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Evaluation of the Urban Regions of Serbia – Functional Polycentricity

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Abstract

The subject of this paper is an evaluation of defined urban regions in Serbia, with an aim towards identifying their basic features, with special emphasis on the measurement of their functional polycentricity. These features include methods with following indicators: share of settled inhabitants to overall population number in the centre of urban region and surrounding area, according to the outcome; concentration level of employees in centres and structure of activities of active population performing an occupation, functional dependence of settlements in the area of the region and determining the functional polycentricity index of the urban region. Therefore, the goal of the paper is to clarify the difference between the urban regions that have developed in the area of Serbia, which are significant factors for further planning of polycentric and balanced regional development. The results of the survey show differences between urban regions. Almost half of the urban regions in Serbia have characteristics of monocentricity, while few polycentric urban regions differ in number of secondary centers. Certain differences between urban regions refer to the results related to share of the employees in primary centres in connection with the secondary centre region, if refers to a polycentric region, or in comparison to the region as a whole, if it implys to monocentric urban regions. All in all, primary differences between urban regions pertain to the degree of functional polycentrism.

Keywords: Urban region; characteristics; functional polycentricity index; functional dependence of settlements

Introduction

After the development of a model for distinguishing a set of centres for which the city regions will be defined (these are urban settlements with more than 50,000 inhabitants and more than 15,000 employees[1]), a model for identifying settlements belonging to the urban region has been formed (Živanović & Tošić, 2017). The results of application of these models shows that in the 16 defined urban regions, with 3,243,546 inhabitants, which is 45% of the total national population. This points to the conclusion that the number of urban regions in the territory of Serbia is small, of relatively small spatial coverage and lower demographic concentrations. Nevertheless, the examination of the basic features of urban regions shows that there are serious differences among them.

In this context, the subject of this paper has been selected, which is, therefore, the evaluation of defined

[1] An explanation of such choice of indicators is given in the paper by Živanović & Tošić, 2017. The hierarchy of the Urban system of Serbia is characterized by disproportionality, incoherence and asymmetry, emphasized by the pronounced urban primacy of Belgrade (Ip = 5.03), as well as the small number of large cities, and supplemented by the absence of urban settlements populated with 200.000 to 1,000,000 inhabitants, macro-regional functions, which would be the bearers of Serbia's internal balanced development. For a general overview of the evolution of the urban system in Serbia, see Živanovic Z., et al., 2019.

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urban regions with the aim of identifying their basic features, with a special emphasis on measuring their functional polycentricity.

Providing this type of input will facilitate the planning process and allow the direction of development and ultimately the achievement of a clearly proclaimed national goal for balanced regional development. The basic measure for achieving that goal is a polycentric urban system. Although achieving polycentricity at the national level is considered a significant measure in the process of overcoming uneven regional development, the research of the importance of primary and secondary centres of urban regions, on meso and micro level, also contributes to achieving the hierarchy of the overall polycentric urban system on the national territory. The application of methods for defining the degree of polycentricity of urban regions will contribute to quality and facilitate planning of the future territorial organization of national urban regions on one hand, and will be an instrument for enhancing regional development on the other.

In connection with this goal, we believe that the contribution of this paper is to point out to the various forms of existence and functioning of urban regions, as an important factor of further planning, as well as to assess the developmental significance of the primary center of the urban region. In addition, the (non)existence of secondary centers in some urban regions has been identified. For the purpose of their formation, i.e. affirmation of the existing ones, it is necessary to take appropriate planning measures, which will contribute to decentralization, overall regional development and reducing regional imbalances.

Creating methods for measuring polycentricity in urban regions, or defining functional polycentricity indexes, is an additional contribution to the international debate on urban regions/polycentric development.

The state of previous research

The urban region is a spatial-functional system composed of one or more centres of different degrees of centrality and hierarchy through which the flow of population, capital and information between centres and settlements in their gravitational environment is carried out. The concept of city-region is actually very old and dates back to the work of 19th century.

In the most recent period, the basic features of urban regions are subject of numerous scientific papers (Etherington & Jones, 2016, 2017; Hennig, 2018; Lawton, 2018; Rus et al., 2018), since the city for a long time is not the subject of research without an surrounding area that gravitates to it (Andreasen et al., 2017; Yankson et al., 2017). In the last decades, in professional circles dealing with this issue, the focus of interest is shifting from the city to the city-region as the primary unit of analysis (Davoudi, 2008; Parr, 2005, 2008; Nielsen, 2015; Agergaard & Ortenbjerg, 2017; Vasárus et al., 2018; Kristóf, 2018).

In former Yugoslavia, first attempt of determining zones of impact of the city is recorded by Bohinec (1926), exploring the gravitational area of Ljubljana. One of the greatest contributions to the study of urban regions was made by Vresk (2002) who was continuously been involved in the analysis of the relationship between cities and their environment already since the 1970s.

A number of geographers (Bukurov, 1980; Djurić, 1970; Ilić, 1970; Milojević, 1956; Savić, 1958; etc.) was dealing with development of the concept of nodal regions and forms of their spatial-temporal expression of the region of Serbia as well, such as Perišić (1985), Veljković et al. (1995) and later other authors were dealing with its reviewing and planning. Theoretical methodological settings of these issues are given in the works of Tošić (2000). The concept of the implementation of functional urban areas aims to increase territorial cohesion in the region, based on the principles of noddlity and sustainable development (Živanović, 2017).

