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Spatial polarity and spatial polarization in the context of supranational and national scales: regions of Visegrad countries after their accession to the EU

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Abstract. The paper focuses on the evaluation of some aspects of the spatial organization of economic development of regions in the V4 countries after their accession to the EU. It focuses on the confirmation or confutation of the application of two principles of spatial organization based on the context of polarization theories, namely the polarity between western and eastern regions (i.e. the West–East gradient) and the polarity between the capital and other regions of the country (i.e. the national metropolitan gradient) at national and supranational levels. In the evaluation of the spatial polarity, the remoteness of various regions of the V4 countries from the economic core area (the Blue Banana, respectively the capital of the country) acts as the independent variable, whereby two economic indicators, i.e. the average monthly wage and the unemployment rate were chosen as the dependent variables. The analysis showed that on the supranational scale of the research in the monitored period, the increase of spatial polarisation was recorded. The increasing role of the West–East gradient and declining role of the national metropolitan gradient in the dynamics of spatial polarity has also been confirmed. The analysis has not confirmed the scale shift of polarity according to the West–East gradient to the national level, but at the same time it has pointed out the significant influence of the national metropolitan gradient in Slovakia, the Czech Republic and Hungary at this assessment level.

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Contents:

1. Introduction

Spatial inequality and regional disparities are the research agenda of several scientific disciplines, the importance of which is growing constantly (Martin, 2005). From the point of view of the internal development of science, no doubt it is due to the spatial turn in social sciences (Warf, Arias, 2009: 3-4). The key external cause that stimulates this research interest lies in the increasing severity and negative effects of excessive inequalities (and within their context, spatial inequalities) and the need for mitigating them suggested by several sociologists, economists, and geographers (e.g., Atkinson, 2015; Harvey, 2005; Stiglitz, 2013; Therborn, 2013) in the past period. Inequalities are more sensitively perceived by the general public, which may lead to social conflicts with serious political, demographic and economic consequences. One of the warning signals is the success of extremist political groups in elections, whose support is more pronounced in less developed areas (1). The social relevance of the solution of the issue was also stressed in theoretical discussions after the outbreak of the financial and economic crisis at the end of the first decade of the 21st century, which criticized the neo-liberalisation of the principles of economic policy in both Europe and individual countries (Nagy, 2015: 167).

The paper deals with one of the partial issues related to the scale dependence of the spatial pattern of the economic regional development in the V4 (Visegrad countries) after their accession to the EU. This issue coincides with the determination of the significance hierarchy of the regional development conditional factors. Specifically, it is the case of the study of dynamics of two spatial-organizational principles arising from polarization theories. These are the plurality of the western and eastern regions (the West–East gradient) and the polarity between the capital and the other regions of the country (the national metropolitan gradient) in the context of the supranational and national research scale. We will consider whether or not the emphasising of regional disparities and the deepening of spatial polarization according to the West–East gradient and the gradual mitigation of spatial polarization according to the national metropolitan gradient on the supranational research scale (the V4 countries) can be approved. We will also investigate whether it is possible to name a trend in the polarity scale shift according to the West–East gradient at the national level in the period after the accession of the V4 countries to the EU.

2. Research materials and methods

2.1. Theoretical-methodological discourse

2.1.1. Spatial polarity and spatial polarization

In economics, sociology, and geography, the issue of polarity between centre (core) and periphery in various scale contexts has a long-lasting tradition

dating back to the first half of the 19th century. The issue appears in the theoretical concepts and models of J. H. von Thünen, J. G. Kohl, H. Mackinder, E. R. Burgess, W. Christaller, J. Friedmann and others. Representatives of the dependency theory (e.g. Prebisch, Frank) and the world-system theoreticians (e.g. Wallerstein) (Blažek, Uhlíř, 2011; Matlovič, Matlovičová, 2015) inclined to this kind of thinking.

Polarization theoreticians (since the 1950s) declare that spatial inequalities lead to circular cumulative causation, which results in a state of spatial polarization—e.g. Myrdal 1957 (Blažek, Uhlíř, 2011). They assume a divergent orientation of the developmental tendencies of economic growth's spatial organization. They work with the core–periphery model that simplifies reality into a state of dichotomy. As a matter of fact, it is a case of certain extremes within the continuum of regions with a differentiated centrality/peripherality degree (Hampl, 2000: 241). In more recent research, we can witness a shift in discussions toward a post-structuralist framework. These apply attitudes of the relational geography that focus on the ways in which individual areas and regions are connected by relations. Its characteristic feature is the ambition to overbridge the dichotomous core–periphery model. The relational space is permanently socially constructed and has a fluid character. Therefore, processual approaches are applied (Murdoch, 2006 in Cresswell, 2013: 218). This is especially the case in the study of polarization and peripherization processes (Lang et al., 2015: 1; Benedek, Kocziszky, 2015; Kühn, 2015). To that effect, we consider it effective to distinguish between spatial polarity as a state and spatial polarization as a process. An immanent feature of this process is the centre–periphery relation, i.e. peripherization assumes implicitly a centralisation process and thus also social-spatial polarization at several levels. Peripherization manifests itself by growing dependence of disadvantaged regions on the centre. In the development of regional differentiation, it shows itself as a deepening of hierarchisation, that is the strengthening of the importance of the strongest cores on the one hand and the weakening of the rest of centres and periphery on the other hand. These hierarchisation tendencies show globalization, and also metropolisation as typical urbanisation processes (Szymańska, Biegańska, 2011). They appear on various scales (national, supranational and global) (Hampl, Marada, 2016: 568). Halás (2008: 352) called attention to the possibility of a scale intersection. A multi-scalar perspective in this context was applied by Šimon (2017).

Within this theoretical outline, it is necessary to mention the need to distinguish between the concept of spatial disparities and the concept of spatial polarity/polarization. In general, this issue was suggested by Esteban and Ray (1994). By means of application of their attitude to our issue, it is possible to compare the development in two marginal groups of regions from the point of view of their geographic localization (western–eastern, metropolitan–peripheral). Polarization appears if the differences between these two groups increase, and simultaneously their intra-group differences decrease (Pauhofová et al., 2016: 20).

The criteria of peripherality were tackled by T.G. Gross (2007 in Zarycki, 2010: 28) who divided them into three types: the criterion of accessibility (distance from the economically developed centres), the economic criterion (e.g., average wages, unemployment rate) and the demographic criterion (e.g., population density, migration balance). Demographic parameters show a higher level of persistence and respond to economic changes with a certain delay (Hampl, Marada, 2016: 582). Thus, the scale concept is of crucial importance. Smith (1993) suggested that a scale is socially constructed. He significantly differed from the traditional concept of a scale as given and fixed (i.e. like the cartographical scale of a map). Scales are historically conditioned unstable consequences of various social processes (e.g., the European Union has brought an overlap of borders and regulations of its individual member states). The importance of a scale is based on the fact that it "materially" includes activities and events with ambivalent consequences. It means that powerful actors in the effort to enforce their agenda restrict the activity scales of those who are in the opposition. However, those who do not have enough power try to increase the scale of their resistance activities to achieve a higher efficiency thereof (Smith, 1993 in Castree, 2011: 377-8).

The study of the dynamics of spatial polarity, that is the process of spatial polarization, assumes multiple variations. According to Havlíček and

Chromý (2001: 4-5), there are four abstract types of the centre–periphery model: increasing polarization (the deepening of the asymmetry between centre and periphery), stagnant polarization (keeping the existing polarity between centre and periphery), decreasing polarization (the decrease in asymmetry between centre and periphery) and levelling polarization (full removal of asymmetry between centre and periphery).

