POLYCENTRICITY ISSUES OF ROMANIA'S SOUTH-EAST REGION

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Abstract:
Polycentricity at regional level, a concept introduced in the 1990's, aims at identifying and describing regional spatial structures and requires a more equitable spatial distribution of economic opportunities, public services, urban amenities etc. Being a complex notion, it has a lot of facets, which is why the assessment of polycentricity dimensions is not an easy task at all. In order to perform polycentricity analysis, first it is necessary to identify functional urban areas, which the building blocks of a polycentric region are. In this paper, after a brief review of the polycentricity concept, a methodology for estimating several dimensions of polycentricity at regional level is presented. More specifically, it is about some indicators of morphological polycentricity and of the polycentricity potential. For the polycentricity potential, a method is also proposed to aggregate indicators into one indicator. Finally, the proposed methodology is applied to Romania's South-East Region.

Keywords: *morphological polycentricity, polycentricity potential, South-East Region, functional urban areas.*

JEL Classification: O11, O20, R12.

1. Introduction

Polycentricity is understood differently depending on the spatial scale one relates to or the criteria one uses (Waterhout et al., 2005). The term of spatial scale refers to the sizes of studied areas: city level (typically a metropolis), regional level, national level, transnational (even continental) level, level of region subdivision.

Polycentric development means connecting a number of places so that they form a network where they can operate together in order to sustain and grow their business, services and facilities (Hague and Kirk, 2003, pp. 11). A region is polycentric if the cities and the smaller settlements that are part of it interact with one another to a significant extent (Bailey and Turok, 2001). In a polycentric region, regional spatial development involves certain potentialities over a stand-alone development strategy of the cities within the region, namely: pooling resources in order to share facilities and services and to achieve a critical mass, developing and exploiting balanced complementarities, optimizing spatial diversity and better protecting the quality of open spaces (Meijers and Romein, 2003).

Rather than saying about a given area that it is polycentric or monocentric, it is better to assign a value to the area on a scale ranging from very monocentric to very polycentric (Meijers and Sandberg, 2008). The first step in evaluating the polycentricity of a region is to establish functional urban areas, i.e. their centers (core) and their adjacent commuting areas. These functional urban areas are the building blocks of a polycentric spatial structure. Once the functional urban areas established, one determines the indicators characterizing dimensions, which are then converted into utilities and aggregated into indices of dimensions. Finally, the indices of dimensions are transformed into the Index of Polycentricity by weighted aggregation. In the ESPON (2004), Egnatia Odos Observatory (2010) and Wegener (2013) approach, polycentricity has tree dimensions: size, location (that describe morphological aspects) and connectivity (that describes relational aspects).

According to other views, polycentricity can be conceptualised from both a functional and morphological perspective (Veneri and Burgalassi, 2012). Usually, morphological polycentricity is measured by the slope of the rank-size regression (Veneri and Burgalassi,

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2012; Brezzi and Veneri, 2014; Meijers and Sandberg, 2008). In order to measure the degree of functional polycentricity, one can use the following indicators: the Entropy Index (proposed by Limtanakool et al. (2007)), Special Functional Polycentricity and General Functional Polycentricity (proposed by Green (2005; 2007).

The concept of polycentric or polynucleated urban region has now become a spatial planning tool or a vision (Bailey and Turok, 2001). A polycentric urban region is "a region having two or more separate cities, with no one dominant centre, in reasonable proximity and well-connected" (Davoudi, 2002). This concept is the subject of several works of urban and regional science literature, such as: Dieleman (1996); Dieleman and Faludi (1998); Bailey and Turok (2001); van Houtum and Lagendijk (2001); Meijers and Romein (2003); Hague and Kirk (2003).

2. Methodology

It is considered the linear regression between the natural logarithm of the position of each functional urban area in the size rating and the natural logarithm of its size (Parr, 1985; Brezzi and Veneri, 2015; Veneri and Burgalassi, 2012):

$$\ln(rank) = \alpha + \beta \ln(size) \quad (1)$$

where $size$ is the total size of each functional urban area within the region;

$rank$ is the rank of functional urban areas by size, computed by region.

In this paper, the size of functional urban areas will be expressed by their turnover and population. The economic dimension of a locality is best assessed by GDP, but since there are no data on the GDP of localities, one should consider turnover instead.

Polycentricity at regional scale can be measured through the beta coefficient of the equation (1). The slope of the regression line, given by the estimated beta, indicates the level of hierarchy among functional urban areas (Brezzi and Veneri, 2015; Veneri and Burgalassi, 2012). Clearly, the beta coefficient is negative. In absolute terms, the higher the slope value, the higher the polycentric level.