Access to the issue of urban planning research has been changed in accordance with the actual laws in the area. Primarily, it refers to population changes in accordance with the dominance of developmental activities, on communications and interactions in space. The second half of the 20th century is a key period of more intensive introduction of quantitative methods in the analysis of urban regions. Quantitative methods primarily relate to the degree and processes of concentration of the population and employees, the functional structure of the centre and the periphery, settled population and daily migrations-which are the most relevant indicator for distinguishing the urban regions (Gajić et al., 2018).

In recent years, however, increasing attention has been paid to measuring polycentricity of urban regions. According to Faludi (2005), there is a universal agreement that polycentrism, as the existence of several centres at both national and regional levels, is more likely to result in what is usually described as "territorial cohesion". Research in this field exist as well, but the estimates show that such e.g., among the EU Member States, there is no harmonized interpretation or understanding of the concept of polycentricity

(Waterhout, 2002). Nevertheless, in the contemporary literature on urban systems, functional polycentricity is considered to be one of the basic analytical concepts. Functional polycentrism refers to the establishment of functional relationships (intensity, direction, duration, territorial reach and character) between the centres of the urban region. According to some authors (Kloosterman & Lambregts, 2001) a system is polycentric when its economic structure is characterized by specialization in urban areas, leading to economic complementarities between cities. Except economy, service activities, as well, can be subject to consideration characteristic of complementarity centres. The other functional aspect is the interaction among centres. Cities are physically interconnected by infrastructures and by flows of commuters, trade or information: these interrelationships would be characterized by higher intensity in polycentric regions, compared to monocentric. In monocentric regions, the strongest gravity links are definitely to the centre (Sat, 2018). And research referring to polycentricity relate to analysis of its characteristics on one hand, and its measurement by certain quantitative methods on the other. Different authors developed various methods for measuring region polycentricity. Limtanakool et al., (2009) measured functional polycentricity by calculating The Entropy Index (EI) on the case of the Netherlands. Grunfelder et al., (2015) compares indicators of polycentricity in a monocentric and a polycentric urban region in Denmark. Burger et al., (2009) designed methodology for measuring functional and morphological polycentricity, which is applied on the example of England and Wels. Spatial and general functional polycentricity is also measured by Green (2007). So far, functional polycentricity has not been quantitatively expressed in Serbia.

Research methodology

The paper on which we are complementing already gave the number of settlements belonging to each urban region, the number of inhabitants living in them, the degree of centralization of urban regions, etc. The methods of this research will refer to:

1. urban regions as areas of concentration of the population, or as an immigration region by pointing to a share of immigrants from the total number of residents in the centre of urban region, as well as in other areas that belong to the region, the aggregate of, that is, in a surrounding area (hereinafter referred to as surrounding area);
2. ratio of concentration of employees in centres of urban regions, as well as the share of concentration of employees in the primary with respect to the other, the secondary centres[2]2 of the region, as well as to the region as a whole;
3. structure of activities of active population performing an occupation in the area of urban regions, which was assayed by monitoring the share of employees by sectors in the centre of urban region in relation to the surrounding area;
4. functional dependence of settlements in the area of urban regions of Serbia, which is defined on the basis of the model presented in Table 1;
5. Although a functional polycentricity can be measured by various methods, and mostly by analysis of structure of activities in centres in the region and establishing possible existence of complementarity among them, as well as examining the intensity of daily migration between centres in the region, for the area in Serbia, we consider that the most suitable is the following method for establishing functional polycentricity index:

Table 1. A model for defining the share of the functional dependence of the settlement

Ratio of functional dependence of settlements	Daily emigrants' share (in %)	Share of employees in secondary and tertiary-quaternary sector in the dwelling (in %)
Functional independent settlement	< 20	> 50
Partially dependent settlement	> 20	> 25
A completely dependent settlement	> 50	< 25

Source: Authors' estimates

$$IP = n - \sum_{i=1}^{n} (1 - L_i)$$

- IP = functional polycentricity index of the urban region
- n = total Number of centres (regional-primary centre and secondary centres) in the urban region

[2] Secondary centres were considered all other urban settlements, with the exception of primary centres, in the area of defined urban areas of Serbia, except for the City of Belgrade, where only municipal centres are considered as secondary centres.

$L = C/(D/n)$ ratio of the number of employees in each centre in relation to the average number of employees in the centres of the region

- C = number of employees in each centre of the urban region
- D/n = average number of employees per centre of the urban region

Urban regions that have only one city settlement on its territory are monocentric. An absolute monocentric region would have value $IP = 0$ in case that all employees work in the primary centre. Regions in which there are employees that work outside of the primary centre (in other settlements that are not secondary centres of the region), are also monocentric, but with the value of the IP from 0 to 1. A region with two or more centres has an IP greater than 1. If the IP value is greater, the region has more centres, or the region is more polycentric.

