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Human Capital in the Visegrad Group NUTS 2 Regions. Convergence or Divergence?

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Abstract
An important objective of the European Union cohesion policy is to remove economic disparities between the various regions. One of the factors capable of stimulating or slowing the development process is human capital. The specialist literature provides many alternative human capital measurement concepts. In quantitative research, various composite measures are most commonly used. Such a measure was also developed in this study. The main aims of the study were: to construct a human capital measure for the Visegrad Group countries' NUTS 2 regions, to examine whether spatial relationships occur in the distribution of human capital in the studied area and to analyze regional convergence in terms of human capital levels in the years 2001–2015. The study applied the marginal vertical β-convergence concept, which enables the determination of individual contributions of particular regions to the general convergence process characterizing all the studied objects. Dynamic panel data models were used to study convergence, and Moran's global and local statistics were used for inference about spatial dependencies. As expected, no spatial autocorrelation was found. In contrast, the hypothesis of convergence was confirmed and regions that contribute to the weakening of its pace were identified.

Keywords: human capital, convergence, Visegrad Group, NUTS 2 regions, dynamic panel data models

JEL: C23, O15, R12

Introduction

The contemporary theory of human capital regards the human, along with his or her knowledge, qualifications, skills and health, as the most valuable element of resources of both a given organization and the entire economy. The specialist literature provides various interpretations of human capital, and thus various methods of its quantification are applied. According to the OECD definition human capital is "the knowledge, skills, competences and other attributes embodied in individuals that are relevant to economic activity."[1] In turn, Domański defined it as "the store of knowledge, skills, health and vitality encompassed by the society. The resource is given once and for all by genetic traits of a given population, but can be increased through investment called investment in the human: in people, in human capital, in human life" (1993, 19). In the context of human capital measure construction assumed for the purpose of the presented study, it is also worth quoting that human capital in its broad meaning includes: "all psychophysical traits of an individual, such as innate abilities, knowledge, education level, professional skills and experience, state of health, cultural level, socioeconomic activity, outlook on life etc., directly or indirectly influencing work output and inextricably linked with the human as the carrier of those values" (Florczak 2007, 113).

1. Human Capital Investment. An International Comparison. Centre for Educational Research and Innovation, OECD 1998, page 9, [@:] https://www.oecd-ilibrary.org/docserver/9789264162891-en.pdf?expires=1523608375&id=id&accname=guest&checksum=10DA0377DF303CB4B057349CCBD2C571.

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The above-cited definitions by Domański and Florczak list health among aspects of human capital, which arises from mutual connections between education and health. Higher health capital impacts the effectiveness of investment in education since healthy children do not miss classes and are better students; better health allows for the better use of the education outcome in the life cycle and increases likelihood of longer life during which the total benefits of education will be higher. In turn, higher capital related to education influences the effectiveness of investment in health as the effectiveness of health promotion programmes requires knowledge acquired, including in schooling, while good education is crucial for increasing medical staff competences.

Human capital can be considered from the point of view of individuals as well as organizations or regional or national economies. On an individual scale, the education level unequivocally positively determines participation in employment and reduces the threat of unemployment. At an organization level, employees' knowledge, skills and qualifications, forming its human capital, co-determine its market competitiveness. On a global scale, differences in human capital quality of particular regions or countries influence the effectiveness of benefiting from the implementation of new technologies and organizational solutions. As a result, higher human capital quality translates into quicker economic growth as well as better social development. As remarked by Kryńska and Arendt, "an appropriate human capital level is, hence, a source of competitive advantage both on the macro- and microeconomic scale."[2] The importance of human capital for the economy is so considerable and commonly appreciated that expenditures made on increasing human capital quality are treated as investment rather than consumption expenses, while modern economic policies promote human capital development spending (Rutkowska 2012, 342). As human capital is one of the most important and valuable resources in the contemporary economy, there seems to be a natural need to measure it in such a way so that it can be efficiently managed. All the above-mentioned human capital definitions include, however, many factors, such as knowledge, skills, competences, professional experience and motivation level, which are heterogeneous and, in its majority, unmeasurable. Thus, indicating a universal measure becomes problematic and the specialist literature provides many alternative human capital measurement concepts.

The main aims of the study were: to construct a human capital measure for the Visegrad Group countries' NUTS 2 regions in the years 2001–2015; to examine whether spatial relationships occur in the distribution of human capital; to analyze regional convergence in terms of human capital levels applying the marginal vertical β-convergence concept, which enables determination of individual contributions of particular regions to the general convergence process characterizing all the studied objects. Construction of the composite measure of human capital, which in addition to factors related to education, science, technology, and demography takes into account the health sphere as well as calculating its values for NUTS 2 regions of the V4 Group is the value added of the paper.