2.1.2. Scale levels and research hypotheses

Many analyses show that due to the social and economic transformation after the fall of communist regimes, which was connected with implementation of the Washington Consensus principles, the period after 1990 saw an increase in socio-economic disparities between regions, cities and populations (EC 2010) in Central Europe (see more in: Ther, 2014). While regional disparities in per capita GDP growth have declined, regional disparities have increased significantly (Schürmann et al., 2008). Central European cities and regions have been marginal as a result of the dominance of global cities in the global economy. European and national policies copy this model of global cities to some extent and focus on supporting the growth of metropolitan regions (Brenner, 2009 in Lang et al., 2015: 3). This is blatantly manifested in the period after the outbreak of the 2008 financial and economic crisis, when executive bodies and decision makers began concentrating scarce resources into large cities, hoping that disadvantaged regions would benefit from a centre–peripheral spillover effect (Lang et al., 2015). It follows that the objective of reducing regional disparities in Europe is gradually weakening and the emphasis is on moving towards a more efficient allocation of scarce resources, which should lead to a further widening of spatial inequalities. Previous empirical research in Central European countries has highlighted three characteristics of spatial development. The first involves the differences between developed urban regions and their less-developed rural surroundings (regional metropolitan gradient). The second feature is polarity between metropolitan areas and other parts of the country (national metropolitan gradient). The third feature is the West–East gradient, with the economic growth rate decreasing to the east (Lang, 2015: 172). In our research we focus only on the second and third features of spatial polarity. We assume that the dominance of the spatial patterns of the polarity of economic development is determined by scale.

At the supranational scale, the West–East gradient can be expected. The surveyed territory includes the V4 countries, which are traditionally a part of Central Europe and fill the space between the eastern edge of the EU's economic core (the so-called Blue Banana (2)) and the EU's eastern border. It is therefore a relatively compact research polygon in terms of its geographical delimitation in the context of latitude and longitude, which creates the conditions for exploring the influence of the West–East spatial polarity gradient. The West–East gradient in the economic standards of the new member states is reported by Dubois et al. (2007: 79). Polish historian M. Małowist (3) (1973) pointed out the deeper historical dependency of this polarity back in the 1970s. The predominant West–East orientation of territorial disparities in most Central European countries was also stated by Nováček (2014: 17), who argued that its effects were most apparent in Germany and Slovakia. Other authors (e.g., Džupinová et al., 2008: 175; Hampl, 1996; Korec, 2005: 160; Klamár, 2011: 112; Matlovičová et al., 2014: 94; Smętkowski, 2015: 551) argued in favour of the West–East (or Northwest–Southeast) gradient in the case of a multitude of signs of socio-economic development. However, they did not investigate the exact confirmation of the occurrence of the gradient.

Based on the formulated theoretical framework and the empirical knowledge we currently have, in this section we will aim to meet the research assumptions and hypotheses within the framework of two scale levels—supranational and national. From the perspective of Grosse´s (2007 in Zarycki, 2010: 28) criterion of periphery, we will consider the distance from the economic core territory (Blue Banana or capital of the respective country) as the independent variable. We use two economic indicators as dependent variables (average monthly wage and unemployment rate).

At the supranational level, we formulate the following hypotheses:

(1) Regional disparities according to the observed economic indicators have increased over the monitored period of 2004–2014 within the exam-

ined territory of the V4 countries. Given the specific nature of the period under review in connection with the outbreak of the financial crisis in 2008 we expect increasing polarization, especially in the first part of the monitored period (2004–2009) and subsequent stagnating-to-decreasing polarization in the second part of the monitored period (2009–2014) as the effect of the said crisis.

(2) In the V4 regions which are farther away from the economic core of the EU, economic development indicators will be worse (higher unemployment and lower average wages) than in regions closer to the economic core of the EU.

(3) The West–East gradient's strength in the context of the supranational level in the monitored period of 2004–2014 increased and the national metropolitan gradient decreased, an effect of the V4 integration into the EU in 2004. This assumption is in accordance with Smith´s theory of a socially-constructed scale.

At the national level, we formulate the following hypotheses:

(4) Regional disparities increased over the monitored period of 2004–2014 within the surveyed V4 countries. Given the specific nature of the period under review and consistent with the outbreak of the financial crisis in 2008, we expect increasing national polarization, especially in the first part of the monitored period (2004–2009), and subsequent stagnant-to-decreasing polarization in the second part of the monitored period (2009–2014) as an effect of the said crisis. We assume that, unlike at the supranational level, the national metropolitan gradient will have greater influence.

(5) In the V4 regions considered at the national level (within each of the V4 countries) which are located farther away from the capital city, the selected economic indicators will be worse (higher unemployment rate and lower average wage) than in the regions that are closer to the capital city of a country. Due to the integration of the V4 countries into the EU in 2004, we introduce, in accordance with Smith's theory of a socially-constructed scale, the following hypothesis:

(6) The West–East gradient's strength in the context of the national level in the monitored period 2004–2014 increased and the strength of the national metropolitan gradient decreased.

On the national level, however, it is possible to envisage a more complex picture of the spatial differentiation of regions' economic development. The West–East gradient's strength can either be weakened or strengthened by the national metropolitan gradient. The geographic location of the metropolis in relation to the state territory and the monocentric/polycentric character of the settlement system of the country will play a major role here. In the case of countries with a polycentric settlement system (the existence of several relatively equivalent regional metropolises), the national metropolitan gradient may be weakened by the regional metropolitan gradient. The following hypothesis has resulted from this considerations:

(7) The West–East gradient on the national scale of research will be the strongest in Slovakia, where it strengthens the national metropolitan gradient resulting from the geographical location of Bratislava and the monocentric settlement system of the country. The second strongest West–East gradient will be reported by the Czech Republic due to the slightly shifted position of Prague to the west and the monocentric character of the settlement system of the country. The weakest role will be played by the West–East gradient in Poland, given the location of Warsaw is slightly shifted to the east and due to the polycentric nature of the Polish settlement system.

2.2. Methodology

In the assessment of spatial polarity in the V4 countries, two economic indicators (4) (average monthly wage and unemployment rate (5)) were used as dependent variables, and the distance from the core areas (of the Blue Banana, or the capital of a particular country) was set as the independent variable. The choice of economic indicators resulted from their accessibility in the monitored statistical regions NUTS 3 as well as the complementarity of their explanatory power in relation to economic development.

Input data were gathered from officially available sources, such as web pages of national statistical authorities (6). For the sake of comparison, average monthly wages in the Czech Republic, Hungary and

Poland were converted into euros with an average annual exchange rate relevant for the reference period (7). Data relating to the unemployment rate were provided by national labour authorities which published their monthly unemployment rate data (8) at the end of the reference period. Our own calculations were used in the analysis, and represent the average unemployment rate for the whole monitored year. For the needs of capturing developmental trends, we evaluated important milestones such as 2004 (V4 countries' entry into the EU), 2009 (the year following the outbreak of the financial crisis) and 2014 (the last year of the evaluation). In terms of space, NUTS 3 regions, whose total number in all four countries is 108, were chosen as basic observational units.

To express the distance of the NUTS 3 regions within the V4 countries, it was necessary to select a method for measuring the distance from the economic core of the EU. The arbitrarily selected meridian 9°30´E, crossing the most westerly point of Austria, was used as an imaginary reference line. This country represents the continuous connection of the V4 area with the economic core of Europe and its most westerly point is part of the central axis of the Blue Banana. Distances were measured in kilometres based on the Euclidean model of space by means of distance arcs—loxodromes, crossing meridians of the reference space at the same angle. The length of the loxodromes was calculated in the geographic information system (GIS) as follows:

$$s = R \cos \frac{|\varphi_2 - \varphi_1|}{\alpha}$$

where: s = length of loxodrome, R = radius of the Earth, φ = longitude, α = azimuth of loxodrome.

Euclidean distance (straight-line, flight distance) is thus accumulated in all directions of movement from starting points alike (Kusendová, Szabová, 1998: 102). For each region, we created a centroid which together with the reference meridian formed the starting and ending points for measuring individual lengths of loxodromes. Subsequently, by means of the QGIS NNJoin Plugin, we recalculated 108 loxodromes. We thus obtained a database of distances of the regions in the monitored area to the meridian, on the basis of which a map of the shortest distances was created. The Jenks natural breaks classification method, designed to create the optimal number of values for individual classes of data, was used for the calculation of the intervals. A similar method was used in the evaluation of the regions' distances from the capitals of the V4 countries.

