Original scientific paper

BORDER AREAS AND EDUCATIONAL ATTAINMENT – LONG-TERM ANALYSIS OF HUNGARY FOR THE PERIOD BETWEEN 1960 AND 2022

János PÉNZES[a], István PAPP[b], Norbert APÁTI[c], János Péter KISS[d]

[a] Department of Social Geography and Regional Development Planning, University of Debrecen, 4032 Debrecen, Egyetem tér 1., penzes.janos@science.unideb.hu

[b] Department of Social Geography and Regional Development Planning, University of Debrecen, 4032 Debrecen, Egyetem tér 1., istvan2992@gmail.com

[c] Department of Social Geography and Regional Development Planning, University of Debrecen, 4032 Debrecen, Egyetem tér 1., norbertszatmarcseke@gmail.com

[d] ELTE Eötvös Loránd University, Budapest, Hungary, Department of Regional Science, 1117 Budapest, Pázmány Péter sétány 1/C., bacsnyir@gmail.com

Abstract

The educational indicators are an important basis for spatial researches focusing on regional development. Border areas provide special conditions for educational attainment, but the levels of aggregated results are worse in general. Different distance categories and given sections of Hungarian border areas are separated in order to detect the altering development paths of the complex educational attainment index (CEAI). This complex indicator combines the number of people with high school graduation and with diploma in the ratio of the 20 years or older population (with a weighting procedure included).

Border areas are generally characterized by worse educational attainment values than the national average, but during the last more than six decades, significant convergence of data could be observed, in which the dominance of large towns is decisive. For this reason, suburbanization significantly impacts the spatial pattern of educational attainment in the border zones. Most parts of the settlements are below the national average, however general conditions are better in the case of the Austrian border section. However, the previously assumed continuous development of this border section has not been confirmed by our analysis.

Keywords: border areas, development paths, educational attainment, regional analysis, spatial structure

INTRODUCTION

Education is one of the most important factors of territorial development, and its investigation has priority among the relevant studies. Border areas have a distinctive character for different reasons, because developed sections of these territories have a better position by concentrating the skilled population exploiting economic potentials on both sides of the border. However, underdeveloped parts of border areas are facing a lower level of educational attainment of the population as a result of the outmigration of working age persons with competitive and higher

educational attainment. This general correlation may predict some changes in the educational attainment of border areas in relation to their development trends.

The objective of the current investigation is to explore the long-term changes in the situation of Hungarian border areas focusing on educational attainment over the last more than half a century. In order to investigate this phenomenon, the border areas of Hungary are delimited with some specific consideration and a complex educational indicator is calculated with the processing of census data.

The objective of the current investigation is to detect trends in the changes of the educational attainment of Hungarian settlements along the state border. Tendencies are compared to the national average which are suitable for exploring the relative position of territories and their changes in different periods during the socialist era, the transition period and after the millennium. As part of the current study, different sections of the border area are delineated and compared in order to assess the specific features of their development.

THEORETICAL BACKGROUND

Educational attainment and territorial development

The education of the population is an issue of decisive importance, as it is fundamentally related to a number of demographic and health factors, and it carries significant inequalities between social territorial groups, which are prominent in some regions (Graetz et al., 2018). The level of education and the educational attainment of the population is clearly related to regional differences in economic growth, competitiveness, and productivity of individual countries and regions, although the causal relationships are partly disputed (Krueger & Lindahl, 2001; Sahlberg, 2006; Czaller, 2016; Kussaiynov et al., 2020). Some authors confirm that human capital is regarded as one of the most important drivers of regional development (Bodnár et al., 2022).

The investigation of educational attainment demonstratively and characteristically highlights regional inequalities and social disparities within given territories because education is an essential part of social mobility and stratification (Rechnitzer & Smahó, 2005).

Different variables of educational attainment are often included in composite indices expressing human or spatial development. The well-known Human Development Index and its adaptations (inter alia Husz, 2001; Farkas, 2012; Lipták, 2017; Szilágyi, 2018), the

territorial deprivation index (Kovács & Koós, 2018), the index of objective well-being (Nagy & Koós, 2014) or the official delimitations of underdeveloped areas (Pénzes, 2015) also contain an educational component.

Long-term regional inequalities of educational attainment are decreasing in Hungary (Sánta et al., 2015; Szakálné Kanó et al., 2017; Németh & Dövényi, 2018) as a consequence of the increasing number of educated persons (primarily among the young generations) and the decreasing ratio of people with low level of education (mostly among the elderly age groups) (Kiss et al., 2008; Harcsa, 2015). Despite the decreasing trends of inequalities, a significant concentration of highly qualified population is detected in the case of Budapest's agglomeration and the regional centers with universities (Németh & Dövényi, 2018). At the same time, increasing spatial segregation of persons with low level of education is also confirmed by the investigation of peripheral areas in Hungary (Pénzes et al., 2018; Pénzes & Demeter, 2021).

Development situation of the border areas

State borders significantly influence spatial processes in various forms and borders act as constraints rather than incentives upon the operation of spatial systems (Reichman, 1993). Border regions, due to their reduced level of economic interactions are typically described as underdeveloped areas and this can often be affirmed empirically (Petrakos & Topaloglou, 2008; Pásztor, 2013), especially in Central and Eastern Europe (Erkut & Özgen, 2003).

This disadvantageous development situation might be a consequence of the barrier function of borders (Geenhuizen et al., 1996; Wróblewski, 2020). The impact of barriers cause distortions in different networks with economic obstacles and financial losses. The number and intensity of activities typically decrease and become discontinuous (Houtum, 2000; Czimre, 2006; Pásztor, 2014). Investments in the case of border areas might be more expensive under insecure political conditions (Hansen, 1977; Ratti, 1993).

In the case of Central Europe, the newly emerging state borders after WWI caused unfavourable conditions for newly formed border areas due to protectionist policies, import substituting industrial developments, and a lack of connections between new states (Süli-Zakar, 1992). Prior to changes of regimes in Central Europe and the European integration process, barriers and filter functions dominated state borders and created significant obstacles to cross-border co-operation (Ratti, 1993). However, some backward areas along the present state border of Hungary existed even before their demarcation (dominantly along the Eastern-Slovakian, the Northern Romanian, and the Slovenian border) (Szilágyi, 2019; Pénzes, 2020).

Border areas are not evidently characterised by backwardness or obstacles for regional development. Integration process might strengthen the contact function of borders instead of the barrier or filter functions and this change might induce cross-border mobility or accelerate economic growth in these regions (Ratti, 1993). An open border area might become attractive for investments gaining advantage from the different characteristics of the other side of the state border (differences in wages, taxes, restrictions, consumption customs, etc.).

Border areas – due to their special role in territorial processes – are important targets for regional development policies, including the efforts of the European Community to create a unified and integrated economic space (the Interreg program launched in 1989 is the most important tool in this respect). Considerable development could be detected in the case of cross-border co-operations in Europe, however a significantly lower intensity of these is observed in the case of countries accessed to the EU after the millennium (Durand & Decoville, 2019). In order to accelerate cross-border cooperations, macro-level conditions and institutional background should be optimal and the physical permeability of border must also be ensured. The number of border crossing points has more than doubled since 1990 in the case of Hungary (especially along the Austrian border) and several euroregions and EGTCs (European Grouping for Territorial Cooperation) were organized (Hardi, 2010; Benczi & Ocskay 2021).

