the rural–urban educational gap reveals the convergent nature of the human capital development in the rural–urban dimension in Poland between 1988 and 2018 (Table 1, Figure 2). This is evidenced by the persistent drop of the BC measure (especially visible since 2004) from 0.263 in 1988 to 0.220 in 2018. The distance in the population structure by educational attainment between rural and urban areas was reduced by eliminating the gap in tertiary and secondary education. The scope of convergent processes was limited by a higher increase rate in the percentage of people with vocational education in the countryside compared to cities.

Internal educational differences in rural and urban areas in Poland

At the local level, within rural as well as within urban areas, the BC measure — calculated in reference to the Polish average rural (urban) areas — took lower values in 2011 than in 1988 (Figure 3). This might suggest that internal educational disparities within the rural and urban populations decreased between 1988 and 2011.

The Pearson correlation coefficients between the BC measure in 2011 and 1988, amounting to 0.676 ($p < 0.001$) for rural areas and 0.694 ($p < 0.001$) for urban areas, however, indicate that the local units with greater structural distance to the national average in 1988 also presented a greater structural distance in 2011. This is the evidence for some of the persistence in the internal division of rural and urban spaces due to the local characteristics favorable or unfavorable to individual investments in human capital through formal education.

Moreover, in 1988–2018, the individual investments in formal education varied in both rural and urban spaces. Across rural and urban areas, the values of the BC measure fluctuated significantly in the studied period (Figure 3). These fluctuations have resulted especially from the deepening of internal educational disparities for the share of people with tertiary education. This is confirmed by a positive and statistically significant value of the α_1 parameter of the linear trend function (Table 2). The polarisation trend was stronger in the countryside than in cities. On the rest of the levels of formal education, the statistically significant reduction in internal disparities was observed for: secondary and primary education in urban areas and for vocational education in rural areas. There is no evidence of convergence

or divergence in relation to secondary and primary education in rural areas or for vocational education in urban areas.

Ambiguous conclusions concerning internal educational diversification in rural and urban areas also result from the clustering of local units (poviats). Six types of rural and urban areas were distinguished (Table 3). The verification of the homogeneity of groups distinguished this way with the Kruskal-Wallis test ($p < 0.05$) suggests that average structural distances between the groups vary in a statistically significant way.

In all groups of rural and urban areas in 2011, as compared to 1988, the structural distance (BC) against an average rural (urban) area in Poland was reduced. This could suggest reduction in internal diversification for the educational structure of rural and urban populations. Conversely, in 2011 — compared to 1988 — an increase in the number of poviats classified as groups 1 and 6 was observed. They are outliers characterised by the highest value of the BC measure (Table 3). Higher BC values in groups 1–2 and 5–6, however, can be attributed to different causes. The greater structural distances of poviats classified as groups 1 and 2, result from a relatively higher share of people with tertiary and secondary education. Greater structural distances of poviats classified as groups 5 and 6 result from a relatively poorer structure of education among their population compared to the national average. Post hoc tests reveal that the characteristics of groups 1 and 6 determine the level of internal diversification within the rural and urban areas. An increase in the number of poviats in groups 1 and 6 might be indicative of the deepening educational diversification inside rural and urban areas.

A study of local development strategies of poviats revealed that rural areas classified as group 1 tend to be (80%) located in proximity to larger urban centres (e.g. Warsaw, Krakow, Wrocław, Katowice, Szczecin, Gdańsk, Rzeszów and Poznań) or industrial areas with a diversified economic structure (e.g. Silesia). Rural areas classified as group 6 are usually located in the peripheries, far removed from major urban centres, characterised by a low level of non-agricultural sector development, as well as high percentage of inhabitants benefiting from community social assistance. These areas are often the post-state farm areas. The following voivodeships have the strongest representations in group 6: Western Pomerania (5 poviats), Warmińsko-Mazurskie (3) and Pomerania (3) (Figure 4).