To evaluate the spatial polarity of regions of the V4 countries by means of the West–East gradient and the national metropolitan gradient, we applied the method of regression and correlation analysis, more precisely of the linear relationship between two variables in which average monthly wage and unemployment rate represented dependent variables and the distance from the core area (of the Blue Banana, the capital city) represented the independent variable. The aim was to find out whether some dependence between these variables can be assumed and if so, how intense this dependence is. On the hypothesis that such a dependence between two variables exists, and that its intensity can be expressed in terms of common variance, it would be possible to approximate one variable by means of the second variable and thus create a regression model where $y_i = a+bx_i$. When applying standardised data, coefficient a was close to 0 and the regression line parameter b, in the case of simple linear regression, matched the Pearson Correlation coefficient (Table 4, Table 6). ANOVA (the analysis of variance) performed using the STATISTICA software evaluated the adequacy of this model. It tested the null hypothesis H0: "the model is not suitable for use." F value represented the tested characteristics determined by the p-value giving the lowest possible significance level for the rejection of the null hypothesis. When the p-value was ≤α=0.05, the null hypothesis was rejected on the particular significance level. A measurement to determine the strength of linear relationship was the Pearson Correlation coefficient (R) whose absolute values approaching 1 indicate a rise in the strength of both gradients and, hence, that of spatial polarity. The coefficient of determination (R^2) expresses the percentage of variability of the independent variable or the amount of the overall variability quantified in a given regression model. For the evaluation of the regional disparities within the monitored indicators, we made use of two statistical measures: the Gini coefficient and the unweighted coefficient of variation (9).

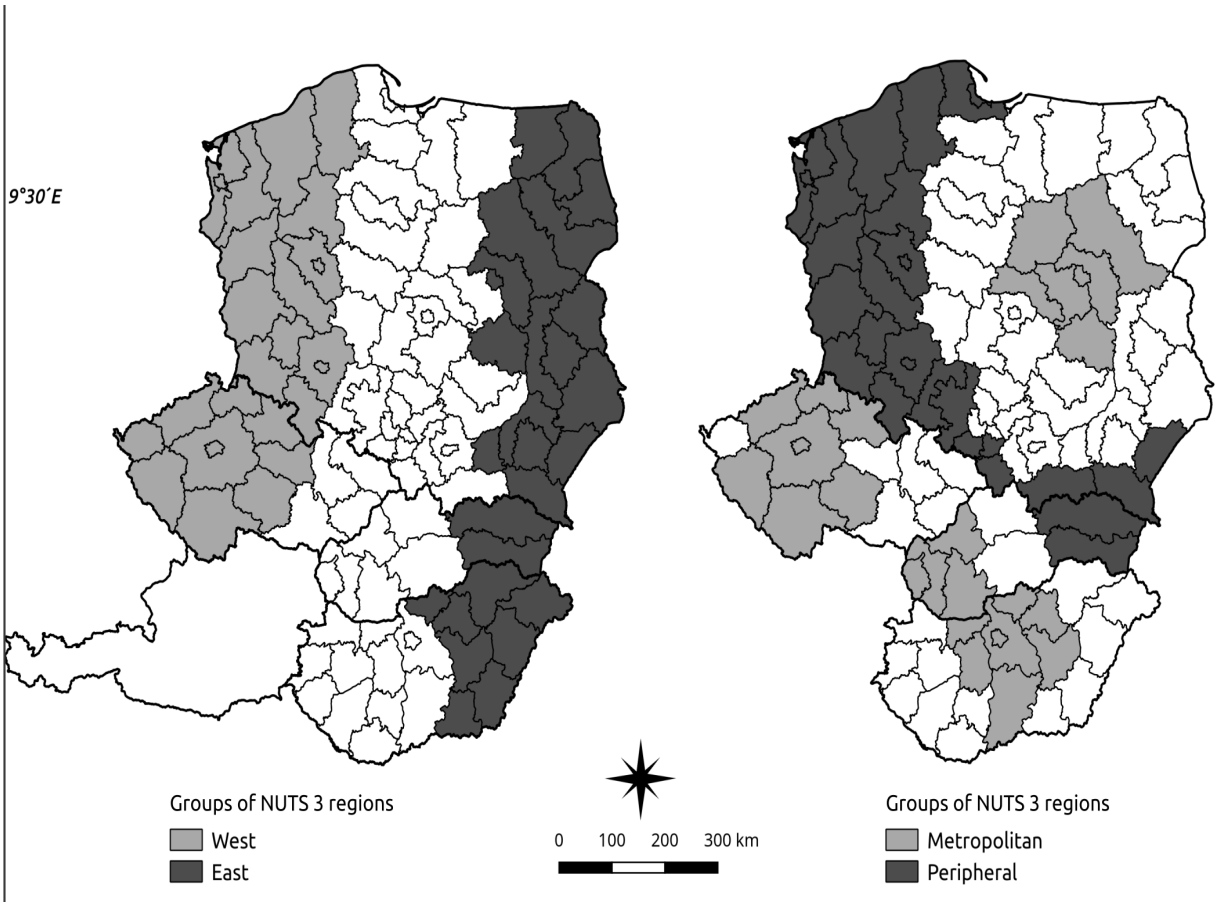

Fig. 1. Groups of NUTS 3 regions: WEST and EAST, METROPOLITAN and PERIPHERAL
Source: Customized image, Author's calculations

To evaluate the polarizing character of the increase in regional disparities within the set of 108 regions, we allocated marginal groups of the NUTS 3 regions on the basis of the first and the last quartile depending on their distance from the economic core of the EU or the country capital. These groups consist of 27 NUTS 3 regions and comprise the following groups: the group of regions with the shortest distance from the economic core of the EU (WEST), the group of regions with the longest distance from the economic core of the EU (EAST), the group of regions with the shortest distance from the country capitals (METROPOLITAN) and the group of regions with the longest distance from the country capitals (PERIPHERAL) (Fig. 1). We observed a rise in the values of economic indicators over the periods of 2004–2009 and 2004–2014, while their rate at the beginning of the reporting period was 100%.

3. Research results

3.1. Interpretation of the results at the supranational scale

The results of the empirical analysis confirmed hypothesis **(1)**. Chosen variables applied to the observed indicators show that regional disparities within the monitored region of the V4 countries increased in the first stage of the reference period (Table 1). In terms of the unemployment rate, its peak was in 2008 then it decreased, and in 2014, was lower than at the beginning of the reference period. As for average wages, these were highest in 2009, later they decreased; however, in 2014, average wages again increased and were higher than at the beginning of the reference period. Such a development, in our opinion, reflects the impact of the financial crisis which broke out in 2008. The in-

Table 1. Coefficient of variation (CV) and Gini coefficient (GINI) in the monitored region over the period 2004–2014

Indicator	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
CV UR	0.462	0.476	0.473	0.490	0.523	0.432	0.405	0.415	0.409	0.386	0.393
GINI UR	0.262	0.270	0.268	0.279	0.297	0.246	0.230	0.236	0.233	0.219	0.223
CV Wage	0.145	0.144	0.149	0.145	0.156	0.165	0.162	0.161	0.157	0.153	0.161
GINI Wage	0.070	0.069	0.072	0.070	0.080	0.084	0.085	0.085	0.083	0.080	0.084

Explanation: UR – unemployment rate
Source: Author's calculations

crease in disparities in 2014 relating to both indicators may signal a recovery from the crisis. Only data from subsequent years can confirm this trend, however.

In order to determine whether the increase in disparities was also of a polarizing nature, it would be relevant to compare the development within the marginal groups of the regions allocated within the context of the West–East gradient and that of the national metropolitan gradient. When comparing growth indices (Table 2), the polarized character of the development in the West–East gradient's activity is visible. The increase in average income in one quarter of the regions (WEST), the group which was closest to the EU core, was higher than in the whole area of V4 countries and much higher than in the group of regions belonging to the quarter with the largest distance from the EU core (EAST). As for the unemployment rate, a similar development was recorded. The WEST group had a more pronounced decrease than the decrease of the whole group of states and a much more substantial decrease than in the EAST group. Differences stem from the fact that while average wages show increasing polarization within the whole reference period, the unemployment rate passed from an increasing phase of polarization into a stagnant one. The development in the context of the metropolitan gradient was different. The rise in average wages in the group formed by one quarter of the states closest to the countries' capitals (METROPOLITAN group) was lower than in the whole examined V4 region and significantly lower than in the group formed by one quarter of the states farthest from the countries' capitals (PERIPHERAL group). Similar developments can be seen in the case of the unemployment rate, which was the lowest in the PERIPHERAL group. This demonstrates that metropolitan regions have exhausted the potential to reduce their unemployment rates as they are already at a very low level.