Assessment of the characteristics of the urban regions of Serbia

Urban regions of Serbia as immigration areas

Number of immigrants, in principle, decreases according to the size of the centre of the urban region. Although the absolute number of immigrants is very different, the share of immigrants in the total number of inhabitants, both in centres and in their surrounding areas, is fairly uniform in all urban regions, i.e. it is in line with the existing total number of inhabitants (Table 2).

There are several times more inhabitants settled in the centres than in their surrounding area (Valjevo, Kragujevac, Subotica, Zrenjanin, Čačak, Vranje,

Table 2. The share of the settled population in the urban region in 2011

Centre of the urban region	Number of immigrants in 2011	Share of immigrants in the total population number (%)	Share of immigrants in total number of immigrants (%)			
			from the area of the same municipality	from the same area	from another area	from abroad
Belgrade	591,614	50.71	0.12	4.95	57.79	37.07
the surrounding area	259,417	57.37	8.82	25.65	40.84	24.64
Novi Sad	136,925	59.07	2.92	17.36	46.01	33.69
the surrounding area	103,836	58.71	15.60	23.99	19.03	41.33
Niš	88,844	48.51	2.92	25.10	59.79	12.15
the surrounding area	50,967	46.73	18.91	41.47	34.60	4.98
Kragujevac	67,080	44.47	6.62	14.02	67.20	12.04
the surrounding area	6,760	50.59	32.43	11.69	48.33	7.51
Subotica	39,203	40.04	18.17	5.42	47.16	29.21
the surrounding area	6,218	58.14	50.10	2.77	22.76	24.38
Zrenjanin	34,309	44.84	20.48	28.21	28.96	22.33
the surrounding area	4,772	46.43	35.08	8.70	19.53	36.67
Pančevo	37,742	49.53	12.07	17.55	42.44	27.91
the surrounding area	17,957	43.73	22.68	6.33	32.39	38.58
Čačak	32,935	44.91	17.55	27.16	39.86	15.40
the surrounding area	5,334	50.45	36.56	21.95	29.53	11.90
Smederevo	6,615	52.26	53.24	6.28	68.84	14.77
the surrounding area	9,502	46.83	30.53	3.38	55.89	10.17
Kraljevo	32,336	50.39	18.95	12.03	55.16	13.83
the surrounding area	17,309	52.51	34.80	10.95	44.64	9.60
Leskovac	22,051	36.58	27.82	28.77	33.68	9.68
the surrounding area	30,086	46.88	10.09	22.25	21.38	3.07
Valjevo	25,230	42.81	30.87	23.08	31.27	14.78
the surrounding area	1,702	47.24	59.69	13.51	20.51	6.29
Kruševac	27,174	46.26	19.25	22.62	47.12	10.98
the surrounding area	18,212	42.46	40.22	17.09	36.18	6.51

Centre of the urban region	Number of immigrants in 2011	Share of immigrants in the total population number (%)	Share of immigrants in total number of immigrants (%)			
			from the area of the same municipality	from the same area	from another area	from abroad
Vranje	29,881	40.41	33.29	40.47	17.97	8.25
the surrounding area	9,736	42.39	47.06	36.72	10.68	5.48
Šabac	25,050	46.46	25.87	32.67	23.46	17.95
the surrounding area	12,340	59.27	34.43	29.77	14.98	20.75
Užice	21,822	41.45	24.15	45.32	17.38	13.11
the surrounding area	5,545	50.51	51.54	27.16	11.09	10.21

Source: Statistical Office of the Republic of Serbia (SORS), 2013d

Užice), but there are two examples of urban regions with more settled in the surrounding area than in the centre (Leskovac and Smederevo).

Most of them are settled in the regions from other areas, especially in the case of regions with large centres, but there is a significant share of settled from the area of the same municipality (Smederevo and the surrounding areas of centres of Subotica, Valjevo Kruševac, Užice and Vranje), as well as from the same area (Vranje, Užice and the surrounding area of Niš). The larger share of immigrants from abroad is in the case of larger centres and their surrounding areas, i.e. in urban regions of Vojvodina Province (in northern part of Serbia).

The degree of employees concentration

The degree of employees concentration in urban regions is very different and is within the range from 60% to 95% (Table 3). The lowest value of this indicator is related to the city of Novi Sad, which, with 8 secondary centres in the area of the region, has all predisposition for considerable polycentricity. Belgrade and Niš, though both with 4 secondary centres, have different values of concentration level of employees, due to a huge absolute number of employees in the centre of the region. Consequently, in case of Belgrade, concentration level of employees is high, as much as 74%. In case of Niš the value of that indicator does not exceed 70%, as well as in case of centres of urban regions

Table 3. The degree of employees concentration in the primary centre, 2011

Centre of the urban region	Number of employees in the centre of the urban region	Number of employees in the surrounding area	The degree of employees concentration in the centre of the urban region	Number of secondary centres in the urban region	Primacy Index of urban regions*
Beograd	428,353	149,839	74.08	4	21.23
Novi Sad	86,534	53,177	61.94	8	3.03
Niš	57,764	25,761	69.16	4	25.38
Kragujevac	46,618	3,040	93.88	0	—
Subotica	31,674	2,939	91.51	1	14.61
Zrenjanin	24,306	2,602	90.33	0	—
Pančevo	24,942	10,255	70.86	2	6.27
Čačak	23,798	2,795	89.49	0	—
Smederevo	18,886	4,235	81.68	0	—
Kraljevo	19,453	8,443	69.73	2	17.12
Leskovac	15,951	2,683	85.60	0	—
Valjevo	20,205	1,024	95.18	0	—
Kruševac	17,102	9,704	63.80	1	13.35
Vranje	17,125	5,443	75.88	1	15.67
Šabac	17,344	5,724	75.19	0	—
Užice	18,361	3,425	84.28	1	8.17

Source: Statistical Office of the Republic of Serbia (SORS), 2011
** Number of employees in the centre of the region refers to the number of employees in all secondary centres.*

in whose areas are two secondary centres (Kraljevo and Pančevo).