Discussion

According to data available in UNESCO Educational Yearbooks (1964–1999), the rural–urban educational inequality in Poland has been reduced since the 1970s. In 1970, the ratio of rural to urban average years of schooling was 0.66 and in 1988 it amounted to 0.80 (Ulubaşoğlu & Cardak, 2007). The current study evidences that although this trend has been continued till 2018, the rural–urban divide in human capital in Poland still exists. A similar situation could be observed also in some developing countries (e.g. India) or CEE countries (e.g. Romania) at the turn of the 20th and 21st centuries (Agraval, 2013; Voicu & Vasile, 2010).

In CEE, countries' reduction of the rural–urban educational disparities was fostered by the socio-economic development and the spread of the knowledge-based economy. These processes, generally, promoted investment in formal education, and the visible manifestation of this was the expansion of tertiary education.

In transition economies, the rural–urban educational gap has a historical (social) background (Voicu & Vasile, 2010) and is related to the specific place of agriculture in the rural economy. This sector is characterised by the highest (90% in Poland; UE–28 80%) share of specific knowledge-based jobs (Cyrek, 2018). It overlaps with cultural differences evidenced by a stronger drive of young people from rural areas, compared to their urban counterparts, to learn a specific job, and higher preferences towards vocational education among rural households (Kacprzak, 2010). This might explain the greater popularity of vocational education with rural inhabitants.

Thus, the educational change is not inherent to the rural area but it is driven from the social and economic transformations in the countryside and, consequently, the change in population structure (Voicu & Vasile, 2010; OECD 2006). In the case of Poland, deagrarianisation processes took place (decrease in the share of agriculture in the structure of income sources, from ca 22% in 1991 to 13% in 2013), proletarianisation (increase in the share of non-agricultural social and labour groups from ca 45% in 1991 to 72% in 2013) and gentrification (inflow of better educated middle-class individuals from the cities to the countryside) (Halamska *et al.*, 2017, pp. 37–39). These processes fostered the reduction of the disparities between rural and urban areas in terms of the educational attainment of the populations.

As the research shows, there is no universal pattern of educational change across the Polish rural areas. To the contrary, there is spatial diversity of rural areas in terms of educational attainment of the population. In

Poland, the most difficult situation occurs in north-eastern voivodeships strongly represented in group 6 (Table 3, Figure 4). These voivodeships suffer from scarcity of people with tertiary education. The conclusions from county groupings are in line with the results of other studies (Bański & Czapiewski, 2009; Kamińska, 2016; Halamska *et al.*, 2017).

Moreover, the recent expansion of higher education has led to the increase of the within-rural educational divide in Poland. Intra-rural inequality and an increasing rural heterogeneity arise as new challenges facing developing and transition countries (Agraval, 2013; Voicu & Vasile, 2010; OECD, 2006). As current research indicates, the gains from socio-economic transformation are greater particularly for rural areas located in proximity to the larger cities or with more diversified functional structure of the economy. These findings are supported by Bański and Czapiewski (2009), Kamińska (2016), Halamska *et al.* (2017) and Voicu and Vasile (2010). In both cases, the local economic structure gives the rural inhabitants the opportunity for non-agricultural employment, raises the rate of return on education and through the labor market channel (higher demand for skilled labor force) encourages private investment in formal education.

The rising rural heterogeneity suggests that the traditional urban–rural divide seems outdated (OECD, 2006) and drives the reconsideration of rural policy in OECD countries from a sectorial to a territorial policy approach.