Another criterion for decision-making about the polarised/non-polarised nature of increasing spatial inequalities is the intragroup inequality decrease (Pauhofová et al., 2016: 20); therefore, we have analysed the level of variability (GINI – Gini coefficient) in the targeted groups of regions (WEST, EAST, METROPOLITAN, PERIPHERAL) (Table 3). This analysis has shown that intragroup inequality was reduced in the case of unemployment

Table 2. Average wage growth indexes and unemployment rate in the marginal groups of regions during the monitoring period

	GI WAGE 2009/2004	GI WAGE 2014/2004	GI UR 2009/2004	GI UR 2014/2004
WEST	150.38	176.70	65.11	67.95
EAST	135.52	164.53	94.17	85.92
METROPOLITAN	140.83	160.48	97.04	99.60
PERIPHERAL	143.31	180.64	61.85	56.37
V4 COUNTRIES TOGETHER	140.76	169.50	82.63	76.92

Explanation: GI – growth index, UR – unemployment rate
Source: Author's calculations

rate in three groups, except for the PERIPHERAL one. In terms of average wage, this declined in the WEST group and stagnation was observed in the PERIPHERAL group. This shows that a decrease of intragroup disparities occurred in more developed regions (METROPOLITAN, WEST) rather than in their less developed pendants (PERIPHERAL, EAST), where the volatility of development is higher.

The increasing role of the West–East gradient and the decreasing role of the national metropolitan gradient in the dynamics of spatial polarity of economic development in the context of the supranational level are also indicated in the results of the regression and correlation analysis (Table 4). The Pearson correlation coefficient (hereinafter: R) indicates in the case of the West–East gradient weak negative dependence on average wage and weak positive dependence on the unemployment rate. From the perspective of our analysis, there is a slight increase in its absolute value, which means a deepening of the West–East polarisation monitored over a period of time. As for the average wage, however, deepening polarisation in the first part of the observed period was replaced by stagnating or even receding polarisation after the beginning of the economic crisis in 2008. If we compare this development with the national metropolitan gradient, we will find the opposite development of R, whose absolute values are decreasing. This confirms the continued decreasing polarization between the metropolitan and peripheral regions after the accession of the V4 countries to the EU, considering the supranational scale of the analysis. All in all, the results did not lead to the confirmation of suitability of the linear regression model in most cases (Table 4), which indicates a weak predictive capacity of the considered independent variable. It also explains the spatial variability of the monitored economic indicators. Despite this fact, hypotheses **(2)** and **(3)** can both be considered valid (Table 4, Fig. 2).

Table 3. Development of intragroup disparities in the groups of regions METROPOLITAN, PERIPHERAL, WEST and EAST in the years 2004, 2009, 2014

	2004	2009	2014
		METROPOLITAN	
GINI Wage	0.0887	0.1088	0.1036
GINI Unemployment rate	0.3244	0.3011	0.2437
		PERIPHERAL	
GINI Wage	0.0679	0.0710	0.0694
GINI Unemployment rate	0.1839	0.2271	0.2238
		EAST	
GINI Wage	0.0586	0.0680	0.0970
GINI Unemployment rate	0.1680	0.1651	0.1503
		WEST	
GINI Wage	0.0661	0.0800	0.0589
GINI Unemployment rate	0.3174	0.3132	0.2525

Source: Author's calculations

Table 4. Pearson correlation coefficient (R) and determination coefficient (R^2) at the supranational level within the West–East and Metropolitan Gradients in the years 2004, 2009, 2014

		West–East gradient		National Metropolitan gradient	
V4 countries together	Year	R	R^2	R	R^2
Average monthly wage	2004	-0.118 (p=0.224)	0.014	-0.307 (p=0.001)	0.094
	2009	-0.346 (p=0.0002)	0.119	-0.199 (p=0.039)	0.040
	2014	-0.242 (p=0.012)	0.059	0.025 (p=0.794)	0.001
Unemployment rate	2004	0.061 (p=0.531)	0.004	0.508 (p=0.000)	0.258
	2009	0.356 (p=0.0002)	0.127	0.266 (p=0.005)	0.071
	2014	0.372 (p=0.0001)	0.138	0.218 (p=0.024)	0.047

Explanation: If the model is not suitable for use, it is marked in a brighter colour. The "p" values are rounded to the third decimal place. In the case the values are very small, the number is rounded to the fourth decimal place. *Source*: Author's calculations

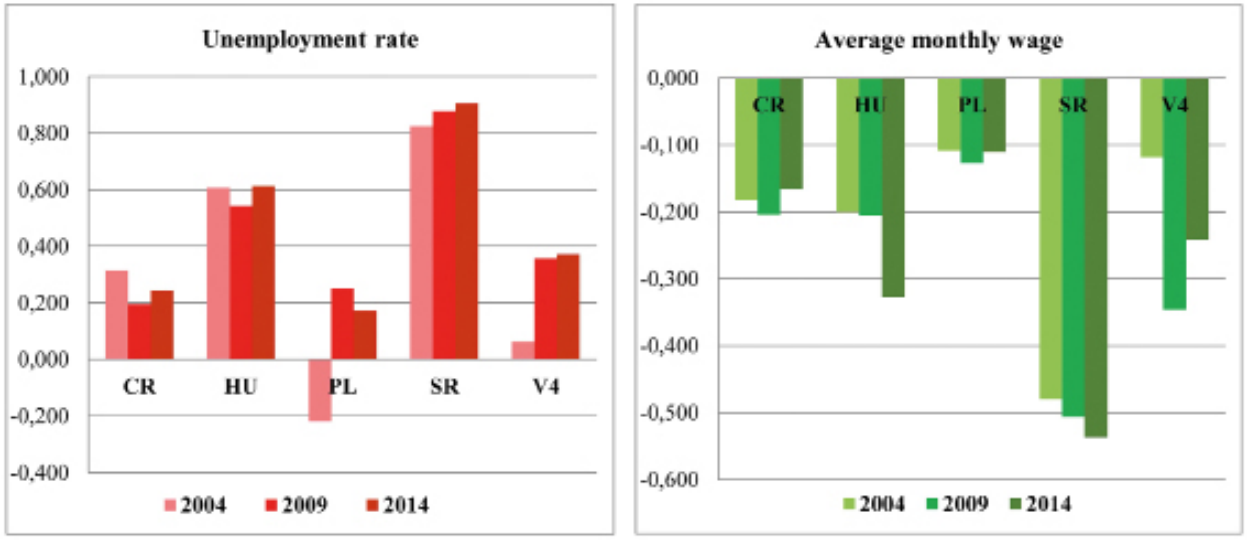

Fig. 2. Pearson correlation coefficient at supranational (V4) and national (CR, HU, PL, SR) levels within the West–East gradient in the years 2004, 2009, 2014
Explanation: CR - Czech Republic, HU - Hungary, PL - Poland, SR - Slovakia, V4 - countries of V4 together
Source: Author's calculations

3.2. Interpretation of the results at the national scale

The development of regional disparities in the context of the national scale is shown in table 5. The spatial pattern of spatial polarization dynamics is highly complex. In the case of the unemployment rate in the whole monitored period, disparities increased in Hungary and Poland and decreased in the Czech Republic and Slovakia. As for the average wage, it increased in Hungary and decreased slightly in other countries. In a more detailed view, the development was different in times before the economic crisis, when disparities, according to the average wage, also grew in Slovakia and Poland. Hypothesis **(4)** was thus only partially confirmed.