Positive impulses of borders – even during the period of barrier and filter dominance – accumulate in the close neighbourhood of border crossing points (Tagai et al., 2008; Pénzes & Papp, 2018), but the anticipated stimulating effect of newly opened border crossing points on local economic development has proved limited along backward border areas (Kiss, 2000). This fact confirms the necessity of a certain level of development to induce economic interaction, bvecause a considerable gap between the development levels of the neighbouring territories might hamper cross-border co-operation and cause imbalanced territorial development (Van der Velde & Wever, 2005; Pásztor, 2014; Morachevskaya et al., 2022).

Differing development trajectories of border zones could be observed after the political changes in Central Europe. In general, emerging Western border areas and declining or stagnating Eastern border zones presented opposing characterics (Rechnitzer, 1993; Gorzelak, 1996; Nemes Nagy, 1996; Szabó & Farkas, 2014; Rechnitzer, 2016). However, per capita values of taxable income showed decreasing values in the last decade mostly in the case of the Hungarian border area along Austria (Egri, 2023). This fact is the consequence of cross-border commuting to Austria and the missing taxation data from the Hungarian income statistics (Pénzes & Papp, 2018). One of the objectives of current research is to highlight the

educational indicators in the different border sections, because – according to our hypothesis – educational attainment reflects the continuous development of the Hungarian-Austrian border area.

Lower level of educational indicators and intensive networks of student commuting were observed in the case of backward border areas and favorable values were detected in the developed border zones (Pénzes et al., 2018; Apáti & Pénzes, 2023), but long-term analysis has not yet investigated this issue from a geographical point of view.

The educational attainment of the population living in border areas is not only impacted by the institutional background, but cross-border educational attraction has become more and more characteristic, especially in the case of our larger cities in recent decades (Teperics, 2013; Váradi, 2020), and the phenomenon of students' commuting to the other side of the national border in the direction of Austria can also be observed (Horváth, 2020). However, above all, it is the domestic and international migration of the skilled or just the low-qualified population which impacts educational indicators in the border areas.

DATA AND METHODS

Measuring educational attainment

Education attainment can be measured by various indicators depending on the levels of education and the educational system of a given country. Most frequently, census data provide information about the educational attainment of the population. Average finished school years of the population (typically compared to the number of 7 years and older population) is an indicator covering and replacing different educational indices – e.g. the proportion of those who have completed at least 8 classes, those who have at least high school graduation and those who have a diploma. These settlement-level datasets have been published as part of the census volumes since 1960 according to the Hungarian educational system.

The mentioned convergence of educational attainment values could be observed in the case of the lower levels of education (Kiss et al., 2008), for this reason we concentrated on the people with at most high school graduation and on those with a diploma as part of the current investigation (the 'average finished school years' indicator is not available for 1960 and 2022). Our dataset included the listed educational indicators and the number of people at the age of 20 or more for each settlement between 1960 and 2022. Some of the settlement's data are missing due to the administrative changes.

In order to take into account these indicators together, a special complex indicator is introduced named "complex educational attainment index". The two educational indicators are included in a weighted format because the diploma – due to its greater competitiveness on the labor market – deserved larger weight within the calculation. The weight – is not a constant value but changes in every census year – depending on the ratio of total number of persons with diploma and the persons with at most high school graduation in Hungary. This value is substituted into the calculations for every settlement in the given year (with index 'a' in the formula) as follows (Table 1):

Table 1 The ratio of total number of persons with diploma and the persons with at most high school graduation (values of 'a')

Census years	1960	1970	1980	1990	2001	2011	2022
'a'	2.629	2.980	2.851	2.135	2.316	1.772	1.481

Source: calculated by the authors from census data by the Hungarian Central Statistical Office (HCSO)

The listed value changes every year according to the number of persons with diploma that is characteristically rising after the political transition in 1989, with the expansion of tertiary education (its consequence is the decrease in the value 'a').

$$CEAI_i = \frac{x_i + a * y_i}{p_i} * 100$$

where *CEAI = complex educational atteinment index; x_i = number of persons with at most high school graduation; y_i = number of persons with diploma; a = ratio of total number of persons with diploma and the persons with at most high school graduation; p_i = number of population aged 20 and more.*

$$CEAI_{nat} = \frac{\sum_{i=1}^{n} x_i + a * \sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} p_i} * 100$$

where *$CEAI_{nat}$ = national average of the complex educational attainment index.*

$$CEAI_i' = \frac{CEAI_i}{CEAI_{nat}} * 100$$

where *$CEAI_i$' = relative value of settlement-level $CEAI_i$ in the percent of the national average (%).*

With the help of the relative values, the significantly growing values between 1960 and 2022 become comparable.

Delimitation of the Hungarian border areas

The issues of the delimitation of the border areas have permanent relevance due to their relative character (Dusek, 2004) and transforming role. For this reason, numerous different border area concepts were published in the related literature (Kovács, 2006), and ten different approaches of delimitations were identified besides their combination (Papp, 2019). The creation of buffer zones along the state border is regarded as one of the most frequently used methods which is supported by various GIS tools (Hurbánek, 2009; Houtum & Eker, 2015). On the basis of this consideration, the approach of buffer zones was adapted in the current research.

Figure 1 Categories of settlements in the buffer zones of the state border
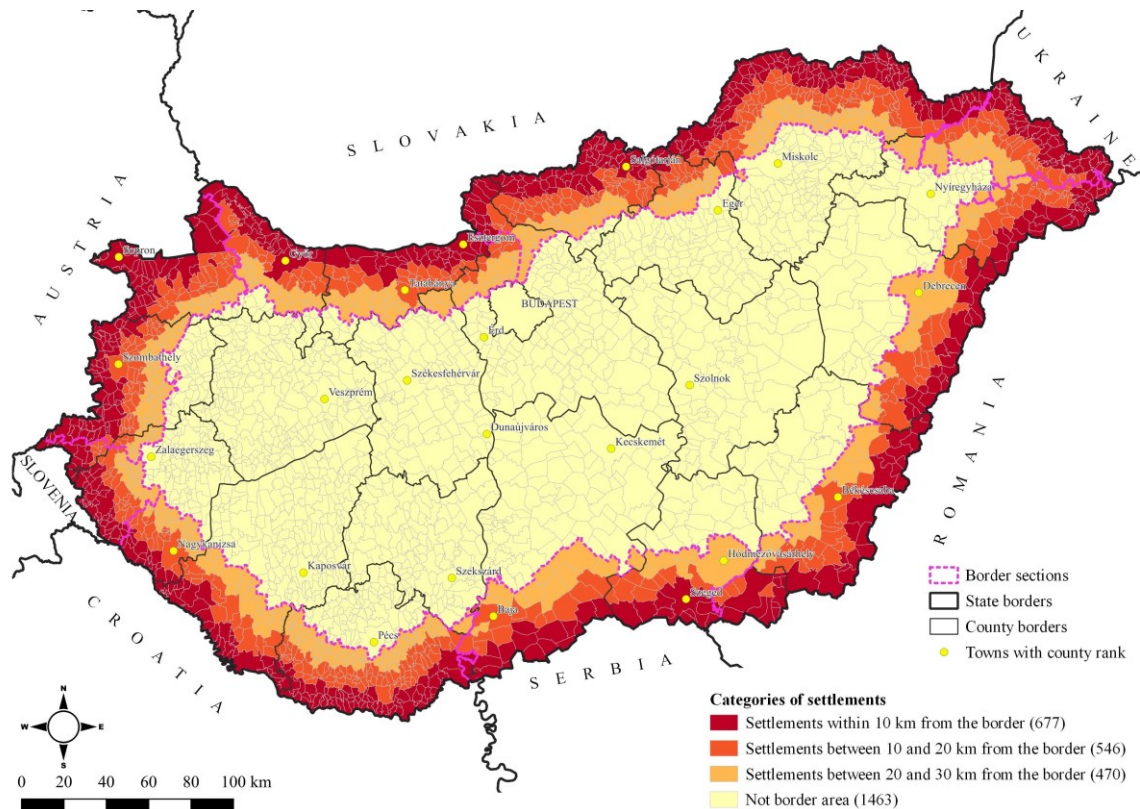
Source: edited by the authors

However, the width of border zones is also arguable in the light of the precedents of the related Hungarian researches. 20 kilometres broad belt along the state border is considered as one of the most frequently applied distance categories (Hoóz, 1992; Houtum & Eker, 2015; Papp, 2019), at the same time Zoltán Kovács delimited the zone within 30 kilometres proximity of the Hungarian border (Kovács, 1990). According to these consideration, three zones were delimited by the distance from state border. The categorisation of settlements

(LAU2) is based on the location of their central inner areas' centroids within 10, 20 and 30 kilometres to the state border (Fig. 1 and Tab. 2).