1. Human capital measurement methods — literature review

The starting point for empirical research concerning human capital is to determine its measurement method. According to Łukasiewicz (2005, 40–43), such methods can be classified into two groups: financial ones through which human capital at an individual and social level is expressed in a monetary form and qualitative ones consisting in applying several indices describing qualitative changes in that capital. At an enterprise level, cost-based methods are usually employed, while methods consisting in ratio analysis (where the ratio is an enterprise's receipt per one employee) are considered too simplified. Other methods include financial and economic ones based on the assessment of the current value of revenues which will be generated in the future or the assessment of a given employee's capital on the basis of his or her future remuneration. Those and other methods used in enterprises are more exhaustively discussed by Wyrzykowska (2008, 164–168) or Czyszkiewicz and Molewicz (2006, 20–22).

2. Rynek Pracy — Wyzwania strategiczne na potrzeby aktualizacji Strategii Rozwoju Kraju 2007–2015. Expertize by Elżbieta Kryńska and Łukasz Arendt, Instytut Pracy i Spraw Socjalnych, IPiSS, page 12.

The measurement of human capital at a regional level is carried out using alternative methods. A thorough research study (Auksztol et al. 2016) employed a qualitative method consisting in the use of three groups of indices: related to quality (including variables connected with education, health and labor market), related to costs (measures of costs borne by state and local self-government units in association with maintaining human capital in its broad sense) and related to income (value of remunerations received in connection with one's education type). Miciuła and Miciuła (2015, 273) also list methods based on indices, benchmarks (based on competence tests) and composite measures whose essence is to develop an index characterizing human capital comprehensively enough (e.g., the Lisbon Council Human Capital Index).[3] Multidimensional characteristics of human capital at a regional level require considering partial indices describing such areas of socioeconomic life as: education, demography, science, technology and innovations, labor market, health and culture.[4] For that reason, composite measures[5] are most commonly used, constructed on the basis of several diagnostic variables describing different human capital aspects. Such a measure was also applied in this study. The selection of diagnostic variables and the construction method are described in the following paragraph.

Attempts to analyze human capital across Visegrad Group are made relatively rarely. The representative examples of such research are the papers by Golejewska (2013), Akócsi (2010), or Kuc (2017). Golejewska analyses the influence of human capital on growth in the NUTS 2 regions in the years 2002–2009. Three factors concerning education: percentage of students in tertiary education, percentage of labor force with tertiary education attainment and lifelong learning indicator are considered human capital indicators. No unique measure of human capital is constructed. Instead, the assessment of the relation between human capital and regional growth is made on the basis of correlation between indicators of these phenomena. Akócsi examines the role of human resources in territorial competitiveness of the NUTS 2 regions in the year 2006. By means of a principal components method a Human Capital Development Index is created, which comprises the aspects of human resources connected with education, R&D, science and technology. Then, cluster analysis method is applied to define groups of similar regions with regard to this Index and the Index of Competitiveness. Kuc analyzes social convergence at national level for the EU countries in the period 2004–2014 and verifies the hypothesis that convergence on the country level is at the expense of internal divergence. A spatial taxonomy measure of development is calculated at the NUTS 2 level of the Visegrad countries. Among the variables used to develop the measure of development there are crude death rates for neoplasms and tuberculosis. However, they serve to assess level of social development, not human capital.

In contrast to the above approaches, the presented study attempts to measure human capital in such a way as to take into account factors related to health.

2 Human capital measure construction and preliminary data analysis

In the presented study, human capital was measured using a composite measure constructed on the basis of data for 35 NUTS 2 regions of the Visegrad Group countries in the years 2001–2015 obtained from the Eurostat database.[6] The selection of diagnostic variables was determined by striving to comprehensively characterize human capital in the regions, with availability of statistical data constituting a certain limitation. Eventually, a set of indices was assumed directly describing human capital or affecting its development in the four below-listed areas:

3. See: The European Human Capital Index — The Challenge of Central and Eastern Europe. By Peer Ederer, Stephan Willms, and Phillipp Schuller, January 2007, [@:] https://www.researchgate.net/publication/235410009_The_European_Human_Capital_Index_-_The_Challenge_of_Central_and_Eastern_Europe.

4. Limited access to data, however, does usually prevent empirical analyses from taking into account all aspects of these categories.

5. A critical review of alternative constructions of the composite indicators can be found for example in (Sarama 2012).

6. http://ec.europa.eu/eurostat/data/database, data accessed on May 2017.