Based on the comparison of the results of regression and correlation analysis in both considered gradients, it was affirmed that the national metropolitan gradient exceeded the West–East gradient in the Czech Republic and Hungary. Both gradients are balanced in the case of Slovakia whereas in Poland, both gradients are insignificant, but the West–East gradient is slightly stronger. However, the suitability of the linear regression model was confirmed only in some cases, most notably that of the unemployment rate in Slovakia (Table 6). Hypothesis **(5)** can be considered confirmed in the case of the Czech Republic, Hungary and Slova-

Table 5. Gini coefficient (GINI) and Coefficient of variation (CV) in the V4 countries in the years 2004, 2009, 2014

	Slovakia			Hungary			Czech Republic			Poland		
	2004	2009	2014	2004	2009	2014	2004	2009	2014	2004	2009	2014
Unemployment rate												
GINI	0.233	0.239	0.186	0.240	0.210	0.264	0.195	0.139	0.115	0.180	0.213	0.196
CV	0.445	0.457	0.355	0.434	0.377	0.477	0.373	0.260	0.214	0.321	0.378	0.351
Average monthly wage												
GINI	0.083	0.092	0.072	0.058	0.064	0.073	0.046	0.049	0.044	0.068	0.070	0.066
CV	0.196	0.229	0.175	0.135	0.141	0.148	0.126	0.125	0.109	0.137	0.140	0.130

Source: Author's calculations

kia. In Poland, it seems that the distance from the capital city has no effect on the observed economic indicators. From the review of application dynamics of both gradients and a comparison of the values of R in the monitored period, it might be stated that the strength of the West–East gradient increased while the strength of the national metropolitan gradient decreased in the Czech Republic and Hungary regarding the unemployment rate during the period after the outbreak of the economic crisis. In Slovakia, due to the position of Bratislava, the effect of both gradients is strengthened. In Poland, neither of these gradients apply. Hence, hypothesis **(6)** was confirmed only partially, in the case of the Czech Republic and Hungary, regarding the unemployment rate. It indicates that at the national scale, the West–East gradient was not notably strengthened. Comparing the R values, it can be said that hypothesis **(7)** was confirmed. The West–East gradient applied most significantly to Slovakia, subsequently to the Czech Republic and Hungary. It was not demonstrated in Poland, however.

The projection of spatial polarization and differentiation of economic development of regions has, within the evaluated countries, its regularities, specifications and particularities (Fig. 5) that will now be discussed in brief.

Table 6. Pearson correlation coefficient (R) and determination coefficient (R^2) at the national level within the West–East and Metropolitan Gradients in the years 2004, 2009, 2014

		West-East gradient		National Metropolitan gradient	
Czech Republic	Year	R	R^2	R	R^2
Average monthly wage	2004	-0.182 (p=0.534)	0.033	-0.498 (p=0.070)	0.248
	2009	-0.204 (p=0.483)	0.042	-0.521 (p=0.056)	0.271
	2014	-0.166 (p=0.571)	0.028	-0.541 (p=0.046)	0.293
Unemployment rate	2004	0.313 (p=0.276)	0.098	0.535 (p=0.049)	0.286
	2009	0.194 (p=0.506)	0.038	0.545 (p=0.044)	0.297
	2014	0.244 (p=0.401)	0.059	0.445 (p=0.111)	0.198
Hungary		R	R^2	R	R^2
Average monthly wage	2004	-0.200 (p=0.399)	0.040	-0.639 (p=0.002)	0.409
	2009	-0.205 (p=0.386)	0.042	-0.645 (p=0.002)	0.416
	2014	-0.328 (p=0.159)	0.107	-0.667 (p=0.001)	0.444
Unemployment rate	2004	0.607 (p=0.004)	0.370	0.548 (p=0.012)	0.300
	2009	0.542 (p=0.014)	0.294	0.572 (p=0.008)	0.327
	2014	0.613 (p=0.004)	0.375	0.414 (p=0.069)	0.171
Poland		R	R^2	R	R^2
Average monthly wage	2004	-0.108 (p=0.387)	0.012	-0.054 (p=0.665)	0.030
	2009	-0.127 (p=0.310)	0.016	-0.018 (p=0.889)	0.003
	2014	-0.111 (p=0.376)	0.012	-0.035 (p=0.782)	0.001
Unemployment rate	2004	-0.219 (p=0.079)	0.048	0.169 (p=0.175)	0.028
	2009	0.025 (p=0.844)	0.0006	0.073 (p=0.558)	0.005
	2014	0.171 (p=0.171)	0.029	-0.069 (p=0.580)	0.005
Slovakia		R	R^2	R	R^2
Average monthly wage	2004	-0.480 (p=0.229)	0.230	-0.507 (p=0.200)	0.257
	2009	-0.508 (p=0.200)	0.258	-0.532 (p=0.175)	0.283
	2014	-0.537 (p=0.170)	0.288	-0.557 (p=0.151)	0.310
Unemployment rate	2004	0.824 (p=0.012)	0.679	0.798 (p=0.018)	0.637
	2009	0.877 (p=0.004)	0.768	0.856 (p=0.007)	0.733
	2014	0.905 (p=0.002)	0.819	0.900 (p=0.003)	0.792

Explanation: If the model is not suitable for use, it is marked in a lighter colour. The "p" values are rounded to the third decimal place.
Source: Author's calculations

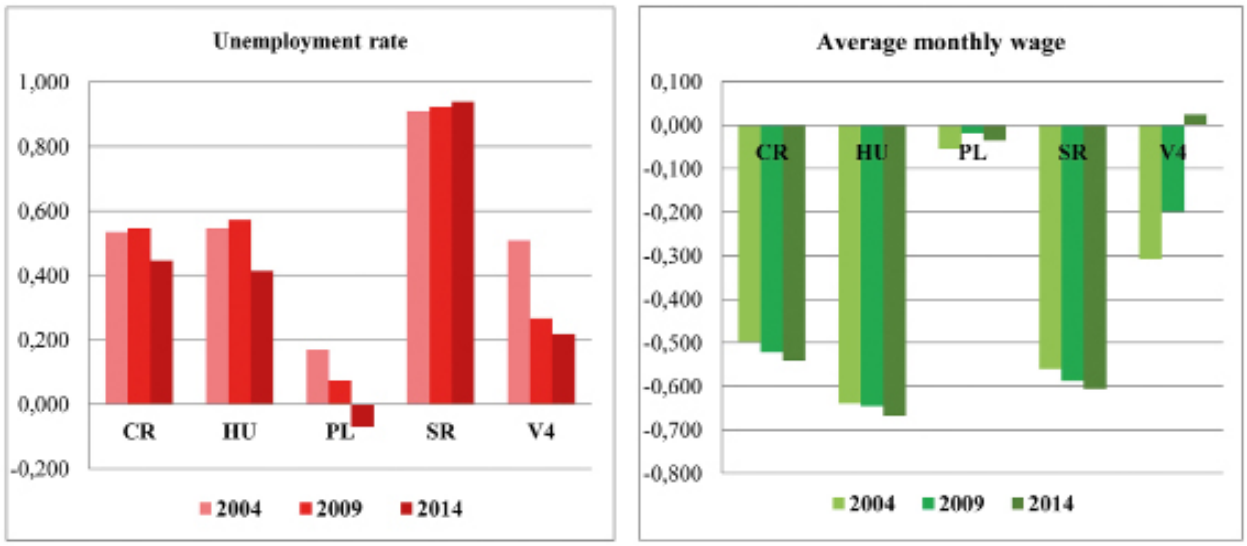

Fig. 3. Pearson correlation coefficient at supranational (V4) and national (CR, HU, PL, SR) levels within metropolitan gradient in the years 2004, 2009, 2014
Explanation: CR - Czech Republic, HU - Hungary, PL - Poland, SR - Slovakia, V4 - countries of V4 together
Source: Author's calculations

The first evaluated country is **Slovakia** which is, among all investigated countries, the smallest by area and number of inhabitants. The specificity of the country is the eccentric location of the capital city Bratislava in the south-west, near the borders with Austria and Hungary. It is the main economic centre of the country and other economically prosperous regions of western Slovakia are joined to it. Their opposite pole is the less developed south and south-east of the country. This fact affected the important and at the same time strengthening West–East gradient by means of R, which obtained a strong positive dependence of the unemployment rate (Table 6, Fig. 2). It is possible to explain 68–82% of changes in unemployment rate by means of distance. The rest depend on other influences.

R indicated a medium strong negative dependence at the level of between -0.480 and -0.537 in the average month salary, but from the point of view of appropriateness the selected linear regressive model was unsuitable. This situation was significantly influenced by the highest salaries in the Bratislava district and the second highest in the Košice district (influence of the second largest city in the country—Košice) situated in the eastern part of the country. Their location significantly distorts the level of dependence of salary on the distance from the meridian. If the Bratislava district was excluded (it did not belong to the 95% confidence interval) from the statistical set, the level of salaries in the Košice district would distort the data to such a degree that the regressive straight line would be almost parallel with axis x. If the Košice district was excluded, the correlation would be very high, R would be at the level -0.907 (year 2004) and the appropriateness of the model would be high (p-value is 0.013). It is obvious that the rather high value of R (in spite of the inappropriateness of the model) of the average month salary is determined by very strong linear regressive dependence of other districts in Slovakia.