The delineation of the sections of the border zone is also necessary to investigate the issues of border areas. Each section of the border area is separated from the others by the road accessibility of the nearest border crossing point (according to the continuously operating border crossing listed by the Hungarian Police and the Traffic Information Centre (Útinform) in 2019 (before the COVID-pandemic). The Slovakian section of the border – due to its extreme length – has been divided into a Western and Eastern part (at the river Danube).

Table 2 Main features of the border sections of Hungary in 2022

Border sections	Number of settlements			Number of population, head		
	0-10 km	10-20 km	20-30 km	0-10 km	10-20 km	20-30 km
Austrian	102	80	83	188.447	148.159	48.561
Western-Slovakian	56	51	64	320.241	209.758	238.527
Eastern-Slovakian	180	148	113	222.140	142.670	254.676
Ukrainian	53	35	23	47.609	64.316	57.690
Romanian	88	70	33	181.293	213.314	296.005
Serbian	25	20	17	215.219	79.871	105.167
Croatian	120	113	114	94.837	111.119	81.364
Slovenian	53	29	23	20.018	9.688	9.301
Border area together	***677***	***546***	***470***	***1.289.804***	***978.895***	***1.091.291***

Source: calculated by the authors from census data by the Hungarian Central Statistical Office (HCSO)

RESULTS

The values of educational attainment significantly increased between 1960 and 2022 due to the previously mentioned reasons impacting the number of people achieving high school graduation or diploma. The intensive growth of this value slowed down during the 1980's and after 2011 at national level. Every category of the border areas unambiguously represented below average levels during the whole period (Table 3 and Table 4).

Table 3 The complex educational attainment index (CEAI) in the categories of the border area in Hungary between 1960 and 2022

Categories of the border area	1960	1970	1980	1990	2001	2011	2022
Average value of settlements within 10 km from the border	10.03	20.00	30.56	36.30	48.56	57.52	63.54
Average value of settlements between 10 and 20 km from the border	8.28	16.72	27.14	33.15	44.39	53.83	60.33
Average value of settlements between 20 and 30 km from the border	9.74	18.57	29.00	34.88	49.31	61.24	68.60
National average	**13.42**	**24.33**	**35.82**	**41.30**	**55.22**	**64.62**	**70.33**

Source: calculated by the authors from census data by the Hungarian Central Statistical Office (HCSO)

Table 4 The relative complex educational attainment index (CEAI') in the categories of the border area in Hungary between 1960 and 2022, %

Categories of the border area	1960	1970	1980	1990	2001	2011	2022
Average value of settlements within 10 km from the border	74.73	82.17	85.32	87.90	87.94	89.01	90.35
Average value of settlements between 10 and 20 km from the border	61.70	68.70	75.76	80.27	80.39	83.31	85.78
Average value of settlements between 20 and 30 km from the border	72.56	76.30	80.97	84.45	89.30	94.77	97.54
National average	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: calculated by the authors from census data by the Hungarian Central Statistical Office (HCSO)

Table 5 The complex educational attainment index (CEAI) in the border sections of Hungary between 1960 and 2022

Border sections	1960	1970	1980	1990	2001	2011	2022
Austrian	10.77	20.77	31.91	38.40	50.24	58.86	64.82
Western-Slovakian	12.25	22.68	34.74	40.60	57.06	67.65	73.62
Eastern-Slovakian	8.74	16.33	26.07	31.07	41.69	51.74	58.75
Ukrainian	5.17	11.64	19.76	24.45	32.39	42.22	52.18
Romanian	9.44	18.88	29.42	35.63	47.35	57.64	63.75
Serbian	11.53	22.94	34.09	40.76	56.06	65.15	70.60
Croatian	5.98	12.93	21.31	26.17	35.53	44.90	50.99
Slovenian	4.25	9.94	17.20	22.27	31.94	42.48	51.56
Border area total	*9.42*	*18.59*	*29.06*	*34.92*	*47.54*	*57.60*	*64.23*
National average	**13.42**	**24.33**	**35.82**	**41.30**	**55.22**	**64.62**	**70.33**

Source: calculated by the authors from census data by the Hungarian Central Statistical Office (HCSO)

Table 6 The relative complex educational attainment index (CEAI') in the border sections of Hungary between 1960 and 2022, %

| Border sections	1960	1970	1980	1990	2001	2011	2022
Austrian	114.30	111.73	109.79	109.96	105.68	102.19	100.93
Western-Slovakian	130.08	122.01	119.52	116.25	120.04	117.45	114.62
Eastern-Slovakian	92.81	87.84	89.70	88.95	87.70	89.82	91.48
Ukrainian	54.92	62.61	67.98	70.01	68.14	73.29	81.24
Romanian	100.19	101.53	101.24	102.01	99.61	100.06	99.26
Serbian	122.38	123.39	117.30	116.71	117.94	113.10	109.93
Croatian	63.44	69.54	73.34	74.95	74.75	77.96	79.39
Slovenian	45.11	53.49	59.19	63.78	67.19	73.75	80.27
Border area total	*70.18*	*76.40*	*81.14*	*84.56*	*86.09*	*89.14*	*91.33*
National average	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: calculated by the authors from census data by the Hungarian Central Statistical Office (HCSO)

The aggregated values of the complex educational attainment index clearly demonstrate the significant convergence of the border sections during the whole period (Table 5 and Table 6). However, convergence to the national average is two-faced, because the above-average

sections (Western-Slovakian, Serbian, Austrian) weakened, while the extremely low values (Slovenian, Ukrainian, Croatian sections) significantly increased until the recent census. The Romanian section of the border area is regarded as an exception, because the values formed a stagnation fitted to the national average.

As a matter of fact, significant disparities can be observed in the case of each section of the border area (Fig. 2). The zone located closest to the border represented major inequalities with above average border sections – Western-Slovakian and Serbian – already in 1960 and spectacularly low values as well. This fact draws attention to the importance of the largest cities in this respect, because only one outstanding value (with large population number) is enough to raise the development level of an expressly backward territory. The values of CEAI significantly dropped after the exclusion of the largest towns (these are identified as the towns with county rank illustrated on Fig. 1) from the calculations. The Serbian border section's value decreased with more than 50 percentage points after excluding the values of Szeged. A similar fall in the values is seen in the case of the Western-Slovakian (after the exclusion of Győr and Esztergom) and less spectacularly of the Austrian border section (after the exclusion of Sopron from the computation).