Other urban regions are characterized by a concentration level of employment in regional centres from 75% to as much as 95%. The regions that besides the regional centre do not have urban settlements in their area are also interesting, but their concentration level of employees in the regional centre is relatively low (Šabac = 75%), or lower than some centres that have one secondary centre (in addition to Palić, the concentration level of jobs in Subotica is 91%, while, for example, in Smederevo it is by 10% lower, although neither settlement belonging to the urban region of Smederevo has no city status, i.e. they were not seen as a secondary centre). Economic objects located in cadastral municipalities of surrounding settlements may be the reason for lower concentration of employees in the primary centre of the region. Such examples bring up a question about structure of population activities which inhabit the urban region, as its centre and the surrounding area, which is subject to the analysis that follows.

The difference between regions also stems from the share of employees in the primary-regional centre in relation to the share of employees in other centres in the region. This value would be the primacy index of the regional centre within the urban region. According to the results obtained among the 16 regions of Serbia, the highest primacy index is found in Niš and Belgrade, and the lowest ones in those regions whose primary centres in their hinterland have secondary centres, which are more important centres of activity: Novi Sad, Pančevo and Užice. Urban region that do not have any secondary centre in their area have no value of primacy index (Table 3).

Structure of activity

In the structure of activity, both of the centres of urban regions and the surrounding areas of these centres, the tertiary-quaternary sector is dominant, but this dominance is far more noticeable in the centres than in the surrounding areas. In fact, the secondary sector dominates in the surrounding areas of Užice, Šabac, Vranje, Valjevo and Smederevo. It is also noticeable that in all regions the share of employees in the secondary sector in the region is higher than in the centre of the urban region (Table 4).

The structure of employees by sectors of activity of the centres of the selected regions does not fully correspond to the one that is distinguished by the very cen-

Table 4. Structure of the activities of urban regions, 2011

Centre of the urban region	The share of the active population that is occupied by sectors of activity (%)				
	I	II	III	IV	III and IV
Belgrade	0.54	17.08	40.21	42.17	82.38
the surrounding area	2.14	23.05	38.86	35.17	74.03
Novi Sad	1.16	20.39	37.43	40.65	78.08
the surrounding area	6.42	30.49	32.89	29.75	62.64
Niš	0.39	22.01	32.65	44.94	77.59
the surrounding area	5.60	33.75	28.94	31.10	60.04
Kragujevac	0.89	32.11	28.99	37.62	66.60
the surrounding area	10.82	39.24	26.90	22.55	49.45
Subotica	2.99	29.20	34.32	33.03	67.35
the surrounding area	9.39	29.08	33.87	27.21	61.07
Zrenjanin	3.02	35.20	26.83	34.58	61.41
the surrounding area	12.73	40.81	23.01	23.08	46.09
Pančevo	2.07	27.75	34.08	35.91	69.99
the surrounding area	9.50	37.95	26.15	26.10	52.25
Čačak	2.02	32.69	35.25	29.79	65.04
the surrounding area	14.85	35.07	29.49	20.32	49.80
Smederevo	1.28	40.29	26.06	31.85	57.91
the surrounding area	7.90	46.91	24.02	20.46	44.48
Kraljevo	1.36	25.10	32.24	40.93	73.17
the surrounding area	6.60	35.10	27.74	30.03	57.77
Leskovac	3.70	24.43	29.47	44.47	73.94
the surrounding area	7.96	35.10	27.96	28.64	56.60

Centre of the urban region	The share of the active population that is occupied by sectors of activity (%)				
	I	II	III	IV	III and IV
Valjevo	1.67	37.51	26.56	34.01	60.57
the surrounding area	17.28	42.44	21.06	18.81	39.87
Kruševac	1.11	30.50	27.96	40.05	68.02
the surrounding area	8.99	41.66	24.66	24.12	48.77
Vranje	1.01	37.77	22.33	38.60	60.93
the surrounding area	6.75	51.27	17.84	23.73	41.57
Šabac	1.04	28.69	32.22	37.59	69.81
the surrounding area	3.77	42.21	30.01	23.16	53.17
Užice	1.36	35.79	29.50	33.23	62.74
the surrounding area	5.18	46.72	25.46	22.61	48.08

Source: Statistical Office of the Republic of Serbia (SORS), 2011

tres of urban regions. In other words, mainly a higher representation of the primary and secondary sector in the surrounding area is compensated by the smaller representation of the tertiary-quaternary sector.