The East–West gradient is significantly strengthened by the Bratislava metropolitan gradient. Values of R, giving signals of strong positive dependence in unemployment rate (Table 6, Fig. 3), where R^2 recorded the very highest values within V4 countries, point to the growth of polarization and the importance of the metropolitan gradient, which is at a level comparable to the West–East gradient.

Concerning salary, as with the West–East gradient, R presented medium-strong negative dependence (Table 6). In spite of this, however, the selected linear regressive model was not appropriate. The evaluation was considerably distorted by the high level of salaries in the Bratislava district and the Košice district located in the eastern part of the country.

The above-mentioned context shows that, within Slovakia, the West–East gradient as well as the

metropolitan gradient act in the same direction, they are strengthened by each other and since 2004 their power has been continuously rising, and thus strengthening the spatial polarity of the country.

According to available data, spatial polarity is paradoxically also increased by the allocation of financial resources from the Structural Funds (Fig. 4), because their largest volume was directed to the most developed regions in the country – the Bratislava (€ 1.87 bn), Žilina (€ 1.77 bn) and Trenčín Region (€ 1.70 bn), even though the country average was only € 1.39 bn per region. The least developed region, namely the Prešov Region, received only € 1.44 bn, the Banská Bystrica Region got € 1.46 bn and the Košice Region € 1.29 bn. However, the amounts per capita were lower in the Prešov Region by € 315 and in the Košice Region by € 450 than the Slovak average (€ 2067). Only in the Banská Bystrica Region was it higher by € 157. Considering these facts, it is evident that in Slovakia fewer financial resources were allocated from the Structural Funds to less developed regions in the south-east part of the country than would be suitable considering their economic situation.

The dominant position of the capital city and its neighbouring regions in the settlement systems became evident in the evaluation of the importance of both gradients in the **Czech Republic** and **Hungary**. In spite of the western position of Prague compared to the more centrally situated Budapest, a stronger West–East gradient (Fig. 2) was recorded within the territory of Hungary. The low values of R in the Czech Republic (Table 6) at the level of weak negative dependence concerning salary and also weak positive dependence concerning unemployment led to the linear regressive model being inappropriate. Prague considerably distorted the linear regressive model in terms of salary but, simultaneously, shifted the West–East gradient to higher values. If it was excluded from the statistical set, the dependence expressed by R would decrease even more and the appropriateness of the model would decline (the gradient of the regressive straight line would be smaller).

In other regional units the difference in salary was small (in 2004 only € 53, in 2014 only € 133), which was confirmed by Gini coefficient as well as variation coefficient, which was the lowest one among all the countries (Table 5). It would be possible to make a similar analysis concerning unemployment, but it would confirm the fact that the West–East gradient is weak in the Czech Republic.

Concerning Hungary, the stronger West–East gradient was more distinct in terms of the unemployment rate, where R pointed at medium strong positive dependence, whereby its changes were dependent on the change of distance for 29-38%. Concerning average month salary, where R indicated only a weak negative dependence as with the Czech Republic, the linear regressive model was not appropriate. The reason can be seen in the existence of three regions (NUTS 3 – Budapest, Fejér and Somogy) with the largest residual variation. If they were excluded from the statistical set, the linear regressive model would be appropriate and the West–East gradient would also be confirmed. Budapest can be understood as a far distant value whose geographical position does not support the hypothesis about the West–East gradient; Fejér confirms it more than Budapest, but in comparison with other NUTS 3, there was a high salary level there, which causes a substantial residual variation from the regressive straight line. Somogy, with the lowest average month salary in the south-west part of the country, also considerably weakened the West–East gradient.

The importance of Prague and Budapest as the capital cities in the settlement systems of the Czech Republic and Hungary became evident within the metropolitan gradient (Fig. 3), which was stronger in both countries in comparison with the West–East gradient (Table 6). The linear regressive model expressing this dependence was in some years evaluated as inappropriate, but with minimum values (with the exception of 2014 concerning unemployment in the Czech Republic) which were caused by variations in salary or unemployment in the given year. The result of R^2 development showed that variability in salaries resulted from the change of distance more considerably in the case of the metropolitan than the West–East gradient.

The globally identified West–East gradient recorded mostly stagnant polarization in both countries. Mostly increasing polarization was recorded within the metropolitan gradient, whereby salary shows a continual growth over the whole period, and unemployment shows decline only in the period 2009-2014. It applies for both countries that the

central position of their capital cities breaks the influence of the West–East gradient by means of the stronger metropolitan gradient and their synergy is eliminated to a large extent in comparison with Slovakia. As regards Hungary, in spite of a slightly stronger influence of the western-eastern gradient (compared to the Czech Republic) and in accordance with Nováček (2014), the forming features of the northern-southern gradient as a result of Budapest influence can be identified.

Spatial polarity between the developed regions in the Czech Republic and Hungary is to a certain extent eliminated by the Structural Funds resources (in Fig. 4 the maps show the 4 poorest regions in terms of unemployment rate and average monthly wages in the Czech Republic and the poorest 5 in Hungary). The majority of funds went to the eastern part of Hungary where the economically weakest regions are located, such as Szabolcs-Szatmár-Bereg, Borsod-Abaúj-Zemplén, Békés, Jász-Nagykun-Szolnok and Hajdú-Bihár (up to € 8.32 bn was allocated in total, i.e. 30.3% of the funds for Hungary). The resources allocated for the regions were also high when calculated per capita (on average up to € 3440 compared to € 3014 for the whole country). What also reflects the relatively fair distribution of financial resources in Hungary is the fact that another region in the eastern part, Csongrád, received the second biggest amount (€ 2.20 bn) after Budapest and per capita it was easily the highest amount (as much as € 5438). Exceptions to this were the under-developed regions of Nógrád in the north and Somogy in the south-west, which were disadvantaged when compared to other under-developed regions in terms of the total amount of money allocated (Nógrád – € 0.39 bn, Somogy – € 0.93 bn) and in the case of Nógrád case also in terms of per capita (€ 2009).

Also in the Czech Republic the economically weaker regions are situated in the east of the country (the Moravskoslezský, Zlínský and Olomoucký Region and partially also the Jihomoravský Region from the point of unemployment rate). These regions (especially the Moravskoslezský and the Jihomoravský Region) got the largest proportions of Structural Funds (in total as much as € 8.44 bn, i.e. 37.2% of all funds for the Czech Republic), while per capita they also got € 162 more than the country average (€ 2182). It is important to stress that a large amount of money went to the developed Středočeský Region, € 3.13 bn, which was significantly more than the country average (€ 1.62 bn). At the same time, a significant amount of money was also allocated to the Jihočeský Region (€ 1.73 bn) especially in terms of per capita (€ 2722).Two regions in the western part of the country (the Ústecký Region – with the highest unemployment rate) and the Karlovarský Region (with the lowest average monthly wages) serve as outliers. Despite the smallest amount of € 0.89 bn going to the Karlovarský Region, it was actually € 2974 per capita due to the low number of inhabitants. In the case of Ústecký Region, it was only € 1669 per capita.

Poland as the fourth country of V4 has, in comparison with the other three countries, more distinctive differences which considerably affect the existence and power of both gradients. Primarily, it is a relatively large country in the European context. In comparison with other monitored countries, it is from 3.4 up to 6.4 times larger by area and 3.7 to 7.1 times larger by number of inhabitants. The country's second special feature is the polycentric character of its settlement system with several metropolitan cities (Warsaw as the capital city – 1.745.000 inhabitants, Cracow – 761.000, Łódź – 706.000, Wrocław – 634.000, Poznań – 545.000, triple-city Gdańsk-Sopot-Gdynia – 746.000). The polycentric character of Poland's settlement combined with its dimension makes it impossible to develop the West–East gradient as well as the metropolitan gradient of the capital city (Table 6). The West–East gradient was very weak in both coefficients (Fig. 2), and R points to this fact by means of an only weak linear dependence up to independence. A similar situation was also found in the metropolitan gradient (Fig. 3), where the capital city Warsaw does not occupy, with regard to other centres of the country, such a dominant position as the capitals do in the other three countries. That is why low R values in both indicators within both gradients determined the inappropriateness of the linear regressive model.