Figure 2 The relative complex educational attainment index (CEAI') in the sections of the border area within 10 km from the state border between 1960 and 2022
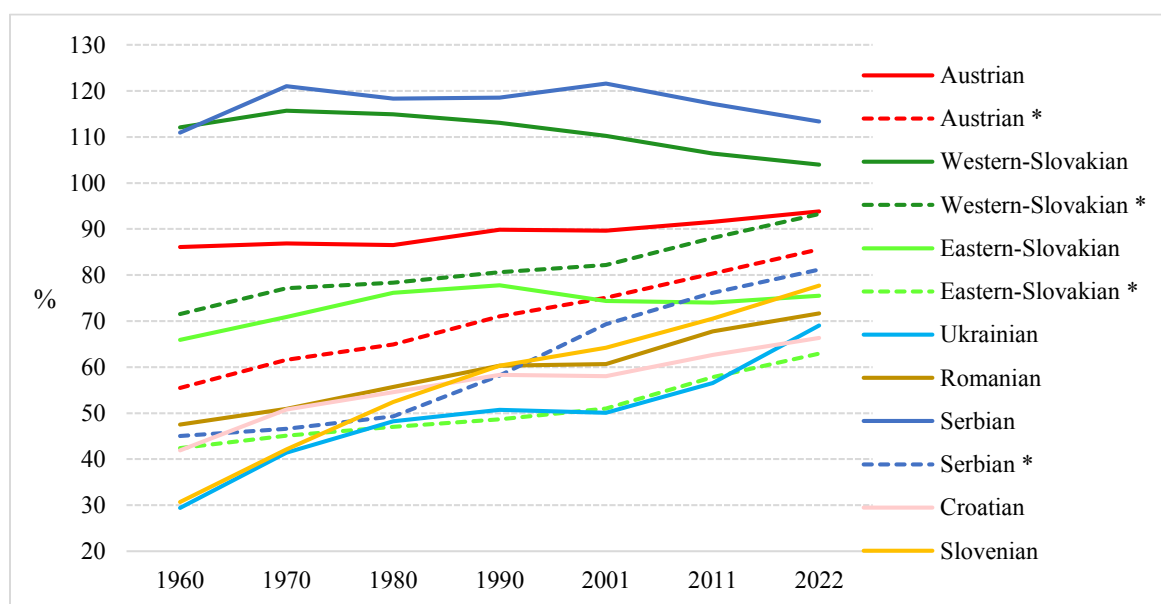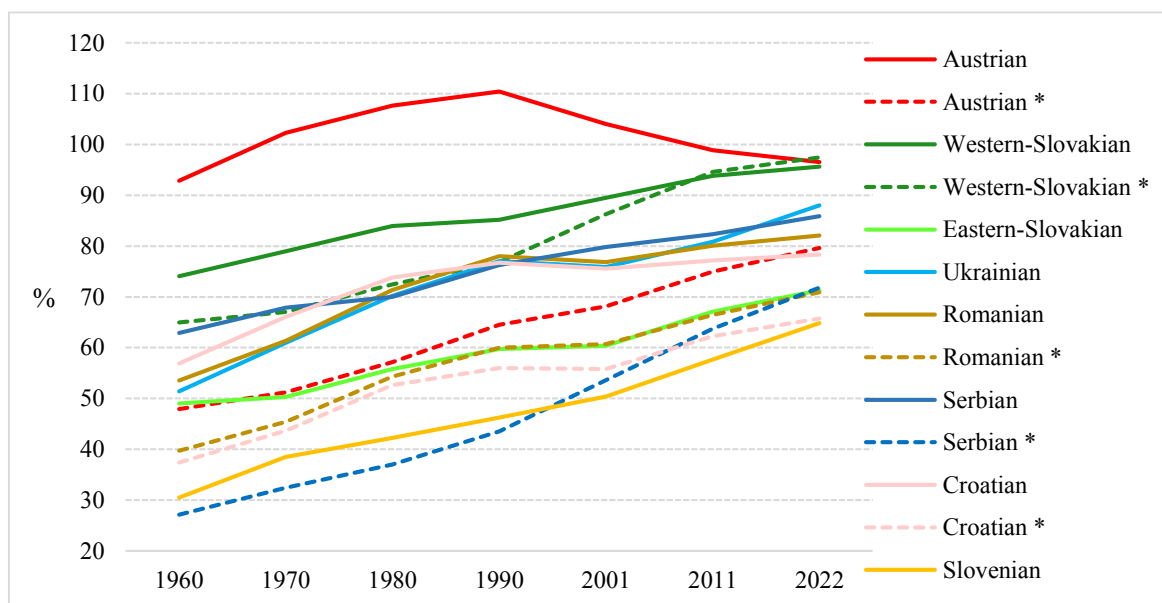

* towns with county rank are excluded from the calculations
Source: Calculated and edited by the authors, based on census data from the Hungarian Central Statistical Office (HCSO)

It is possible to detect an obvious convergence of the lower values to the national average (100% in the graph) during the total period. Some of the trends – both the Slovakian and the Austrian sections – deviate from the continuously increasing tendencies. Less dynamism of the larger towns is the most important factor in this case, because the county seats (and towns with county rank) reached higher CEAI values earlier due to their advanced economic profile and better institutional positions. Unambiguous stagnation is observed during the 1990s in more border area sections (Ukrainian, Romanian, Croatian). The Austrian border area does not exhibit outstanding dynamism, but the Ukrainian section shows outstanding growth after 2011 (important small towns stabilized this part of the border – e.g. Fehérgyarmat, Kisvárda, Mátészalka, Vásárosnamény) and outperforms the Croatian section on the basis of the recent census. Similar trends can be observed in the zone between 10 and 20 kilometers from the border (Fig. 3). The Austrian section's tendency differs from the others', however the exclusiov of the county seat (Szombathely) diminishes this unique character. Apart from a few exceptions, these values remain below the national average during the whole investigated period. An obvious trend of convergence is also detected – except for the 1990s' values. The Slovenian border area is in the last position since the millennium, but the Ukrainian section has better values in this category.

Figure 3 The relative complex educational attainment index (CEAI') in the sections of the border area between 10 and 20 km from the state border between 1960 and 2022
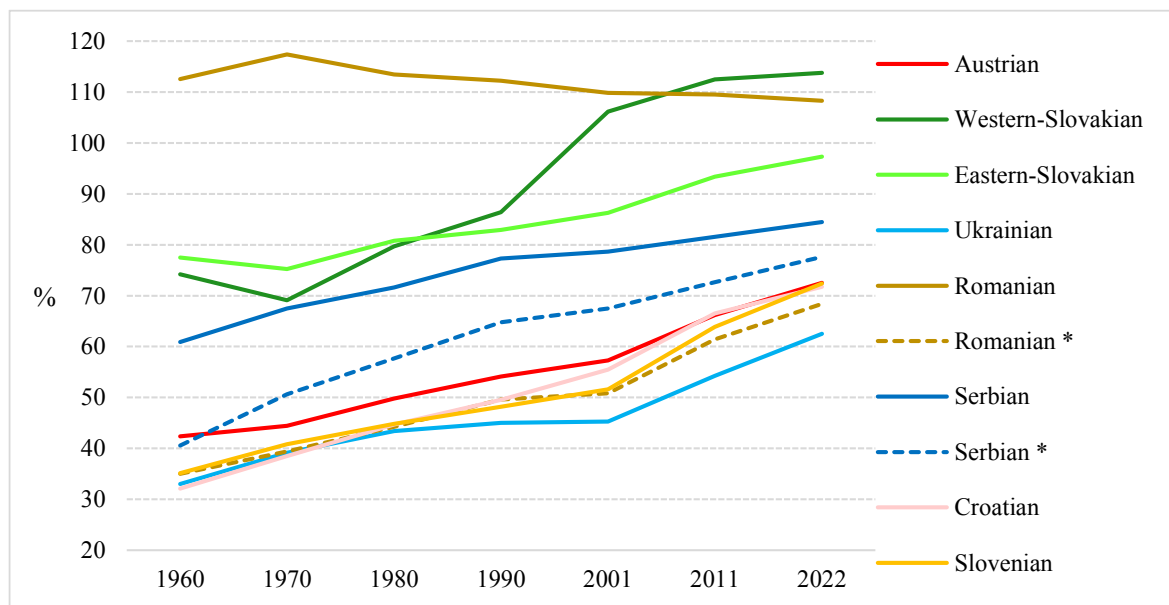