- science, technology, innovation:
  - hrstact — Human Resources in Science and Technology (persons with tertiary education (ISCED) in fields covered by the category of science and technology or employed in a profession in which such education is required) in relation to 100 persons economically active (aged 15–64)
- education:
  - edu02 — persons with less than primary, primary and lower secondary education (levels 0–2) as the percentage of population aged 25–64
  - noedu — young people neither in employment nor in education and training as the percentage of population aged 15–24
  - trng — participation rate in education and training (last 4 weeks) as the percentage of population aged 25–64
  - stpop — number of students at first and second stage of tertiary education (levels 5 and 6) in relation to 100 persons aged 20–34
- demography:
  - ddr — demographic dependency ratio — number of persons under 15 and over 64 in relation to 100 persons of working age (i.e., aged between 15 and 64)
- health:
  - life — life expectancy at birth, years (whole population)
  - doct10 — health personnel, medical doctors per ten thousand inhabitants

The composite measure of human capital in region i (hc_i) was calculated as an unweighted mean of the unitarized values of the eight above mentioned individual diagnostic characteristics. This measure characterizes human capital in its broad sense, considering also the state of health of examined regions' societies, which is consistent with definitions by Domański and Florczak quoted in the Introduction. The hc values in the first and last year of the analyzed period are shown in figure 1.

In 2001, values of the hc measure lie in the interval from 0,151 in Hungarian region Észak-Magyarország to 0,955 in the Praha region in Czech Republic.[7] In 2015 the lowest value is 0,134 in Észak-Magyarország and the highest, equal 0,843, in Praha. Praha, together with Slovak region Bratislavský kraj (Bratislava Region) are the leaders in terms of the level of human capital throughout the analyzed period. The NUTS 2 Praha region is identical with the capital city of Prague, which explains the unusually high level of human capital in this region. In 2014 its GDP per capita

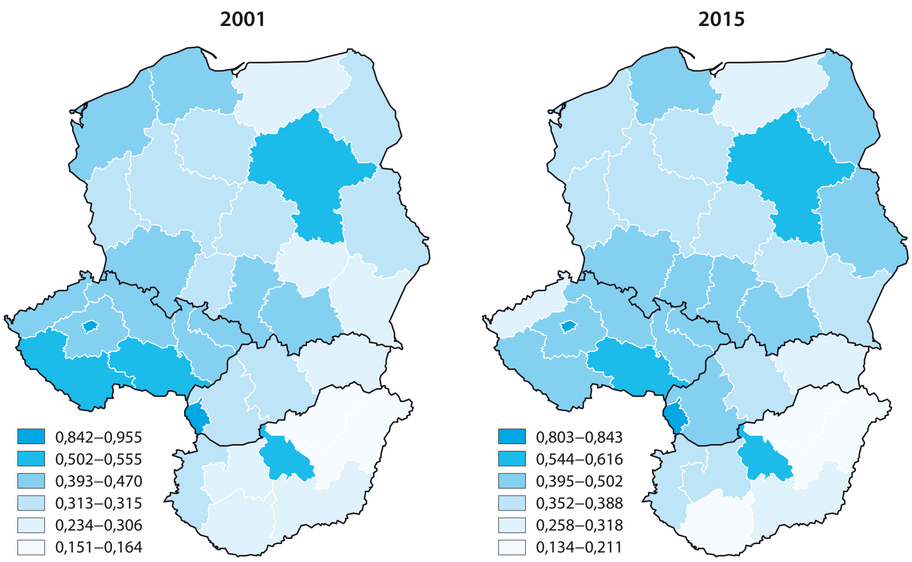

Fig. 1. The level of human capital in NUTS 2 regions of the V4 group in the years 2001 and 2015

Note: The presented maps are so called "natural breaks maps", which means that each grouping is arranged in such a way that there is less variation in each class.

7. [In the journal European practice of number notation is followed — for example, 36 333,33 (European style) = 36 333.33 (Canadian style) = 36,333.33 (US and British style). — Ed.]

in PPS was 1,75 of the EU average. A very similar situation was noted in the Bratislava Region, which is the smallest in Slovakia and highly urbanized. In 2014 its GDP per capita in PPS was 1,86 of the EU average. Economies of each of the metropolitan regions accounted for about a quarter of the national GDP.[8] The NUTS 2 regions: Mazowieckie and Közép-Magyarország, covering the Polish and Hungarian capitals have larger areas and are more internally differentiated. These regions also have the highest values of human capital in their countries, but these values are much lower than in the regions of Prague and Bratislava (in the year 2015 the values of hc were equal to 0,544 for Mazowieckie 0,575 for Közép-Magyarország, 0,843 for Praha and 0,803 for Bratislavsky Kraj).