Conclusions

On the basis of the conducted studies, several conclusions can be formulated:

1. In the period 1988–2018, in Poland, the distance in educational attainment between rural and urban populations was gradually reduced. This is proven by the persistent downward trend of the Bray-Curtis measure. This tendency resulted from bridging the rural–urban gap in tertiary and secondary education. The process of closing this gap prevailed over an increase in urban–rural differences in vocational education. Under these circumstances, it can be stated that hypothesis No. 1 was positively verified.
2. The conclusion regarding the internal educational disparities within the rural and urban populations is ambiguous. On the one hand, the measure of structural distance inside rural and urban areas in 2011 took lower values than in 1988, which might suggest convergent transformations. On the other hand, symptoms of preserving the spatial disparities or

even internal polarisation within rural and urban areas could be observed. The reason might be the deepening of disparities on the tertiary education attainment rates. Under these circumstances, it cannot be clearly stated that hypothesis No. 2 was positively verified.

3. The study results might suggest the diminishing role of factors related to the division into urban–rural areas in diversifying the Polish socio-economic space. These factors are gradually replaced by functional features related to the capacity and ability of a particular area to provide conditions for the development and absorption of highly qualified labor.
4. The research findings entail implications not only for Polish rural development policy, but also for other Central and Eastern European countries, as they all experience a transition process and transformation of the agricultural sector, and they all struggle with rural–urban divides. The findings call for the design and implementation of policies not only to address rural–urban inequalities in education, but also to tackle within–rural inequalities. In the case of Poland, the situation could be improved in this respect by greater stimulation of the economic structure of remote (peripheral) rural areas than has been the case so far. The diversified functional structure of the economy fosters the bridging of the rural–urban and within–rural educational gap. Conversely, inadequate human capital constrains not only agriculture but also economic restructuring in general. Nevertheless, there is a need for additional in-depth empirical research to compare how rural–urban inequalities have evolved over time in CEE countries in response to their socio-economic transformation.

This research is based on quantitative aspects of human capital. Although the research provides a general picture of rural–urban educational disparities, it has some limitations. It neglects lifelong learning and the quality of education, both of which are required for the comprehensive evaluation of human capital development. A further validation could apply other measures of rural–urban educational inequalities, as the GINI coefficient and its decomposition. Further studies could also verify the impact of different economic factors on the rural–urban educational gap. Moreover, it would be interesting to link educational inequalities with other dimensions of rural–urban diversification in Poland and other CEE countries, such as income or structural disparities.

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Annex

Table 1. Rural–urban differences in Poland in terms of the educational structure of populations (by poviats)

Ratio:	a-1988 b-2011	Population* by level of education							BC
		T	S	V	P	NC	BC		
Rural/urban areas (total)	a	0.19	0.41	1.04	1.52	3.34	0.263		
	b	0.46	0.71	1.40	1.73	2.49	0.232		
Rural/urban areas (cities with powiat status)	a	0.15	0.38	1.10	1.64	4.31	0.310		
	b	0.39	0.70	1.60	1.96	2.75	0.281		
Rural/urban areas (without cities with powiat status)	a	0.30	0.45	0.97	1.37	2.52	0.208		
	b	0.59	0.72	1.22	1.51	1.94	0.173		

1988 - population aged 15 and over; 2011 - population aged 13 and over.

T - tertiary, S-secondary, V - basic vocational, P - primary, NC - primary not completed; BC - structural distance.

Source: own calculations based on National Census 1988 and 2011.

Table 2. Internal educational differences in rural and urban areas in Poland 1988–2018 (*standard deviation (sd) linear trend*), FGLS Cochran-Orcutt estimations)