On the basis of these facts, it is evident, that with respect to Poland, it is not possible to speak about the application of the West–East nor the national metropolitan gradient. With regard to the polycentric character of the settlement system, the regional

metropolitan gradient (by Lang classification, 2015: 172) would probably play a major role.

The size of country and its polycentric character of settlement also influenced the allocation of financial resources from the Structural Funds (Fig. 4, on the maps are the 15 poorest regions in Poland selected according to unemployment rate and average monthly wages). As much as € 60.47 bn was allocated to Poland, which is the same amount as to the other three countries in total, but per capita it was only € 1507 (in Hungary – € 3014, in the Czech Republic – € 2182, in Slovakia – € 2067) and on average it was only € 0.92 bn per region. The maps attached (Fig. 4) show that the least developed regions also received less money in total as well as per capita. The regions in the north of the country, Elbląski (€ 1.26 bn, € 2392 per capita) and Olsztyński (€ 1.33 bn, € 2140 per capita), Sieradzki (€ 1.02 bn, € 2249 per capita) in the central part and Tarnowski (€ 0.94 bn, € 2034 per capita) in the south-east were excluded. Conversely , the largest amounts were received by big economic centres, both in absolute terms and more surprising, perhaps, per capita – Warsaw (€ 6.30 bn, € 3632 per capita), Wroclaw (€ 2.30 bn, € 3630 per capita), Trójmiejski (€ 2.43 bn, € 3249 per capita) and Poznań (€ 1.32 bn, € 2410 per capita). Amongst the highest placed were also the Rzeszowski Region (22nd place in average monthly wages, 35th place in unemployment rate), which got as much as € 2.12 bn and € 3357 per capita and the Lubelski Region (13th place, 19th place) with € 1.75 bn and € 2453 per capita situated in the south-eastern part of the country. Considering the amount per capita, a relatively large amount of money was also received by the Gliwicki Region (€ 2864), which is one of developed regions in Silesia in the south of Poland.

When comparing allocated resources, we can see that in total 21.9% of the Structural Funds went to the WEST regions and a little more, 27.7%, to the EAST regions. The discovery that as much as 32.9% was allocated to more developed METROPOLITAN regions and only 18.8% to PERIPHERAL regions is indeed problematic. In this case, the financial resources from the Structural Funds do not contribute to elimination of regional disparities occurrence, but rather to strengthening metropolitan regions and their position towards periphery.

4. Conclusions

The analysis showed that at the supranational scale of the research, a growth, polarized in character, in regional disparities was recorded during the monitored period. Hypothesis **(1)** was thus confirmed. To compare marginal groups of regions, it is shown that the tendency for reducing intragroup inequality became more evident in more developed poles (METROPOLITAN, WEST). The increasing role of the West–East gradient and declining role of the national metropolitan gradient in the dynamics of spatial polarity of economic development within this scale of research after the entry of V4 countries into the European Union have been found out and thus hypotheses **(2)** and **(3)** have been confirmed. This tendency confirms theoretical assumptions formulated by Smith (1993).

On the national level, the development of regional disparities was more complicated. Their overall increase was monitored in Hungary and Poland (in case of unemployment) while a decrease in Slovakia and the Czech Republic was observed. In general, mostly increase of national polarisation was recorded during the first part of the monitored period (2004–2009). Hypothesis **(4)** was thus only partially confirmed. The analysis has not yet confirmed the scale shift of polarity by the West–East gradient at this level since the accession of V4 countries to the European Union. The signals found out in unemployment rate in the Czech Republic and Hungary are not considered to be sufficiently convincing. Hypothesis **(6)** was thus confirmed only partially. Conversely, the national metropolitan gradient exceeded the West–East gradient in the Czech Republic, Hungary and equalled it in the case of Slovakia. That is why hypothesis **(5)** is considered confirmed in the mentioned countries. The question is if one decade of the V4 countries existence in the EU has been sufficient for making these changes of the major role of spatial-organizational principles evident.

Slovakia is the only analysed country where the West–East gradient has been clearly established and this results from the strengthening by the national metropolitan gradient conditioned by the geographical location of Bratislava. Poland represents a special unit where none of the considered gradients has become evident. This is probably conditioned by the

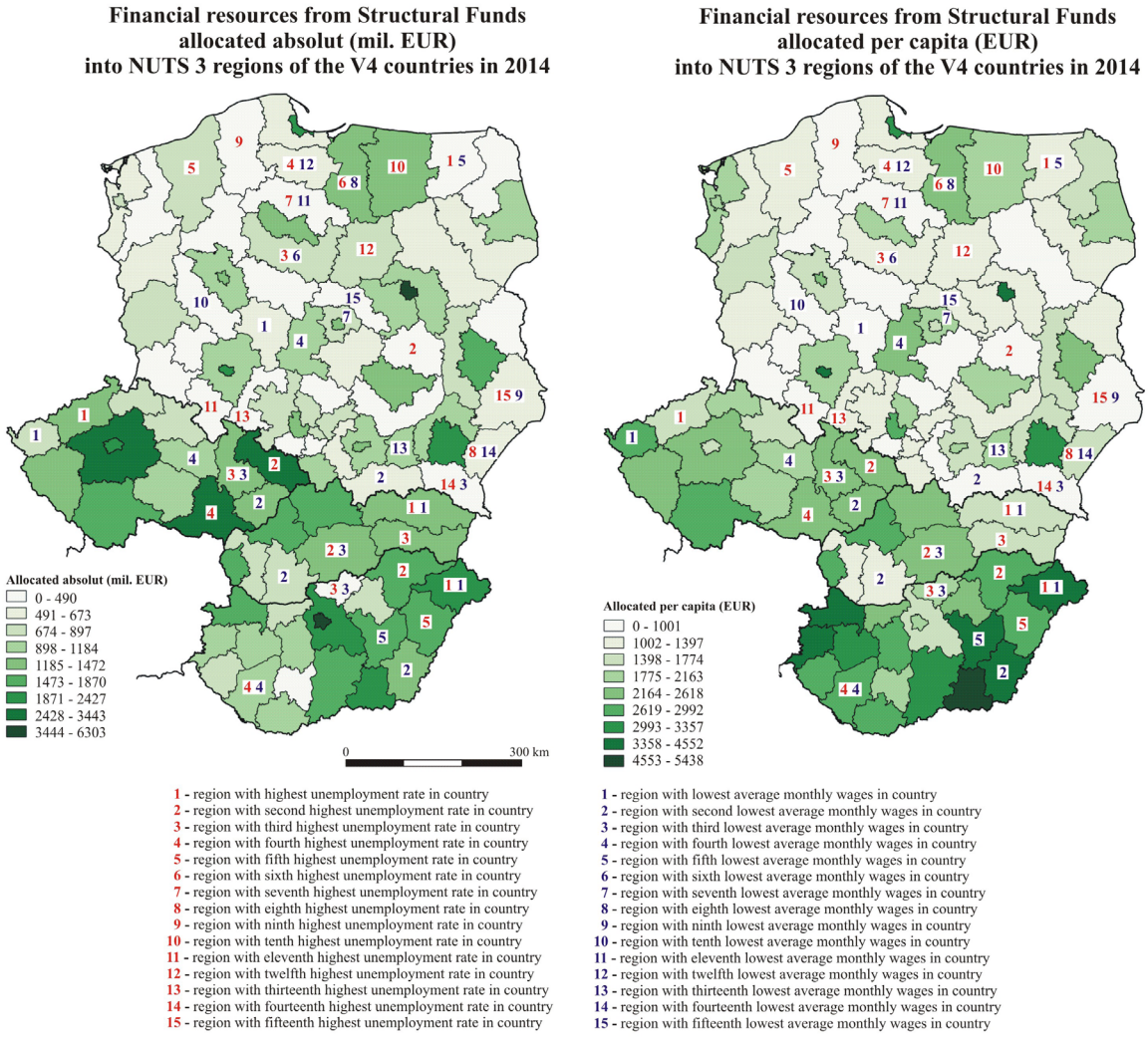

Fig. 4. Financial resources from Structural Funds allocated to NUTS 3 regions of the V4 countries (2014).
Source: Eurostat, 2018: Database of the cumulative allocations to selected projects and expenditure at NUTS 3 level broken down by the 86 priorities. http://ec.europa.eu/regional_policy/en/policy/evaluations/data-for-research/, Author's calculations

polycentric character of its settlement system, which makes assumptions for application of the regional metropolitan gradient. Hypothesis **(7)** has thus been confirmed.