* towns with county rank are excluded from the calculations
Source: Calculated and edited by the authors, based on census data from the Hungarian Central Statistical Office (HCSO)

The distant border area (further than 20 kilometers from the border) represents interesting trends besides the typical converging trends (Fig. 4). The particularly altering curve of the Romanian section is largely increased by the contribution of Debrecen to the relative complex educational attainment index. Both Slovakian trends are impacted by the significantly rising values of the Budapest agglomeration and this fact is confirmed by the massive growth of the Western part during the 1990s (which was the most intensive period regarding suburbanization in the surrounding area of the capital city) (Bajmócy, 2014). Besides the lowest values of the Ukrainian section, the Austrian trends are also significantly below the national average (in parallel with the Slovenian and Croatian values).

Figure 4 The relative complex educational attainment index (CEAI') in the sections of the border area between 20 and 30 km from the state border between 1960 and 2022

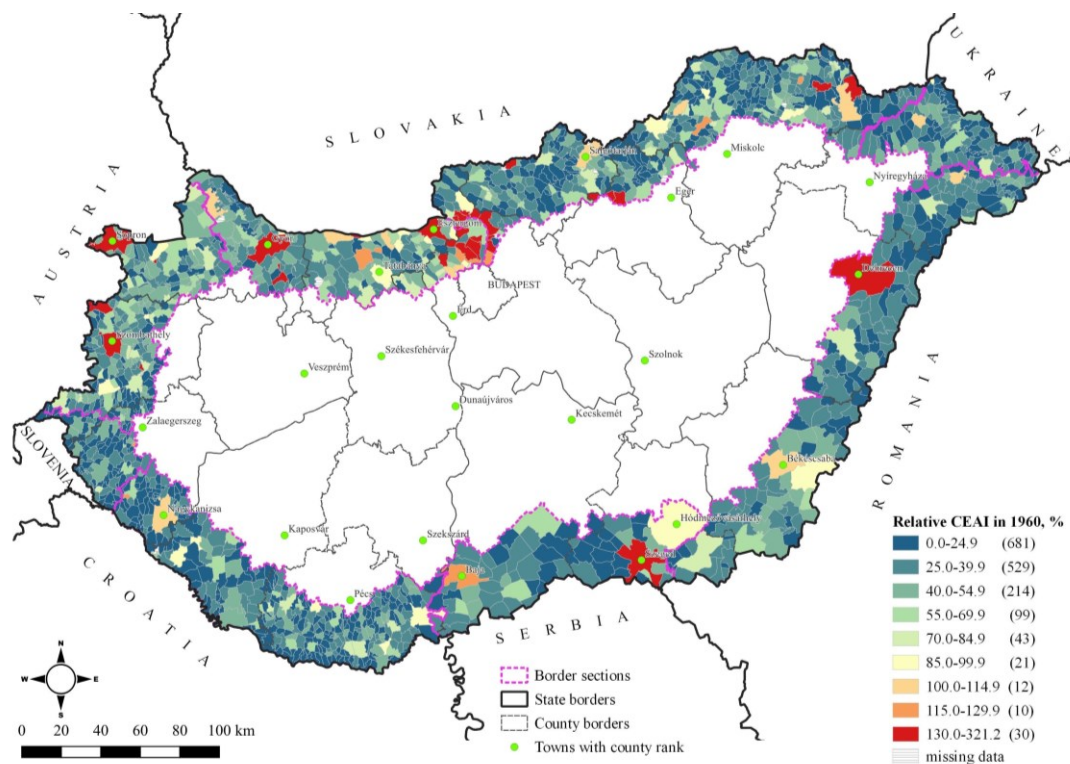* towns with county rank are excluded from the calculations
Source: Calculated and edited by the authors, based on census data from the Hungarian Central Statistical Office (HCSO)

The three distance categories experienced significant convergence to the national average, all of them exceeds the 60 percent value of the CEAI in national comparison, furthermore, most of them are deeply below the Hungarian average. The Austrian border zones stand out from the other tendencies mostly as a result of the increased contribution of large towns, in the absence of which they are lagging behind on the basis of the comparison. The Western-Slovakian section is in a better condition than the other sections. In contrast, the most backward Ukrainian, Slovenian, Croatian and Eastern-Slovakian trends are significantly lagging behind the national level.

The relative values of the CEAI represented extremely polarized cases in the first investigated census year (1960) (Fig. 5). Approximately 40 percent of the settlements in the border area were below 25 percent of the national average, but some of them – primarily the largest cities – had outstanding values. The spatial pattern is regarded as polarized due to the island-like location of the high values – except for the characteristic concentration in the Northern part of the agglomeration of Budapest. This extreme polarization became more moderate during the years of socialism (Fig. 6) and a slight convergence could be detected in terms of the complex educational attainment index.

The formation of suburban territories – mostly in the surroundings of Budapest, Győr, Szeged and Szombathely – significantly moderates the spatial structure of educational attainment in the border zones after the political transition (Fig. 7). In these cases, the spreading of the radiation of urban centers is the most determining spatial process (Vaishar et al., 2020; Berkes 2020; 2021) instead of the accelerating effect of the state borders. However, indisputably, the cross-border impulses dominated in the rapid development of Rajka at the Western-Slovakian border (Balizs & Bajmócy, 2018).
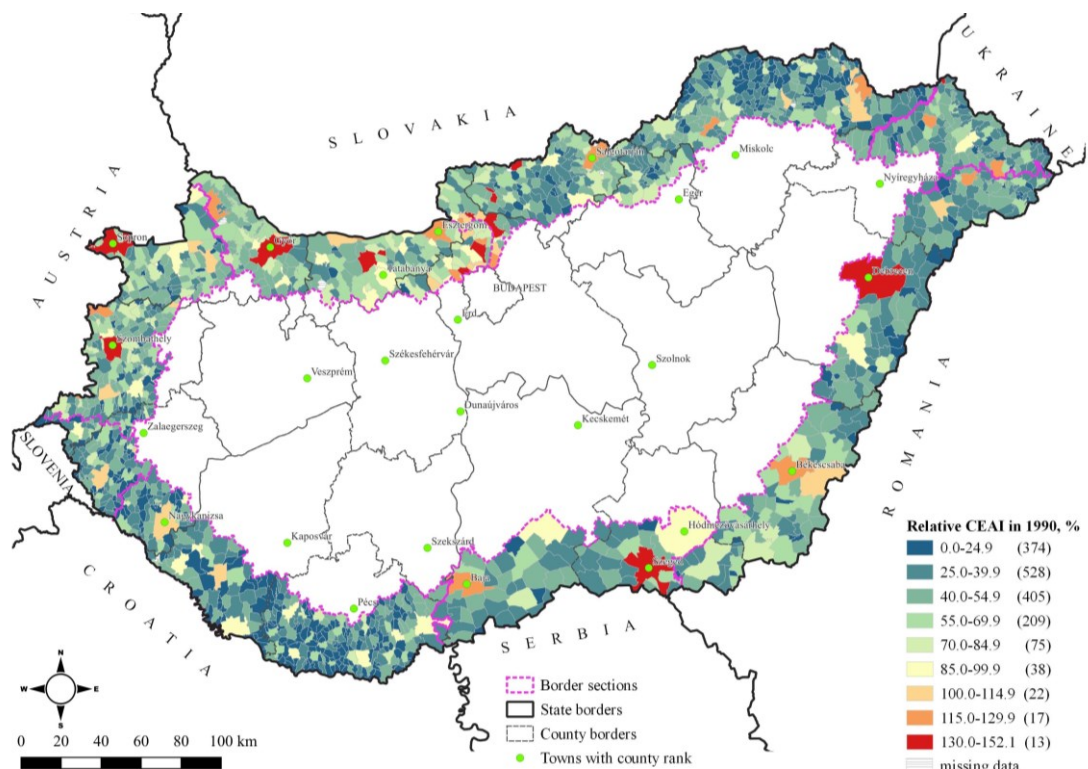
Figure 5 The values of the relative complex educational attainment index (CEAI') in 1960, %