Figure 2 shows the histogram of the hc measure and basic statistics for the extreme years of the research period. Maximum and minimum values of the measure in 2015 were lower as compared to those in 2001. The simultaneous slight rise in the median and arithmetic mean and fall in variation (measured with the standard deviation) may be interpreted as the equalization of human capital levels among the studied regions. The advantage of the two dominant regions decreased. In 2001 there was an empty interval separating those from the others, while in 2015 that interval contained the Czech Jihovýchod region, which in figure 1 belongs to the same group as the Mazowieckie Voivodship and Közép-Magyarország. The Jihovýchod region encompasses Brno, the second biggest city of the Czech Republic, an important academic center (6 higher education institutions, including the Masaryk University and the Technical University), as well as the center of the judiciary: equivalents of the Polish Constitutional Court, the Supreme Court and the Ombudsman. The number of regions in the middle interval in figure 2 also went up, with the diminished number of regions in the lower interval. Thus, the above-mentioned equalization can be understood as the averaging of values rather than their rise.

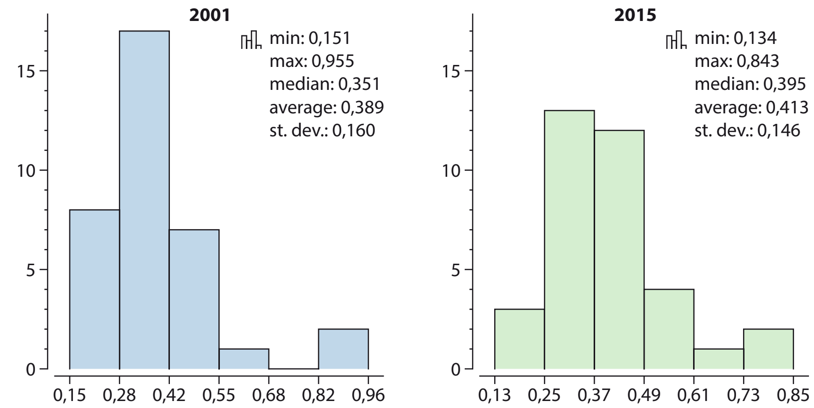

Fig. 2. Human capital — histograms and basic statistics — in the years 2001 and 2015

While constructing the human capital measure, it was assumed that each diagnostic variable exerted an identical influence on the value of the composite measure. Figure 3 shows values of three variables which most considerably affected the spatial variation of the human capital measure and, in particular, the exceptionally high values in the Praha and Bratislava regions. Human resources in science and technology (hrstact) were a variable whose levels in each of the capital city regions were exceptionally high, with the levels being comparable. The Praha and Bratislava regions stood out in terms of the numbers of students and medical staff (stpop, doct10).

The last stage of the statistical analysis was to examine whether there were spatial relationships in the human capital levels in the Visegrad Group regions. In all the analyzed years, Moran's I statistics' values ranged from 0,07 to 0,09, with pseudo p-values varying from 0,126 to 0,141. That means the absence of global spatial autocorrelation. Even if there is no global relationship, local level clusters may occur. Their presence can be determined based on local indicators of spatial association (LISA), proposed by Anselin (1995) and computed for each region. Such clusters

8. See: 2014 GDP per capita in 276 EU regions. Twenty-one regions below half of the EU average... and five regions over double the average. Eurostat Newsrelease, 39/2016 – 26 February 2016, [@:] http://ec.europa.eu/eurostat/documents/2995521/7192292/1–26022016-AP-EN.pdf/602b34e8-abba-439e-b555-4c3cb1dbbe6e.