Another indicator of the spatial structure is primacy, which is defined as the share of population in the functional urban area that is classified first in the size rating over the region's total population (Brezzi and Veneri, 2015). A new definition of the primacy is proposed, namely the ratio of the size of the largest urban functional area and the average of functional urban areas' sizes. Clearly, in this case, the primacy is greater than 1. In view of the fact that a polycentric structure should not be dominated by one city, the closer the primacy is to 1, the more polycentric the region is. Unlike this paper, Brezzi and Veneri (2015) and Veneri and Burgalassi (2012) express the size of functional urban areas only by population.

Next, the discussion will focus on the polycentricity potential, which is why is considered $L_1, L_2, \ldots, L_n$ – the functional urban areas' centers which are part of a region. We denote

d_{ij} = distance between localities L_i and L_j, $i = 1,2,\ldots,n$, $j = 1,2,\ldots,n$, $i \neq j$;

m_i = size of locality L_i, $i = 1,2,\ldots,n$.

Starting from the law of universal gravitation and considering two localities L_i and L_j, $i = 1,2,\ldots,n$, $j = 1,2,\ldots,n$, $i \neq j$, one defines the intensity of influence exerted by the greater settlement on the smaller settlement of the two, as

$$F_{ij} = \lg \frac{m_i m_j}{d_{ij}^2} \quad (2)$$

Of these intensities of influences F_{ij}, one retains only those for which $d_{ij} \le d$, where d is a threshold distance that is chosen depending on the country or region and denotes this statistical series by F. We logarithmate in the base 10 the attractive forces between cities in (2) in order to get the order of magnitude of these forces. Generally, there are great differences between the values of attractive forces between the cities of an urban network. However, we believe that the order of magnitude of these attractive forces should not differ too much from one force to another in case of a polycentric urban network. Therefore, we use the coefficient of variation of this series to assess the degree of the region's polycentricity. So, we define the next indicator of polycentricity potential:

$$IPP = 1 - CV_F \quad (3)$$

where $CV_F = \frac{\sigma_F}{\overline{F}}$; CV = coefficient of variation of series F;

$\overline{F}$ = mean of series F;

σ_F = standard deviation of series F.

In this paper, the size of localities will be expressed by the population and turnover, and we take the threshold distance value $d = 120$ min. The polycentricity potential (PP) is defined as the arithmetic average of two indicators defined by equation (3), namely IPP_{pop} and IPP_{turn}, calculated for population and turnover, respectively. Clearly, the closer this average is to 1, the higher the polycentricity potential is.

3. Results and analyses

The population in 2014 and turnover in 2012 along with the annual average rate of exchange for the year 2012, 1Euro=4.4560 Lei have been used in this study. As stated in the methodology, the functional urban areas have been classified according to their population and turnover (Table 1).

For the linear regression between the natural logarithm of each functional urban area's position in the population rating and the natural logarithm of its population (Figure 1), the following results have been obtained:

Regression equation: $\ln(rank) = 11.278936 - 0.813538 \ln(pop)$

Slope= – 0.813538

P-value=0.000000349

R^2 = 0.872706

Adjusted R^2= 0.862914

The low value of probability associated with beta coefficient (0.000000349) and the high value of the adjusted coefficient of determination (0.862914) validate the model. The modulus of linear regression slope has a small value (0.813538), which indicates a low degree of polycentricity of the South-East Region.

We must also calculate the primacy, i.e. the degree by which the size of the largest functional urban area deviates from the average size of functional urban areas. The primacy is 2.991834, quite a small value, considering that in the region there are more functional urban areas with low population. In a polycentric urban system, the dominance of the largest city must be limited, and the previous result shows that this polycentric condition is accomplished.

Table 1. Rating of the functional urban areas in the South-East Region based on population and turnover

Functional urban area	Population (in thousands)	Rank	Turnover (in million euros)	Rank
Constanța	453.266	1	5743.618975	1
Galați	336.565	2	4280.110898	2
Focșani	247.071	3	956.733298	5
Brăila	239.918	4	1476.047552	4
Buzău	239.387	5	2246.934876	3
Tecuci	163.708	6	231.722064	9
Tulcea	129.406	7	868.545043	6
Râmnicu Sărat	97.478	8	258.120338	8
Medgidia	89.277	9	192.217478	10
Adjud	72.874	10	109.580877	11
Mangalia	60.768	11	336.024710	7
Ianca	46.378	12	75.286460	13
Măcin	35.729	13	58.370589	14
Nehoiu	34.503	14	50.534435	15
Hârşova	26.188	15	80.768406	12

Source: The data in the table have been determined by the author based on the information provided by the National Institute of Statistics (http://statistici.insse.ro/shop/index.jsp?page=tempo3&lang=ro&ind=POP102D) and the National Bank of Romania (http://www.bnr.ro/ Cursul-de-schimb-3544.aspx)

We have the following results on rank-turnover distribution of functional urban areas in the South-East Region (Figure 2):