Source: Calculated and edited by the authors, based on census data from the Hungarian Central Statistical Office (HCSO)
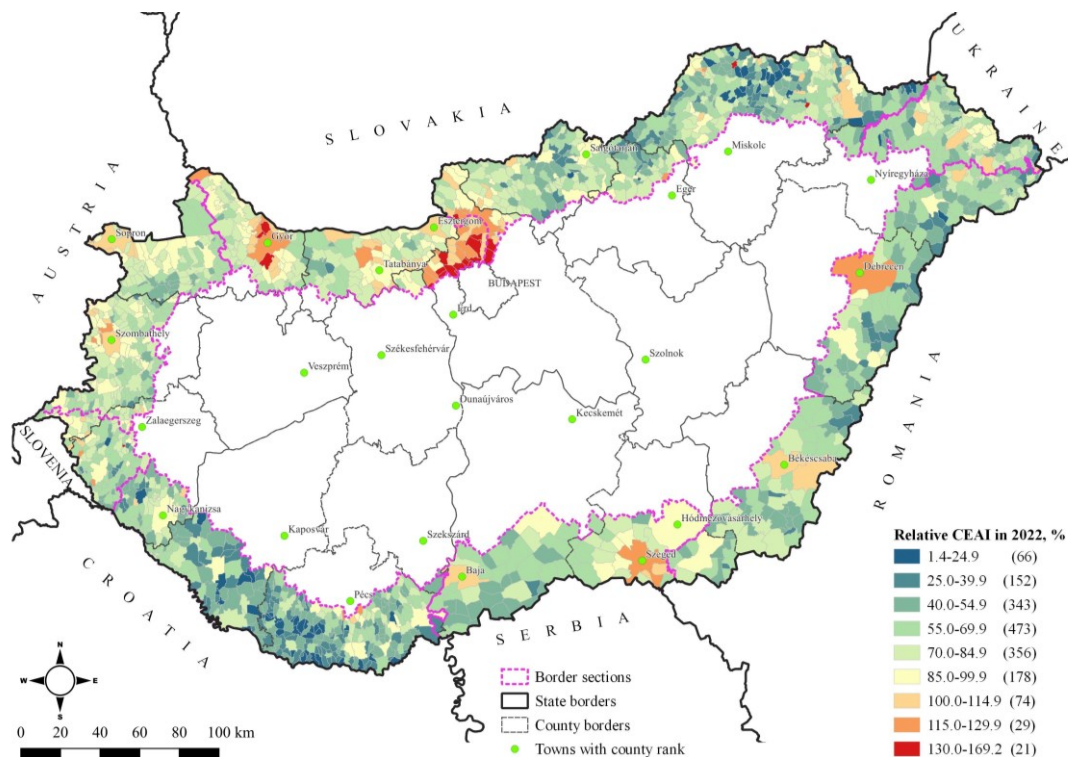
Figure 6 The values of relative complex educational attainment index (CEAI') in 1990, %

Source: Calculated and edited by the authors, based on census data from the Hungarian Central Statistical Office (HCSO)

Figure 7 The values of the relative complex educational attainment index (CEAI') in 2022, %

Source: Calculated and edited by the authors, based on census data from the Hungarian Central Statistical Office (HCSO)

The Eastern-Slovakian border section represents a rather polarized pattern even in 2022, where traditional backward zones (Cserehát and Bodrogköz) and recently formed structural crisis areas (surroundings of Ózd and Salgótarján) show a sharp contrast with the favorable territory of the Budapest agglomeration. In spite of the convergence processes, the average position of the Croatian border area is characterized by very limited values of the relative complex educational attainment index.

DISCUSSION

Educational attainment is regarded as an essential indicator to express the development level of different territories and the spatial inequalities (Graetz et al., 2018). Current investigation also confirmed the relevance of these indicators in the investigation of territorial processes at the level of settlements. The combination of different educational indicators has some precedents (Farkas, 2012), but the introduced complex educational attainment index is specific due to the applied weighting procedure. With the help of this methodology, the number of persons with high school graduation and with diploma could be combined with a relevant and reliable weighting of the latter component.

The delimitations of border areas provide a broad range of possibilities according to the different concepts (Papp, 2019). The approach applied in the current investigation covers the area which is influenced by the existence of state borders (Hansen, 1977) and supports those often-used methodologies based on the buffers along the border line.

Our findings confirm the results published in the relevant literature on the backwardness of border areas from this respect (Süli-Zakar, 1992), however the long-term tendencies clearly demonstrate the catching up of the most backward border areas to the national average. Convergence in the case of educational indicators has been highlighted by a number of studies (Kiss et al., 2008; Sánta et al., 2015; Szakálné Kanó et al., 2017; Németh & Dövényi, 2018), but groups of backward settlements have also been detected (Pénzes et al., 2018). Current investigation explored the unambiguous development of educational attainment in the case of border areas.

Major disparities were detected during the first period of the investigated time interval that have become more moderate nowadays. The role of the largest towns proved to be decisive in the processes of the border areas (together with the relative weakening position of the largest centers). Suburbanization becoming the most intensive from the 1990s until the mid-2000s (Bajmócy, 2014) has played an important role in the spatial extension of increased CEAI

values. In light of our researches, this process has been more significant than the development impulses of the border or the border crossing points. The development impulses generated by the increasing permeability of borders can be demonstrated only in specific cases – e.g. in the surroundings of Rajka (Balizs & Bajmócy, 2018).

The often noted higher development level of the Austrian border section (Rechnitzer, 1993; Gorzelak, 1996; Nemes Nagy, 1996; Szabó & Farkas, 2014; Rechnitzer, 2016) is not unambiguously supported by our results, however the largest towns have significantly improved their educational attainment values. At the same time, some backward zones mostly in the Croatian, Slovenian and Ukrainian border sections provided charactristic examples for the homogenous external peripheries along the state border in 2022 as well. The Eastern-Slovakian and Romanian sections of the border are regarded as polarized due to their discontinuous backward zones separated by some developed groups of settlements.

CONCLUSION

The analysis of complex educational attainment with the help of the indicator introduced drew attention to the general backward situation of the Hungarian border areas. It has been demonstrated that the different sections of the border area (according to the neighboring countries with additional segmentation) and the various distance categories have their own characteristics from this respect. However, a general and significant convergence can be observed in the long-term trends and the previously detected extremely low levels of educational attainment have definitely increased. This trend is a consequence of the national educational policy (compulsory education until the age of 18 years – actually 16 years) that caused unambiguous increase in the levels of educational attainment among the young generations. For this reason, the traditional advantage of larger towns has become more moderate over the decades, but they continue to make an important contribution to the better educational attainment of their surroundings (this territorial diffusion became more visible after 1990, mostly in case of the agglomeration of Budapest). The situation of educational attainment in the border areas has shown a significant improvement, but certain sections are still significantly lagging behind the national average and form a concentrated backward territory (at the Croatian border or the Eastern-Slovakian border).