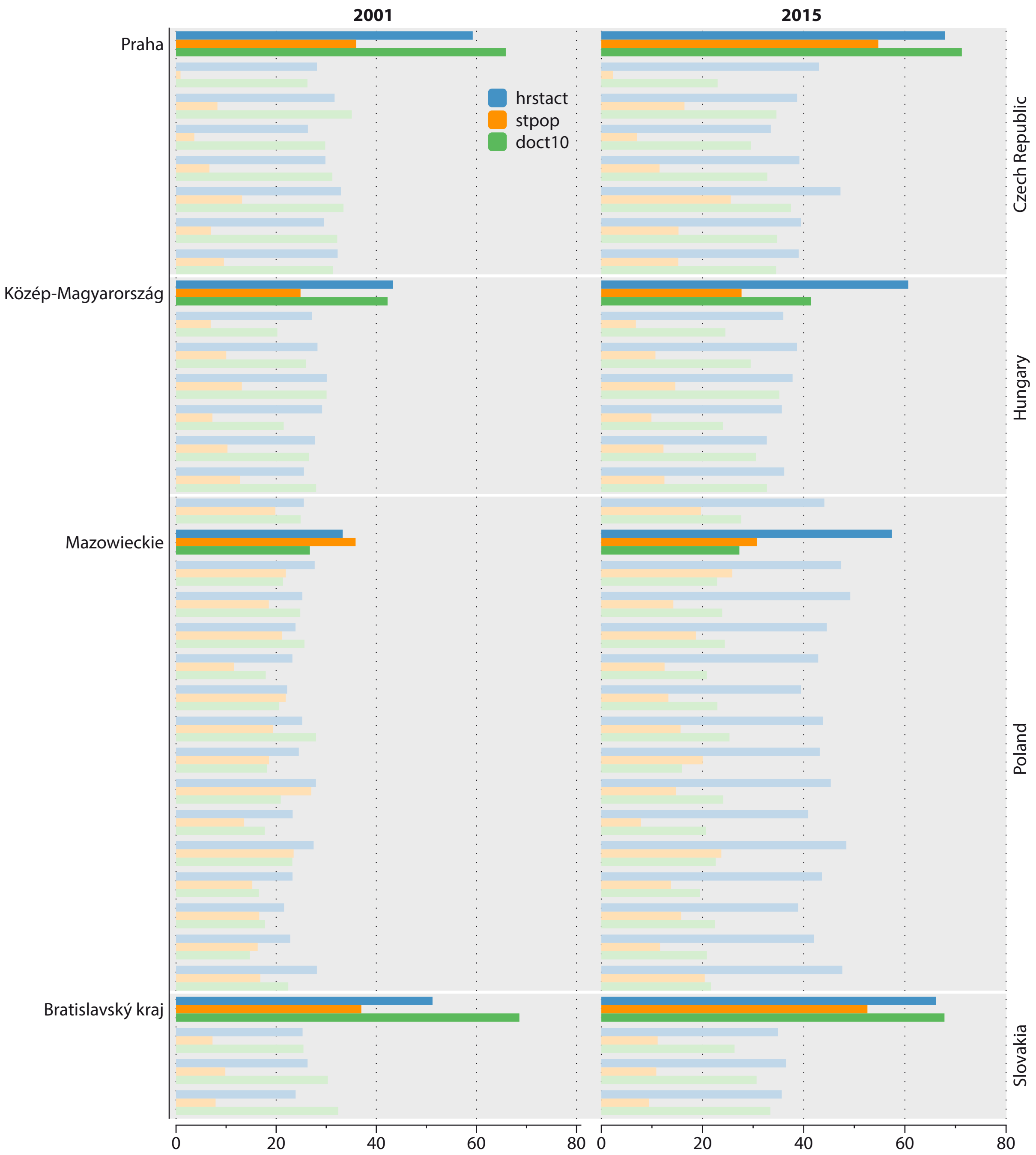

Fig. 3. Values of selected diagnostic variables in the years 2001 and 2015

Note: Abbreviations: hrstact — human resources in science and technology in relation to 100 persons economically active; stpop — number of students per 100 people aged 20–34; doct10 — number of doctors per 10 thousand people.

practically did not appear in the analyzed area as can be seen in Figure 4. An exception was a small cluster of low values in Hungary (the HU32 — Észak-Alföld region and, only in 2001, the HU23 — Dél-Dunántúl region) and Slovakia (the SK04 — Východné Slovensko region), and regions: Praha (the high-high cluster center) and Közép-Magyarország (the high-low cluster center), which can be interpreted as a dual influence of capital city regions. In the Czech Republic, where the human capital level is generally high (fig. 1), Praha not only attracted human capital, but also positively affected its level in the neighboring region. On the other hand, in Hungary, which is a country characterized by a low human capital level, the Budapest region became a strong center, but did not positively impact the surrounding regions.