Note

(1) For example, Ľudová strana Naše Slovensko (Kotleba) saw more robust support in less developed regions in the south of central Slovakia (area of Gemer and Horehronie) and the upper Spiš region of eastern Slovakia in the elections held in 2010-2016. In the parliamentary election of 2016, this support was extended to other regions of western, central and eastern Slovakia (Záhorie, Hont, Orava, Kysuce, southern Abov). It turns out that it was due to support from frustrated voters who were dissatisfied with the policy of the traditional political parties (Mikuš et al., 2016). The unexpected results of the Brexit referendum and the United States presidential election have also been attributed to a frustrated electorate.

(2) This is the concept of the "European back", also known as the European megalopolis that was

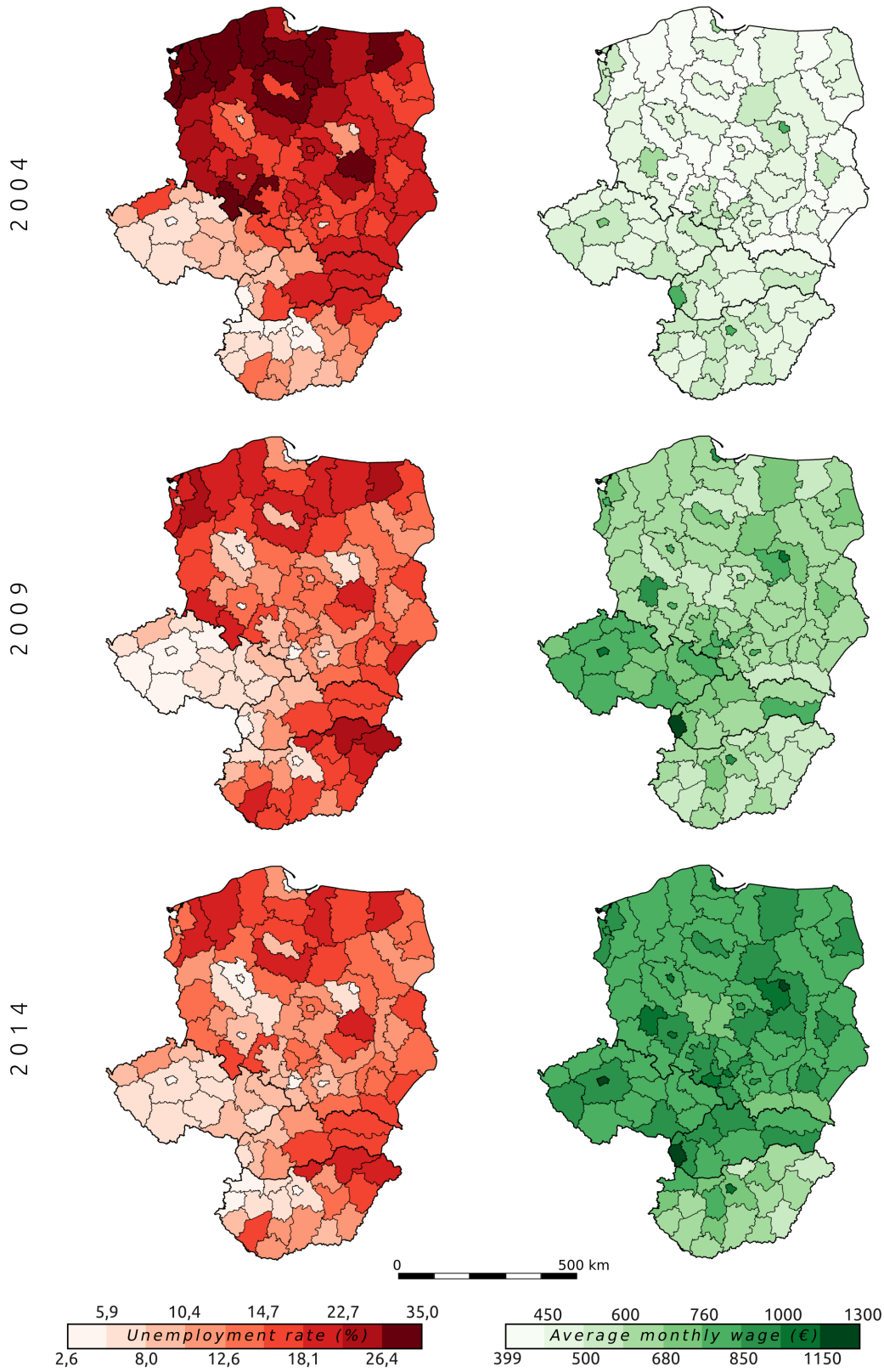

Fig. 5. Unemployment rate and average monthly wage in NUTS 3 regions in V4 countries in the years 2004, 2009, 2014
Source: Author's calculations

developed by a group of French geographers managed by Roger Brunet (1973, 1989 in Brunet, 2011). Blue Banana is an expression that journalists use to refer to this concept (Brunet, 2011: 309).

(3) M. Małowist (1973) argued on the basis of his analysis of grain trade that the dependence of Eastern Europe on Western Europe was increasing. By the same token, the polarization between them had been growing since the 14th century. I. Wallerstein, author of the theory of the world system I., also cited Małowist´s ideas (Holubec, 2009: 21).

(4) The indicator of regional GDP per capita was not used in the evaluation of spatial polarity considering certain difficulties in its use in a spatial context as pointed out by Lapišáková (2002), Buček et al. (2010) and Matlovič and Matlovičová (2011). An important issue is the effect of commuting to work. It means that there are a lot of employees contributing to the regional GDP who commute from other regions. It is known that they spend their income predominantly in their place of residence. In this way, the regional GDP per capita is statistically overrated in the targeted region with high rates of commuting for work and is statistically underrated in the starting region, from which people commute to other regions for work (Lapišáková, 2002). Another problem is related to the regions with a high share of foreign investments where GDP includes generated profit which is subsequently repatriated to the country of a particular owner, which again results in overrating of a regional GDP (Buček et al., 2010). Average wage is considered to be an appropriate indicator reflecting the qualitative selection, more precisely the concentration of the organisational power conditioned by the localization of management and innovative activities (Hampl, Marada, 2016: 568). It is closely related to wage differentiation with a strong presence of economic activities with higher added value. This allows us to deal with possible differences between regions with a similar unemployment rate, but which are qualitatively different in terms of the economic structure of various branches.

(5) Unemployment rate as a share of the available number of jobseekers and the total economically active population expressed as a percentage.

(6) https://www.czso.cz/csu/czso/krajske-rocenky#10a; DoA: 16 January 2017 http://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_qli049b.html; DoA: 25 January 2017 https://bdl.stat.gov.pl/BDL/dane/tablica; DoA: 06 February 2017 http://datacube.statistics.sk/TM1WebSK/TM1WebLogin.aspx; DoA: 09 December 2016

(7) http://widukind.cepremap.org/views/explorer/dataset/eurostat-ert-bil-eur-a; DoA: 15 February 2017

(8) http://portal.mpsv.cz/sz/stat/nz/casove_rady; DoA: 20 January 2017 https://portal.mpsv.cz/sz/stat/nz/zmena_metodiky; DoA: 20 January 2017 http://nfsz.munka.hu/engine.aspx?page=stat_afsz_nyilvtartasok; DoA: 27 January 2017 https://bdl.stat.gov.pl/BDLS/dane/podgrup/wymiary; DoA: 08 February 2017 http://www.upsvar.sk/statistiky/nezamestnanost-mesacne-statistiky.html?page_id=1254; DoA: 12 December 2016

(9) Novotný et al. (2014).

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