SUMMARY

Educational indicators are an important basis for spatial researches focusing on regional development. Border areas provide special conditions for educational attainment, but the levels of aggregated results are worse in general. Different distance categories and given sections of Hungarian border areas are separated in order to detect the altering development paths of the complex educational attainment index (CEAI). This complex indicator combines the number of people with high school graduation and with diploma in the ratio of the 20 years or older population (with a weighting procedure included).

The Hungarian border areas are generally characterized by worse educational attainment values than the national average, but during the last more than six decades, significant convergence of data could be observed, in which the dominance of large towns is decisive. For this reason, suburbanization significantly impacts the spatial pattern of educational attainment in the border zones. Most parts of the settlements are below the national average, however general conditions are better in the case of the Austrian border section. Sharp territorial segregation in some backward zones is also demonstrated by the recent census data (mostly along the Croatian and the Eastern-Slovakian border area).

Acknowledgement

REFERENCES

Apáti, N., & Pénzes, J. (2023). A középfokú oktatási ingázás vizsgálata Magyarországon a 2010-es években. *Educatio*, 32(2), 207-227. DOI: 10.1556/2063.32.2023.2.3

Avdić, A., Avdić, B., & Zupanc, I. (2022). Socio-demographic analysis of border regions of Bosnia and Herzegovina. *Acta Geographica Slovenica*, 62(3), 7-19. 10.3986/AGS.10859

Bajmócy, P. (2014). A szuburbanizáció két évtizede Magyarországon. *Észak-magyarországi Stratégiai Füzetek*, 11(2), 6-17.

Balizs, D., & Bajmócy, P. (2018). Szuburbanizáció a határon át: társadalmi, etnikai és arculati változások Rajkán. Tér és Társadalom*, 32(3), 54-75. DOI: 10.17649/TET.32.3.3046

Benczi, M., & Ocskay, G. (2021). The evolution of cross-border cooperation in Hungary. *Észak-magyarországi Stratégiai Füzetek*, 18(2), 54-67. DOI: 10.32976/stratfuz.2021.35

Berkes, J. (2020). The economic structure and performance of the catchment area of the Hungarian regional centers. *Deturope*, 12(3), 58-81. DOI: 10.32725/det.2020.022

Berkes, J. (2021). Highly qualified social strata in urban areas of Hungarian regional centres from 1980 to 2011. *Regional Statistics*, 11(4), 126-149. DOI: 10.15196/RS110406

Bodnár, G., Kovács, P., Egri, Z. (2022). Elements of Endogenous Development in the Regions of Visegrad Countries. *Deturope*, 14(1), 29-49. DOI: 10.32725/det.2022.002

Czaller, L. (2016). Increasing social returns to human capital: evidence from Hungarian regions. *Regional Studies*, 51(3), 467-477. DOI: 10.1080/00343404.2015.1112898

Czimre, K. (2006). *Cross-Border Co-operation – Theory and Practice*, Debrecen: Kossuth Egyetemi Kiadó.

Durand, F., & Decoville, A. (2019). A multidimensional measurement of the integration between European border regions. Journal of European Integration, 42(1), 1-16. DOI: 10.1080/07036337.2019.1657857

Dusek, T. (2004). *A területi elemzések alapjai*. Budapest: ELTE Regionális Földrajzi Tanszék, MTA ELTE Regionális Tudományi Kutatócsoport.

Egri, Z. (2023). Local Dimensions of Regional Income Inequalities in the 2010s - Geographical Proximity Based Experiences from Hungary. *Deturope*, 15(1), 95-124.

Erkut, G., & Özgen, C. (2003). *The Economic and Spatial Peripherality of Border Regions in South-eastern Europe*. In The 43rd European Congress of the Regional Science Association, 27-30 August, Jyväskylä, Finland [conference proceeding]. Retrieved from https://www.econstor.eu/bitstream/10419/116063/1/ERSA2003_254.pdf (accessed: 15 November 2023).

Farkas, M. B. (2012). A korrigált humán fejlettségi mutató kistérségek közötti differenciáltsága Magyarországon. *Területi Statisztika*, 15(52)(3), 230-249.

van Geenhuizen, M., van der Knaap, B., & Nijkamp, P. (1996). Trans-border European networking: Shifts in Corporate Strategy? *European Planning Studies*, 4(6), 671-682.

Gorzelak, G. (1996). *The Regional Dimension of Transformation in Central Europe*. Regional Policy and Development 10. RSA, London: Jessica Kingsley Publishers.

Graetz, N., Friedman, J., Osgood-Zimmerman, A., Burstein, R., Biehl, M. H., Shields, C., … Hay, S. I. (2018). Mapping local variation in educational attainment across Africa. *Nature*, 555, 48-53.

Hansen, N. (1977). Border Regions: a critique of spatial theory and a European case study. *Annals of Regional Science*, 11(1), 1-14.

Harcsa, I. (2015). A területi fejlettség és egyenlőtlensé-gek lehetséges értelmezései – kritikai értékelés és kutatási eredmények I. *Statisztikai Szemle*, 93(5), 460-486.

Hardi, T. (2010). *Cities, regions and transborder mobility along and across the border*. Pécs: Centre for Regional Studies of the Hungarian Academy of Sciences. (Discussion Papers, 82).

Hoóz, I. (1992). A határmenti települések elnéptelenedése. *Statisztikai Szemle*, 70(12), 1005-1018.

Horváth, V. (2020). A határon átnyúló tanulmányi célú ingázás mint az intergenerációs társadalmi mobilitás eszköze. *Tér és Társadalom*, 34(3), 46-67. DOI: 10.17649/TET.34.3.3257

van Houtum, H. (2000**).** An overview of European Geographical Research on Borders and Border Regions. *Journal of Borderlands Studies*, 15(1), 57-85.

Houtum, van H., & Eker M. (2015). Border Scapes: redesigning the borderland. *Territorio*, 72, 101-107.

Hurbánek, P. (2009). Theoretical and methodological remarks on peripherality research: periphery-border relationship and periphery-settlement relationship. In Wilk, W. (Ed.), *Global Changes: Their Regional and Local Aspects* (pp. 115-122), Warsaw: University of Warsaw, Faculty of Geography and Regional Studies.

Husz, I. (2001). Az emberi fejlődés indexe. *Szociológiai Szemle*, 11(2), 72-83.

Kiss, J. P. (2000). Illúziók nélkül. A határátkelőhelyek szerepe a határ menti kapcsolatok alakulásában az ukrán, a román és a szerb határszakaszokon az 1990-es években. *Tér és Társadalom*, 14(1), 179-192.

Kiss, J. P., Tagai, G., & Telbisz, E. (2008). A szürkeállomány területi különbségei – katedrán innen és túl. *Területi Statisztika*, 48(3), 315-334.

Kovács, C. (2006). *Az országhatármentiség értelmezésének földrajzi problémái*. Szeged: Szegedi Tudományegyetem (SZTE) Földtudományok Doktori Iskola.

Kovács, K., & Koós, B. (2018). A település-állomány jólléti pozíciójának mintázatai és azok változása 1990-2016. *Észak-magyarországi stratégiai füzetek*, 15(3), 13-30.

Kovács, Z. (1990). A határ menti területek központhálózatának átalakulása az első világháború utántól napjainkig. Földrajzi Közlemények, 114(38)(1-2), 3-16.