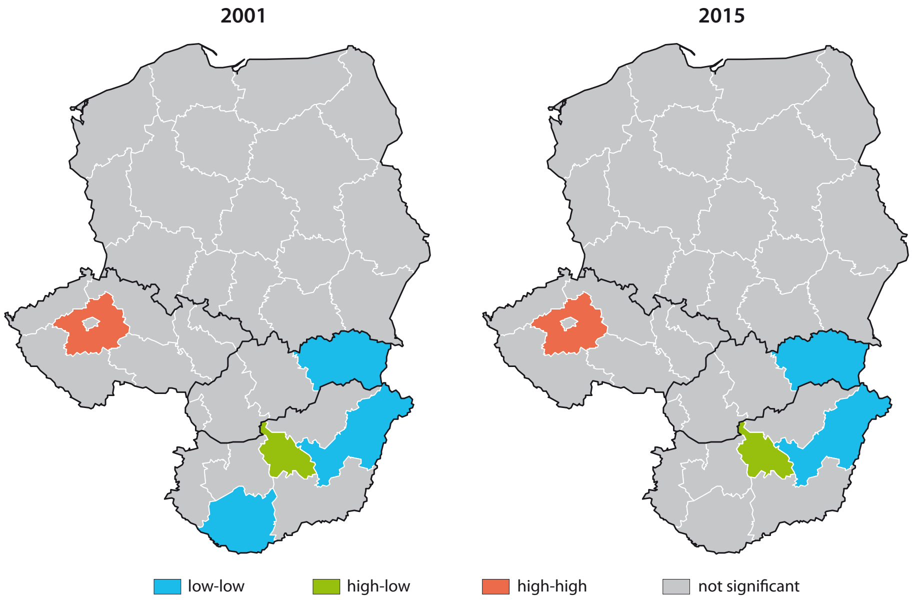

Fig. 4. Local Moran's statistics LISA in the years 2001 and 2015

3 β-convergence concept and vertical convergence concept

Absolute β-convergence means that the values of a given variable y are equalized in the studied area. In order to verify the hypothesis about the occurrence of β-convergence, a regression model is estimated where the dependent variable is the average rate of change of the variable y, and the explanatory variable is its initial level. The model takes the following form:

$$\frac{1}{T}\ln\frac{y_{i,t+T}}{y_{it}} = \alpha_0 + \gamma\ln y_{it} + u_{it}, \tag{1}$$

where $y_{i,t+T}$ and y_{it} are the values of the variable y in region i in the last and in the initial periods respectively, T is number of periods considered in the analysis (number of years for which the growth rate is calculated. The dependent variable in equation (1) is the average growth rate of y in the studied period. A negative value of the estimate of the parameter γ means that absolute β-convergence occurs (because the value indicates the direction of the relationship between the initial variable level and its growth rate). In order to write (1) in a form convenient for estimation, it should be converted to

$$\ln y_{i,t+T} = T\alpha_0 + (T\gamma + 1)\ln y_{it} = \theta_0 + (\theta_1 + 1)\ln y_{it} + u_{it}. \tag{2}$$

The value of the β coefficient, indicating the pace of convergence—i.e., what percentage of distance in the direction of long-term equilibrium is covered by the economy during one period, is estimated as

$$\hat{\beta} = -\frac{1}{T}\ln(1 + T\hat{\gamma}), \tag{3}$$

as pursuant to the convergence theory[9] parameter γ in model (1) equals $-(1 - e^{-\beta T})/T$.

The weakness of such a procedure is that it does not allow identification of a situation where there is a certain subgroup characterized by convergence of the variable y to a certain common level in the studied group of regions, while the phenomenon does not take place in the other regions. Then, based on model (1), erroneous conclusions may be drawn on the occurrence of convergence in the whole analyzed group (cf. Nowak 2007, 77–78). Furthermore, even if the conclusion of general convergence (or divergence) is correct, models of the form (1) do not enable evaluation of the extent to which particular regions affect the process. Such assessment can be performed using the marginal vertical β-convergence concept (cf. Batóg 2010, 2013).

9. Justification is presented in (Barro and Salaimartin 1992).

The estimate $\hat{\beta}_i$ of the marginal vertical β-convergence value is calculated as a difference between the value $\hat{\beta}$ obtained from (3) and the $\hat{\beta}_i^{N-1}$ value calculated in the same way but after removing observations concerning the region i from the sample:

$$\hat{\beta}_i = \hat{\beta} - \hat{\beta}_i^{N-1}. \tag{4}$$

A positive $\hat{\beta}_i$ value means a positive impact of region i on the process of convergence, whereas a negative value indicates that the region contributes to slowing the convergence rate.

Based on the estimate of the β-convergence parameter, the so-called half-life interpreted as time needed for existing differences to be reduced by half can be worked out:

$$T_{1/2} = \frac{\ln 2}{\hat{\beta}}. \tag{5}$$

Similarly, replacing $\hat{\beta}$ with $\hat{\beta}_i$ in the above formula, a change in the length of a half of the $T_{1/2,i}$ convergence period is calculated. Negative (positive) values indicate by how many years the period is shortened (prolonged) due to considering country i in the group of studied objects.