The differences in the representation of the tertiary-quaternary sector of activity in the structure of employment between surrounding areas and centres do not exceed 20%. Differences in the representation of the secondary sector of activity in the structure of employment between surrounding areas and centres do not exceed 15%. Although larger differences should be expected between the shares of both development sectors between the centre and the surrounding area, such a situation is a consequence of deagrarization and the surrounding area itself, whose population is predominantly engaged in the activities of the secondary and tertiary-quaternary sectors. Relatively large share of the primary sector, or a small share in the quaternary sector of the population in the neighborhood settlements of some centres (Valjevo, for example) came up for a number of reasons–the existence of a production facility in settlements, a small number of settlements that do not have the equipment of public service facilities, etc.

Dominance of tertiary-quaternary sectors, both in urban region and surrounding areas, is based on the largest number of employees in the following activities: retail and wholesale and repair of motorized vehicles and motorcycles (within tertiary sectors) and state administration and defence and obligatory social insurance (within the quaternary sector).

Functional dependence of settlements in urban regions

All regional centres, except Pančevo, are functionally independent settlements, according to the applied model they have less than 20% of daily emigrants in overall active population and students and more than 50% of employees in tertiary-quaternary sector in the dwelling (Table 5).

On the study areas, 33 partially dependent settlements (Table 6) are recorded (with more than 20% of the daily emigrants, and more than 25% employed in the tertiary-quaternary sector). Among them are 16 municipal centres and even a regional centre of Pančevo, which is dependent on Belgrade (with 21.88% of daily migrants, among the regional centres only Smederevo has close to 20% of daily emigrants, which is by the model margin between functionally independent and partially dependent settlements). In addition to the proximity of Belgrade, the reasons for a higher share of daily emigrants from Pančevo centre are in the fact that the workplaces, or larger industrial facilities, are located in the cadastral municipalities of neighbouring settlements. Furthermore, among the partly dependent settlements there are also those in which the share of daily migrants is very high (more than 50%), and the share of employees in the tertiary-quaternary sector in the residential area is only about a quarter. Such settlements, for example, are Sremčica and Umka.

In the total number of settlements in surrounding area regional centres functionally completely dependent settlements are absolutely dominant, from which more than half of the active are daily emigrants (in regions of Užice, Čačak, Vranje and Belgrade more than ¾ of the surrounding area has more than 70% of daily emigrants, while on the territory of Vojvodina there are no or very few numbers of settlements among surrounding area of the regional centre that have such a high percentage of daily emigrants), while in the dwelling less than a quarter of the active population performing an occupation are employed in the tertiary–quaternary sector.

Functional polycentricity index

Among 16 defined urban regions there are numerous regions with only one urban centre on their territory, centre of the region, without secondary centres. Therefore, these centres (Kragujevac, Zrenjanin,

Table 5. The share of employees in development sectors and the share of daily emigrants in settlements in urban regions, 2011

Centre of the urban region	Share of employees in secondary and tertiary sector in the dwellings in the total active population performing an occupation (%)	Share of daily migrants in total number of active population performing an occupation and students (%)
Smederevo	67.59	19.25
Kraljevo	71.22	15.65
Užice	75.34	12.29
Šabac	77.25	11.15
Čačak	78.49	11.14
Zrenjanin	84.24	10.78
Leskovac	79.89	10.48
Kruševac	79.02	9.10
Novi Sad	84.66	8.83
Valjevo	78.91	8.64
Vranje	81.26	8.28
Subotica	86.52	6.08
Kragujevac	84.14	5.54
Beograd	92.00	3.50
Niš	86.67	7.86
Pančevo	71.99	21.88

Source: Statistical Office of the Republic of Serbia (SORS), 2011

Table 6. Functional dependence of settlements in urban regions

Urban Region	Functional independent settlement	Partially dependent settlement	A completely dependent settlement
Belgrade	regional centre	5 (4 MC)	54
NoviSad	regional centre	9 (5 MC)	17
Niš	regional centre	8 (4 MC)	99
Kragujevac	regional centre		20
Subotica	regional centre		3
Zrenjanin	regional centre		3
Pančevo		2 (2 MC)	7
Čačak	regional centre		9
Smederevo	regional centre	1	10
Kraljevo	regional centre	1	24
Leskovac	regional centre		7
Valjevo	regional centre	1	2
Kruševac	regional centre	3 (1 MC)	45
Vranje	regional centre	1 (1 MC)	36
Šabac	regional centre	1	4
Užice	regional centre	1	6

Note: *MC = municipality centre*

Čačak, Smederevo, Leskovac, Valjevo and Šabac) can be considered functionally monocentric. None of these regions has the values of the polycentricity index, $IP = 0$, since all employees do not work only in the regional centre, but also in other settlements of the region. Polycentricity index of monocentric regions ranges between 0 and 1 (Table 7), depending on the number of employees of the region outside the regional centre. Therefore, the values are identical to the values that refer to the number of employees in the centre of the region in relation to the total number of employees in the region.