Estimate	Tertiary		Secondary		Vocational		Primary	
	U	R	U	R	U	R	U	R
Cons.	-97.9*** (4.61)	-130.1*** (14.52)	78.8*** (24.8)	-5.39 (8.28)	12.9** (6.16)	34.9*** (10.6)	19.9*** (3.71)	31.0*** (8.44)
α_1	0.049*** (0.002)	0.065*** (0.007)	-0.038*** (0.012)	0.003 (0.014)	-0.01* (0.003)	-0.017*** (0.005)	-0.01*** (0.002)	-0.015*** (0.004)
adj. R ²	0.960	0.883	0.875	0.539	0.452	0.793	0.560	0.815
F-model	<0.0001	<0.0001	0.005	0.830	0.073	0.005	0.004	0.002
Durb.- W.	1.945	1.66	1.98	1.60	1.541	1.322	1.948	1.598
rho	-0.011	0.147	-0.014	0.148	0.209	0.314	0.013	0.175
JB test	0.795	0.834	0.491	0.932	0.082	0.890	0.299	0.453
(χ^2)(p)								
<i>Validation of OLS model</i>								
White- linearity,	0.360	0.708	0.117	0.012	0.035	0.337	0.693	0.002
LM (p)								
White -	0.422	0.405	0.12	0.125	0.300	0.142	0.112	0.832
hom.(p)								
AR1 (p)	0.773	0.147	0.002	0.001	0.016	0.006	0.842	0.001
sd 1988	2.5	0.6	4.2	2.4	4.4	5.0	5.3	6.8
sd 2000	2.1	0.5	2.6	1.9	3.4	4.9	2.4	5.9
sd 2018	5.2	1.8	1.6	2.1	3.3	3.6	2.0	4.3

U-urban areas (total); R-rural areas;

*** p<0.001; ** p<0.05, * p<0.10 (t-Student test). Standard errors in parentheses. JB- Jarque-Berry test for a normal distribution of residuals; White-linearity test of the model (logarithm), White homoscedasticity test (for residuals).

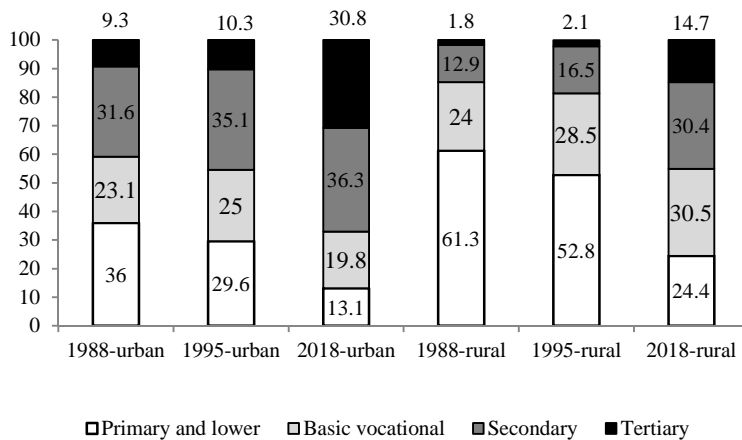
Table 3. Grouping of powiats according to population structure by educational attainment

Gr	Number of powiats				BC (average) within				% tertiary	
	U		R		U		R		U	R
	1988	2011	1988	2011	1988	2011	1988	2011	2011	2011
1	32	64	5	33	0.080	0.070	0.060	0.105	21.3	15.7
2	73	38	72	57	0.057	0.048	0.074	0.063	19.5	11.1
3	47	62	70	65	0.047	0.040	0.057	0.051	18.2	9.3
4	47	48	85	65	0.054	0.049	0.070	0.056	16.1	8.5
5	81	55	75	71	0.071	0.059	0.081	0.075	14.8	7.5
6	24	44	-	23	0.079	0.063	-	0.084	14.0	7.2