4 Empirical Analysis of Human Capital Convergence Process

Based on the correlation coefficient between the annual human capital growth rate and its lagged value, it can be preliminarily assessed whether there is convergence among the examined regions. The negative sign of the coefficient would indicate a convergent trend, hence decreasing differences in human capital levels among the regions. Table 1 contains Pearson's correlation coefficients for all the regions and for a reduced set — after excluding a selected region. The excluded regions were those, characterized by the highest human capital values. Especially in Praha and Bratislavský Kraj, human capital levels considerably exceeded those in the other regions, which can be clearly seen in figures 1 and 2. Therefore, the removal of those regions from the whole set could be expected to influence the assessment of the occurrence of convergence and its pace. Moreover, two more regions were eliminated: the Mazowieckie Voivodship and Közép-Magyarország, hence the regions where the capital cities of Poland and Hungary are located. They were also characterized by very high human capital levels: figure 1 shows that they belonged to the group of regions with the second highest level of the variable.

All the correlation coefficients in table 1 are negative and statistically significant, which was checked using the significance test of correlation coefficient. It indicates the equalization of human capital levels in the studied regions. Differences between the values of r coefficients for all the regions and the r_i values (after removing the region indicated in the first column) are negative, except for the value for the Mazowieckie Voivodship. That may indicate that Bratislavský Kraj and Praha were regions particularly slowing down the convergence pace. Those were regions with such high variable values that the others found it difficult to get close to them. From the point of view

Tab. 1. Correlation coefficients between the growth rate and the lagged level of human capital in the NUTS 2 regions of the Visegrad Group

		r	$r-r_i$
All regions		−0,1128	
The excluded region	Praha	−0,1130	−0,0002
	Bratislavský kraj	−0,1164	−0,0036
	Praha and Bratislavský kraj	−0,1242	−0,0114
	Közép-Magyarország	−0,1137	−0,0009
	Mazowieckie	−0,1121	−0,0007
	3 Hungarian regions	−0,1307	−0,0179

Note: The last column presents the differences between the correlation coefficient r for a full set of observations (all regions) and coefficients r_i calculated after excluding the i-th region (or regions) indicated in the first column.

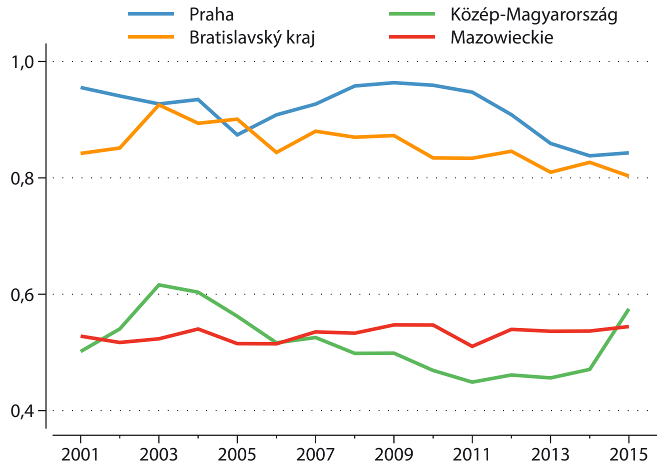

Fig. 5. Human capital in the capital regions of the V4 countries in 2001–2015

of those regions' development, however, convergence may not be desirable because, as shown in figure 5, the Bratislavský Kraj region experienced a falling human capital level, whereas the 2015 variable level in the Praha region was the lowest in the analyzed period, although it is difficult to indicate a clear trend.

In accordance with the β-convergence concept and the vertical convergence concept, alternative human capital models in the Visegrad Group countries' NUTS 2 regions in the years 2001–2015 were estimated. Both cross-sectional data models and panel data models were used. Tables 2 and 3 contain selected models' estimation results. The dependent variable in convergence models was assumed to be the logarithm of the analyzed value. Since the hc human capital measure took fractional values, in order to avoid negative values of its logarithms, it was converted: 1 was added to all values. Thus, the dependent value in the presented models was $\ln(hc + 1)$, which did not in any way influence conclusions concerning convergence processes.

It seems that more acceptable results were received based on panel data models. The convergence pace obtained on the basis of cross-sectional models was too rapid; in addition, it seems difficult to explain that it would slow after excluding regions with the highest human capital values

Tab. 2. Estimation results of panel data models

The excluded region	$\hat{\gamma}$	$\hat{\beta}$	$\hat{\beta} - \hat{\beta}_i^{N-1}$	$T_{1/2}$	$T_{1/2} - T_{1/2,i}$
None (the whole sample)	−0,0232	0,0280		24,7433	
Praha	−0,0252	0,0310	0,0030	22,3457	−2,40
Bratislavský Kraj	−0,0237	0,0288	0,0008	24,0493	−0,69
Praha and Bratislavský Kraj	−0,0244	0,0298	0,0018	23,2244	−1,52
3 Hungarian regions	−0,0243	0,0297	0,0017	23,3401	−1,40

Note: The 3 Hungarian regions to which the last row refers are those which in 2015 formed the poorest group in terms of human capital (shown in figure 1). The estimate of parameter γ in all models is statistically significant at the level 0,05. Standard tests used to evaluate dynamic panel data models have shown that the estimators have the desired properties.