Table 7. Functional polycentricity of urban regions

Centre of the urban region	Secondary centres	Functional Polycentric Index (IP)	Share of employees in all centres of the urban area in total employees in the region (%)
Belgrade	Barajevo, Grocka, Obrenovac, Surčin	3.87	78
Novi Sad	S. Karlovci, Irig, Temerin, B. Petrovac, Petrovaradin, Beocin, Futog, S. Kamenica	7.42	82
Niš	Niška Banja, Merošina, Gadžin Han, Doljevac	3.59	72
Kragujevac	/	0.94	94
Subotica	Palić	1.96	98
Zrenjanin	/	0.90	90
Pancevo	Kačarevo, Starčevo	2.46	82
Čačak	/	0.89	89
Smederevo	/	0.82	82
Kraljevo	Mataruška Banja, Ribnica	2.21	74
Leskovac	/	0.86	86
Valjevo	/	0.95	95
Krusevac	Ćićevac	1.37	69
Vranje	Vranjska Banja	1.61	81
Sabac	/	0.75	75
Uzice	Sevojno	1.89	95

Source: Authors' estimates

Subotica, Kruševac, Vranje, and Užice are following by the value of functional polycentricity index, which with one urban settlement belonging to the urban region, except for the regional centre, have a functional polycentricity index less than 2. In the area of urban regions of Kraljevo and Pančevo, in addition to the regional centre, there are 2 urban settlements, and accordingly the their functional polycentricity index is between 2 and 3. Although having numerous secondary centres in the area of their urban regions, Niš and Belgrade, due to the high concentration of employees in the regional centre, still have a functional polycentricity index of less than 4. Far more polycentric urban region was established around Novi Sad, with 8 urban settlements, secondary centres. The region's functional polycentricity index, calculated on the basis of the applied methodology, is even IP = 7.42.

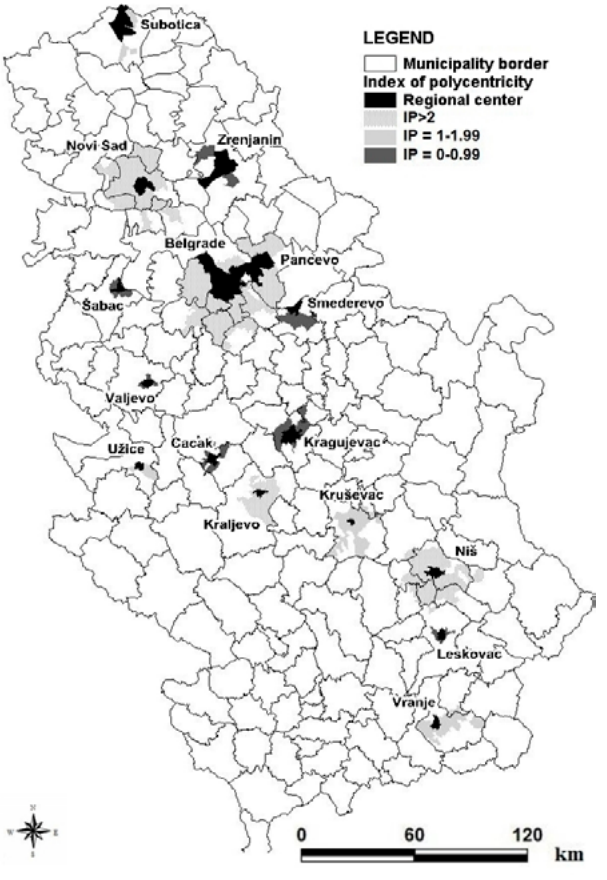

Figure1. Functional polycentricity index

Conclusion and recommendations

The results of this study show some similarities, but also differences in the basic characteristics of urban regions of Serbia, which should be taken into account when defining future planning solutions related to the regional development of Serbia.

Similar status characteristics of the urban regions according to the latest census (2011) is predominantly related to the dominance of the share of development sectors of activity, both in centres and in their surrounding areas. Service activities (tertiary-quaternary sector) on average have a higher share than production (secondary sector), both in centres of urban regions and in their surrounding areas. Production activities are dominant only in the surrounding areas of industrial centres of Vranje, Valjevo and Smederevo.

The degree of employees concentration in the centres of the region is expected to be high, ranging from 60% to 95%, and is not associated with the size of the centres, nor with the size of urban regions by the number of inhabitants, nor with the number of settlements in the region that have characteristics of complete dependence from the centres (determined according to the method that brings in relation the share of employees in development activities in the settlement and the share of emigrants from the settlement towards the centre). However, higher concentration values of employees in the centre of the urban region are brought into connection with a small number of secondary centres, i.e. with the existence of only one centre in the region, which points to the need to implement decentralization, that is, decentralized concentration as a principle promoted by national strategic development documents (SPRS, 2010-2020).

Significant differences between urban regions are related to the degree of their polycentricity. Almost half of the urban regions in Serbia have characteristics of monocentricity (Kragujevac, Zrenjanin, Čačak, Smederevo, Leskovac, Valjevo and Šabac). In the polycentric region there, a number of secondary centres varies, one in the case of Subotica, Kruševac and Užice, up to eight on the example of Novi Sad. Certain differences between urban regions refer to the results related to share of the employees in primary centres in relation to the secondary centre region, if it is a polycentric region, or in comparison to the region as a whole, if it comes to monocentric urban regions.