Krueger, A., & Lindahl, M. (2001). Education for growth: why and for whom? *Journal of Economic Literature*, 39(4), 1101-1036.

Kussaiynov, T. A., Mussina, G. S., Bulkhairova, Z. S., & Saimagambetova, G. A. (2020). Impact of expenses on human capital on the economic growth of the country: case study of the Republic of Kazakhstan. *Deturope*, 12(2), 56-70. DOI: 10.32725/det.2020.012

Lipták, K. (2017). Települési humán potenciál vizsgálata Magyarországon. *Észak-magyarországi Stratégiai Füzetek*, 14(2), 55-65.

Morachevskaya, K., Karpenko, M., & Sebentsov, A. (2022). Border divergence or convergence in the context of integration: A case study of the Russian-Belarusian and Russian-Kazakhstan borderlands. *Hungarian Geographical Bulletin*, 71(1), 39-53. DOI: 10.15201/hungeoobull.71.1.3

Nagy, G., & Koós, B. (2014). First results in modelling objective well-being in Hungary at lower territorial level. *Regional Statistics*, 4(2), 71-86.

Nemes Nagy, J. (1996). Centrumok és perifériák a piacgazdasági átmenetben, *Földrajzi Közlemények*, 120(44)(1), 31-48.

Németh, Á., & Dövényi, Z. (2018). „Kiművelt emberfők" a térben – A diplomások területi eloszlása valóban a kiegyenlítődés irányába mutat? Területi Statisztika, 58(2), 129-150. DOI: 10.15196/TS580201

Papp, I. (2019). A határ menti területek lehatárolása térinformatikai módszerekkel. In Molnár, V. É. (Ed.), *Az elmélet és a gyakorlat találkozása a térinformatikában X.* (pp. 239-246). Debrecen: Debreceni Egyetemi Kiadó.

Pásztor, S. (2013). A tér és a közgazdaság-tudomány kapcsolatának korlátai a határ menti területek kutatásában. *Competitio*, 11(1), 98-116. DOI: 10.21845/comp/2012/1/7

Pásztor, S. (2014). Special Border Development Issues in Central and Eastern Europe. In Kaczmarska, E., & Raźniak, P. (Eds.) *Społeczno-ekonomiczne i przestrzenne przemiany struktur regionalnych* (pp. 101-115). Kraków: Krakowska Akademia im Andrzeja Frycza Modrzewskiego.

Pénzes, J. (2015). A kedvezményezett térségek lehatárolásának aktuális kérdései. *Területi Statisztika*, 55(3), 206-232.

Pénzes, J., & Demeter, G. (2021). Peripheral areas and their distinctive characteristics: The case of Hungary. *Moravian Geographical Reports*, 29(3), 217-230. DOI: 10.2478/mgr-2021-0016

Pénzes, J., Kiss, J. P., Deák, A., & Apáti, N. (2018). Térségi sokszínűség és stabilitás: az iskolázottság települési szintű egyenlőtlenségeinek változása Magyarországon 1990-2011 között. *Területi Statisztika*, 58(6), 567-594. DOI: 10.15196/TS580602

Pénzes, J. & Papp, I. (2018). Települési fejlődési pályák Magyarország határ menti térségeiben. In Molnár, V. É. (Ed.), *Az elmélet és a gyakorlat találkozása a térinformatikában IX.* (pp. 285-293). Debrecen: Debreceni Egyetemi Kiadó.

Petrakos, G., & Topaloglou, L. (2008). Economic Geography and European Integration: The Effects of on the EU External Border Regions. *International Journal of Public Policy*, 3(3), 146-162. DOI: 10.1504/IJPP.2008.019064

Ratti, R. (1993). Strategies to Overcome Barriers: From Theory to Practice. In Ratti, R., & Reichman, S. (Eds.), *Theory and Practice of Transborder Cooperation* (241-267). Basel: Helbing and Lichtenhahn.

Rechnitzer, J. (1993). Szétszakadás vagy felzárkózás? (A térszerkezetet alakító innovációk). Győr: MTA RKK Észak-dunántúli Osztály.

Rechnitzer, J. (2016). Elmozdulások és törésvonalak Kelet-Közép-Európa térszerkezetében. *Tér és Társadalom,* 30(4), 36-53. DOI: 10.17649/TET.30.4.2811

Rechnitzer, J., & Smahó, M. (2005). *A humán erőforrások regionális sajátosságai az átmenetben*. Budapest: MTA Közgazdaságtudományi Intézet (KTI).

Reichman, S. (1993). Barriers and Strategic Planning: Spatial and Institutional Formulations. In Ratti, R., & Reichman, S. (Eds.), *Theory and Practice of Transborder Cooperation* (pp. 55-64). Basel: Helbing and Lichtenhahn.

Sahlberg, P. (2006). Education reform for raising economic competitiveness. *Journal of Educational Change*, 7(4), 259-287. DOI: 10.1007/s10833-005-4884-6

Sánta, É., Szakálné Kanó, I., & Lengyel, I. (2015). Csökkennek az iskolázottság területi egyenlőtlenségei? A felsőfokú végzettségűek területi eloszlása a népszámlálások adatai alapján, 1990-2011. *Területi Statisztika*, 55(6), 541-555.

Süli-Zakar, I. (1992). A study of state borders as factors blocking socio-economic progress in North-Eastern Hungary. *Földrajzi Értesítő, International Edition*, 66(40), 53-64.

Szabó, P., & Farkas M. B. (2014). Kelet-Közép-Európa térszerkezeti képe. *Tér és Társadalom,* 28(2), 67-86. DOI: 10.17649/TET.28.2.2612

Szakálné Kanó, I., Kazemi-Sánta, É., & Lengyel, I. (2017). Territorial distribution of highly educated individuals in Hungary after 1990. *Regional Statistics*, 7(2), 171-189. DOI: 10.15196/RS070209

Szilágyi, Z. (2018). Az életminőség területi különbségeinek változása a 20. század első harmadában Magyarországon. *Történeti térinformatikai tanulmányok*, 8, 1-59.

Szilágyi, Z. (2019). Regional Differences in Development and Quality of Life in Hungary During the First Third of the Twentieth Century. *The Hungarian Historical Review. New Series of Acta Historica Academiae Scientiarum Hungaricae*, 8(1), 121-152.

Tagai, G., Pénzes, J., & Molnár, E. (2008). Methods of the analysis of integration effect on border areas – the case of Hungary. *Eurolimes*, 6(2), 150-159.

Teperics K. (2013). Debrecen határokon átnyúló oktatási vonzáskörzete. In Szilágyi, F., & Zakota, Z. (Eds.), *Partium: Társadalom- és térszerkezet* (pp. 103-133). Nagyvárad: Dokumentum Kiadó.

Vaishar, A., Zapletalová, J., Dvořák. P (2020). Transition to the post-productive countryside as a function of a distance from the big city. Case North-East fringe of Brno, Moravia. *Deturope*, 12(2), 4-17. DOI: 10.32725/det.2020.009

Váradi, M. M. (2020). Az (im)mobilitás dinamikái vidéki terekben – szakirodalmi kitekintés empirikus kiegészítésekkel. *Tér és Társadalom*, 34(3), 114-141. DOI: 10.17649/TET.34.3.3285

van der Velde, M., & Wever, E. (2005). Border and labour market. *Jurnalul Economic*, 8(16), 139-151.

Wróblewski, Ł. (2020). Rethinking cross-border integration. A step to further discussion. *Border and Regional Studies*, 8(3), 111-135. DOI: 10.25167/brs2129