Tab. 3. Estimation results of cross-sectional models based on three-years means

The excluded region	$\hat{\gamma}$	$\hat{\beta}$	$\hat{\beta} - \hat{\beta}_i^{N-1}$	$T_{1/2}$	$T_{1/2} - T_{1/2,i}$
None (the whole sample)	−0,0411	0,0449		15,4329	
Praha	−0,0317	0,0339	−0,0109	20,4330	5,00
Bratislavský Kraj	−0,0370	0,0400	−0,0049	17,3124	1,88
Praha and Bratislavský Kraj	−0,0205	0,0214	−0,0235	32,4174	16,98
3 Hungarian regions	−0,0460	0,0509	0,0060	13,6259	−1,81

(Praha and Bratislavský Kraj) and it would increase after removing the weakest regions situated in Hungary. Therefore, further analysis will be carried out based on results received from panel data models, shown in table 2.

Convergence was found in all the examined cross-sections. Its pace for all the regions was 2,8%. If that pace is maintained, the half-life period — i.e., the time necessary for existing differences to be reduced by half, is under 25 years. The time is almost 2 and a half years shorter if the Praha region is excluded from the study and it is the biggest change. Removing other regions also affected an increase in the convergence pace but to a considerably smaller extent. Among the selected regions, the Bratislava region slowed down the convergence pace to the smallest extent (a slowdown of 0,3 percentage point). The effect of excluding groups of "strong" regions (Praha and Bratislavský Kraj) and "weak" regions (Hungarian ones) was comparable: slowing down convergence by about 0,2 percentage point and shortening the half-life period by about one and a half years. The results may be interpreted as confirming the initial hypothesis on the 2001–2015 averaging of human capital levels, which was formulated on the basis of Figure 2 analysis. The clearly standing out Praha region was characterized by hc measure values above 0,8 over the whole sample period, which can be seen in Figures 2 and 5 (for comparison: the values did not exceed 0,3 in the weakest Hungarian regions). It should be borne in mind that Praha is a very specific region, covering the city of Praha, and its potential was outlined in subsection 3. Thus, by definition, it ought to be considered separately. The same reservation concerns the Bratislava region, which, however, exerted a relatively small influence on the convergence pace. That could come as a surprise, taking into account the Bratislava region's hc variable values being comparable to those received for the Praha region. Figure 5, however, shows a steady fall in its value, which means that the human capital level in the region was getting close to the levels in other regions and may explain the received result. To sum up, it can be assumed that the human capital levels in the V4 groups' NUTS 2 regions was generally equalizing to approach a certain common mean. There were stand out regions: small capital city regions of the Czech Republic and Slovakia with very high human capital values characteristic of those countries' capital cities, as well as agricultural regions situated in Hungary where human capital levels were low and the catching up process was slower than in the other regions.

Summary

The V4 group countries' NUTS 2 regions' human capital levels were analyzed based on composite measure values. The measure considered, along with education and professional qualifications measures, also demographic and health factors. No spatial relationships were found, but the mean 2001–2015 human capital level was the highest in the Czech regions and the lowest in the Hungarian regions. In addition, there were two atypical regions in the studied group: Praha and Bratislavský Kraj, practically covering the territories of both the capital cities, characterized by exceptionally high human capital levels. In 2015, the advantage of those regions over the other ones was smaller as compared to 2001. The equalization of human capital levels among all the studied regions was also found, with the Praha region and the weakest regions located in Hungary exerting the most considerable negative influence on the convergence pace.

The presented conclusions will be deepened in further research. An attempt will be made at excluding the other two capital cities: Warsaw and Budapest from their surrounding regions in order to comparably assess the situation and power of influence of capital cities on their neighboring areas. A conditional convergence hypothesis will also be verified by introducing control variables, in particular those describing the regions' sectoral structure — e.g., participation of particular sectors in GDP, into the model.

Provided that statistical data are available, interesting results could be offered by an analysis carried out for smaller territorial units, preferably at the NUTS 4 level. Then, it would be possible to identify spatial relationships, especially the effects of transferring or draining human capital.

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