The functional polycentricity index (IP) of urban regions of Serbia, obtained by application of the designed method, has higher values in urban regions with a higher number of centres. For the sake of further development–the dispersion of the activities should be performed in order to achieve a more functional polycentricity. Notwithstanding the high concentration of employees in the primary centres, the index points to dispersion of the labour function, or the existence of a greater or lesser concentration of employees in secondary centres in the area of urban regions. There is a certain number of employees in the surrounding areas of monocentric region with a share of 5–25%, since there are significant industrial facilities on their territories, and those surrounding areas have properties of centre of work.

Therefore, future development solutions should be directed to strengthening these settlements, whose affirmation would be a step towards the achievement of the general national goal of decentralization at all territorial levels and, ultimately, a balanced regional development as a precondition for general prosperity.

We propose to public policy and decision makers to intensify activities on the re-industrialization of Serbia, that is, to introduce some forms of industrial production in areas of urban regions, as areas favorable for production, both in terms of concentration of population and capital, and infrastructure and human capital. In particular, the deployment of, as a rule, small and medium-sized industrial enterprises in secondary centers should be defined in accordance with cluster principles, or in accordance with the type of production in the centers of urban regions. Such an approach in planning is considered to be a key initial factor in the formation and affirmation of secondary centers, which in the future will contribute to further attraction of the population and agglomeration of activities, and thus to decentralization and overall development of urban regions.

Research using similar demographic and functional characteristics of centres and their environments can determine the characteristics of urban regions in other areas. Similar research has already been done in some European countries (Poland, the Netherlands, England, Wales…). Determining the functional polycntericity of urban regions according to the methodology used in the paper may find its application in countries with significant differences in regional development. Polycentricity could be achieved through favourable (international) investment projects, activation of local potentials, agglomeration of economic activities and, consequently, population concentration in medium-sized centres. Accompanied with incentives, this approach could encourage young people to settle in those centres. This would have to be dome to make them attractive and competitive. By improving the situation in those centres and their immediate surroundings, development process-

es in the country's interior would be encouraged and this could help mitigate the differences that mark the current regional imbalance. The future spatial effects of urban regions will depend on the height of the centrality level in the functional gravitational zone of urban centres.

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References

Agergaard, J., & Ortenbjerg, B. S. (2017). Urban transformations and rural-city connections in Africa. *Geografisk Tidsskrift-Danish Journal of Geography*, 117(2), 63–67. doi:10.1080/00167223.2017.1367698

Andreasen, H. M., Agergaard, J., Kiunsi, B. R., & Namangaya H. A. (2017). Urban transformations, migration and residential mobility patterns in African secondary cities. *Geografisk Tidsskrift-Danish Journal of Geography*, 117(2), 93–104. doi:10.1080/00167223.2017.1326159

Bohinec, V. (1926). The agglomeration of the city of Ljubljana and its anthropogeographical boundaries. *Geografski vestnik*, 1, 22–35.

Bukurov, B. (1980). The problem of determining urban settlements in Vojvodina (In Serbian). *Journal of the Geographical Institute "Jovan Cvijic" SASA*, 32, 51–60.

Burger, M., Van Oort, F., & Linders, G. J. (2009). On the specification of the gravity model of trade: zeros, excess zeros and zero-inflated estimation. *Spatial Economic Analysis,* 4(2), 167–190. doi.org/10.1080/17421770902834327

Davoudi, S. (2008). Conceptions of the city-region: a critical review. Proceedings of the Institution of Civil Engineers. *Urban Design and Planning,* 161(2), 51–60. doi:10.1680/udap.2008.161.2.51

Djurić, V. (1970). General Approach to the Functional Classification of Urban Communities in Serbia (In Serbian). Geographical Papers, 1, 83–94.

Etherington, D., & Jones, M. (2016). The city-region chimera: the political economy of metagovernance failure in Britain. *Cambridge Journal of Regions, Economy and Society*, 9(2), 371–389. doi:10.1093/cjres/rsw007

Etherington, D., & Jones, M. (2017). Re-stating the post-political: Depoliticization, social inequalities, and city-region growth. *Environment and Planning A: Economy and Space,* 50(1), 51–72. doi:10.1177/0308518X17738536

Faludi, A. (2005). Polycentric territorial cohesion policy. *The Town Planning Review,* 76(1), 107–118. https://www.jstor.org/stable/40112634

Gajić, A., Krunić, N., & Protić, B. (2018). Towards a new methodological framework for the delimitation of rural and urban areas: a case study of Serbia. *Geografisk Tidsskrift-Danish Journal of Geography*, 118(2), 160–172. doi:10.1080/00167223.2018.1503551

Green, N. (2007). Functional Polycentricity: A Formal Definition in Terms of Social Network Analysis. *Urban Study*, 44(11), 2077–2103. doi:10.1080/00420980701518941

Grunfelder, J., Nielsen, A.S. T., & Groth, B. N. (2015). Changes to urban form and commuting patterns: trends in two Danish city regions. *Geografisk Tidsskrift-Danish Journal of Geography*, 115(2), 73–87. doi:10.1080/00167223.2015.1060864.