U-urban areas (without cities with powiat status); R-rural areas

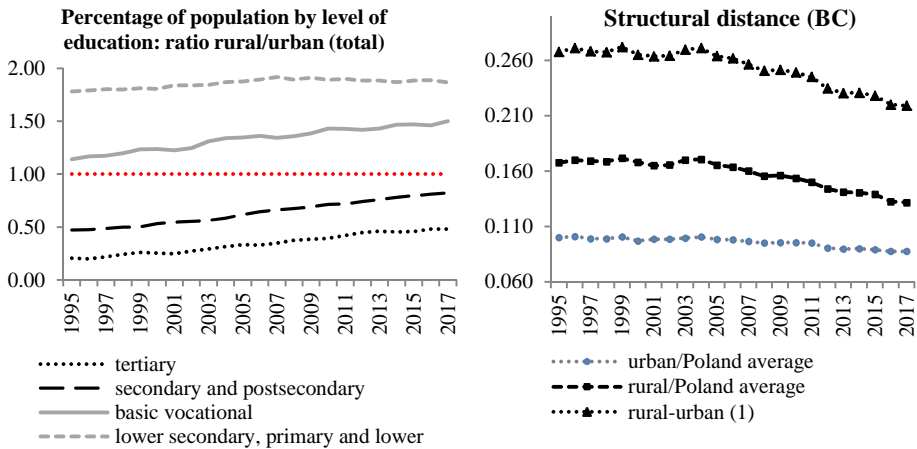
Source: own calculations based on the National Census 1988 and 2011.

Figure 1. Population structure by educational attainment in Polish rural and urban areas



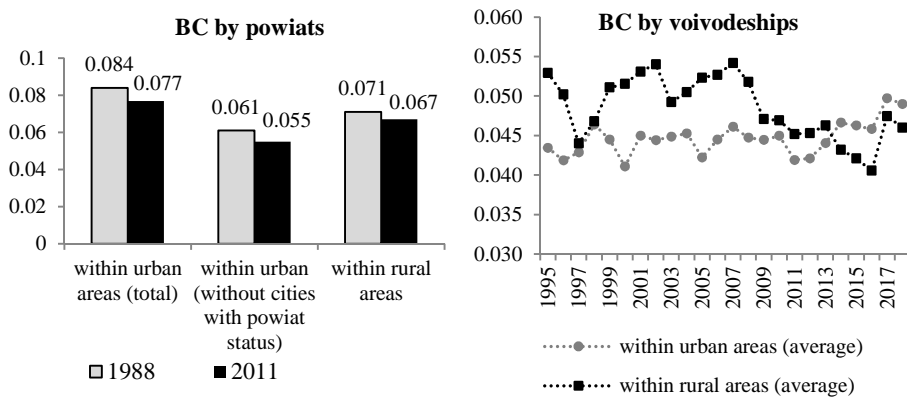
Source: 1988 - the National Census 1988; 1995 and 2018 CSO data on economic activity of population aged 15 or above, Labour Force Survey (LFS).

Figure 2. Rural–urban differences in Poland in terms of the educational structure of populations (by voivodships)



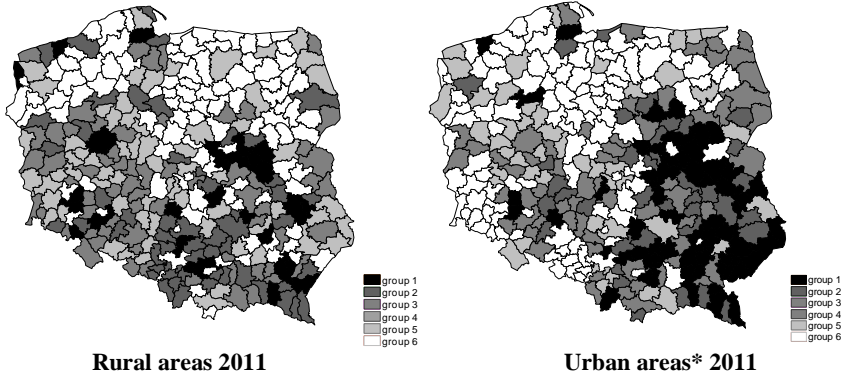
Source: CSO data on the economic activity of population aged 15 or above (LFS).

Figure 3. Internal educational differences in rural and urban areas in Poland



Source: 1988 - the National Census 1988; 1995 and 2018 CSO data on economic activity of population aged 15 or above, Labour Force Survey (LFS).

Figure 4. Grouping of powiats according to population structure by educational attainment



* without cities with powiat status.

Source: own calculations based on the National Census 1988 and 2011.