Hennig, B. D. (2018). The growth and decline of urban agglomerations in Germany. *Environment and Planning A: Economy and Space,* 51(6), 1209–1212. doi:10.1177/0308518X18798835

Ilić, J. (1970). The characteristics of functional relations between cities and their environment with special emphasis on Serbia (In Serbian). Stanovništvo, 8(3–4), 167–189.

Yankson, W. K. P., Gough, V. K., Esson, J., & Amankwaa, F. E. (2017). Spatial and social transformations in a secondary city: the role of mobility in Sekondi-Takoradi, Ghana. *Geografisk Tidsskrift-Danish Journal of Geography*, 117(2), 82–92. doi:10.1080/00167223.2017.1343672

Kloosterman, R., & Lambregts, B. (2001). Clustering of Economic Activities in Polycentric Urban Regions: The Case of the Randstad. *Urban Studies*, 38(4), 717–732. doi:10.1080/00420980120035303

Kristóf, A. (2018). The Impact of Suburbanization on Social Differentiation in Hungary: a Case Study of the Miskolc Agglomeration. *Geographica Pannonica*, 22(3), 176–188. doi: 10.5937/gp22-17081

Lawton, P. (2018). Uneven development, suburban futures and the urban region: The case of an Irish 'sustainable new town'. *European Urban and Regional Studies*, 25(2), 140–154. doi:10.1177/0969776417694679

Limtanakool, N., Schwanen, T., & Dijst, M. (2009). Developments in the Dutch Urban Systems on

the Basis of Flows. *Regional Studies*, 43(2), 179–196. doi:10.1080/00343400701808832

Milojević, B. Ž. (1956). A General Regional Geography (In Serbian). Belgrade: Naučna knjiga.

Nielsen, T. (2015). The polymorphic, multilayered and networked urbanised territory. *Geografisk Tidsskrift-Danish Journal of Geography*, 115(2), 88–104. doi:10.1080/00167223.2015.1082431

Parr, J. (2005). Perspectives on the city-region. Regional Studies,39(5),555–566.doi:10.1080/00343400500151798

Parr, J. (2008). Cities and Regions: Problems and Potentials. *Environment and Planning A: Economy and Space*, 40(12), 3009–3026. doi:10.1068/a40217

Perišić, D. (1985). About spatial planning (In Serbian). Belgrade: Institut za arhitekturu i urbanizam Srbije.

Rus, P., Nared, J., & Bojnec, Š. (2018). Forms, areas and spatial sharacteristics of intermunicipal cooperation in the Ljubljana *Urban Region*. Acta geographica Slovenica, 58(2), 47–61. doi:10.3986/AGS.4830

Savić, O. (1958). The influential sphere of Aleksinac and its properties (In Serbian). Belgrade: Geographical Institute "Jovan Cvijić" SASA.

Sat, N. A. (2018). Monocentric or Polycentric? Defining Morphological Structure of NUTS-2 Regions of Turkey from 2000 to 2016. *Geographica Pannonica*, 22(1), 1–13, doi:10.5937/gp22-15726

Statistical Office of the Republic of Serbia (SORS). (2011). Economically active population performing an occupation, by activities, by settlements - Documentation material. Belgrade: SORS. (In Serbian)

Statistical Office of the Republic of Serbia (SORS). (2013d). 2011 Census of Population, Households and Dwellings in the Republic of Serbia. In Book No. 11. Daily migrants. Belgrade: SORS. (In Serbian)

The Official Gazette of the Republic of Serbia (OGRS). (2010). The law on Spatial Plan of the Republic of Serbia from 2010 to 2020 (SPRS). (Report No. 88). Belgrade, Serbia: OGRS. (In Serbian)

Tošić, D. (2000). Spatial-functional relationships and connections in urban regions (In Serbian). *Arhitektura i urbanizam*, 7, 50–58.

Vasárus, G., Bajmócy, P., & Lennert, J. (2018). In the Shadow of the City: Demographic Processes and Emerging Conflicts in the Rural-urban Fringe of the Hungarian Agglomerations. *Geographica Pannonica*, 22(1), 14–29. doi: 10.5937/22-16572

Veljković, A., Jovanović, R., & Tošić, B. (1995). Towns of Serbia – The Centres of Development in the network of Settlements (In Serbian). Belgrade: Geographical Institute "Jovan Cvijić" SASA.

Vresk, M. (2002). City and urbanisation: An Introduction to Urban Geography (In Croatian). Zagreb: Školska knjiga.

Waterhout, B. (2002). Polycentric development: What's behind it? In A. Faludi (Eds.), European Spatial Planning: Lessons for North America (pp. 83–103). Cambridge: MA Lincoln Institute of Land Policy.

Živanović, V. (2017). The Role of Nodal Centers in Achieving Balanced Regional Development. *Journal of the Geographical Institute "Jovan Cvijić" SASA*, 67(1), 69–84. doi:10.2298/IJGI1701069Z

Živanović, Z., & Tošić, B. (2017). Defining urban regions in Serbia. *Geographica Pannonica*, 21(2), 85–95. doi:10.18421/GP21.02-02

Živanović, Z., Tošić, B., Nikolić, T., & Gatarić, D. (2019). Urban System in Serbia–The Factor in the Planning of Balanced Regional Development. Sustainability, 11(15), 4168, 1–19. doi.org/10.3390/su11154168.