Regression equation: $\ln(rank) = 11.327746 - 0.479190 \ln(turnover)$

Slope= – 0.479190

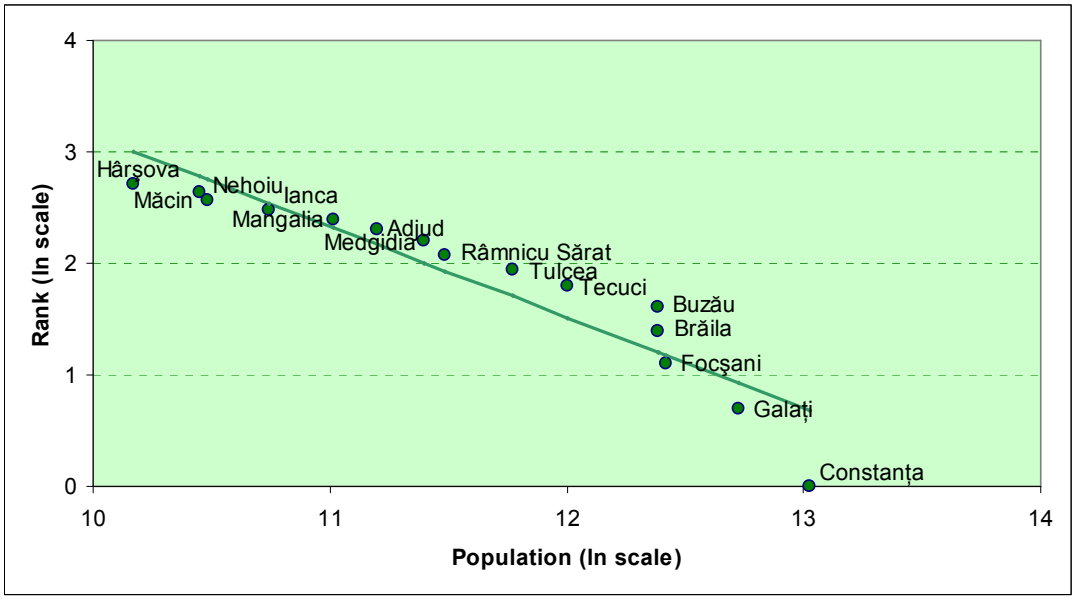

Figure 1. Linear regression between logarithm of position in the rating and logarithm of population

P-value= 0.0000000051

R^2 = 0.933249

Adjusted R^2= 0.928115

As appears from the above information, the model is valid. The absolute value of the regression line slope is small (0.479190), even lower than in the case of population, which is an argument for a low-polycentricity.

The primacy has a value of 5.078469, which corresponds to a medium level of polycentricity.

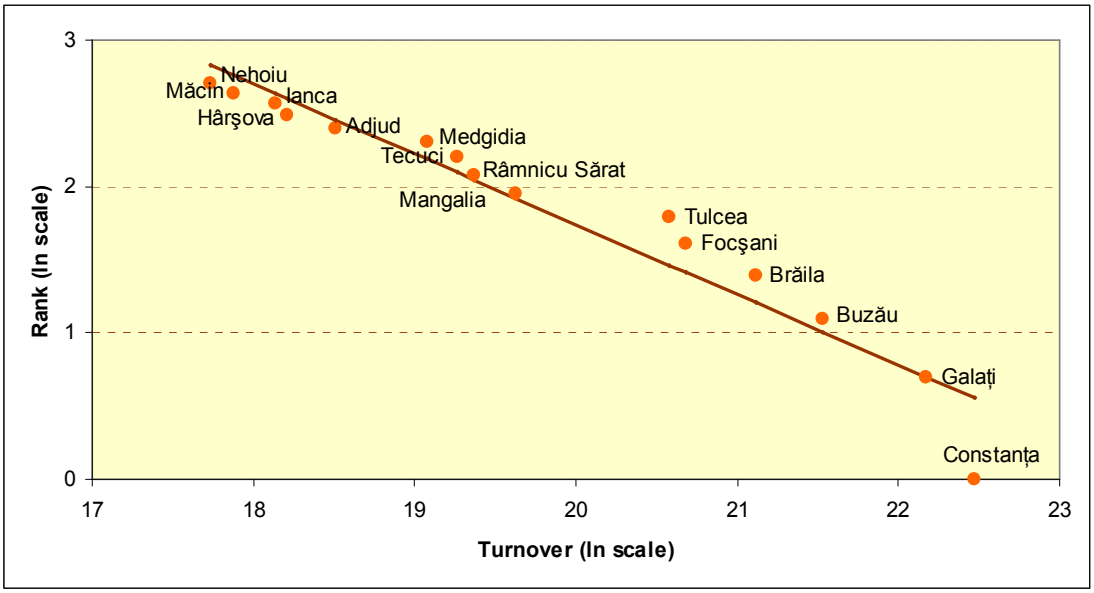

Figure 2. Linear regression between logarithm of position in the rating and logarithm of turnover

The values of the four indicators (the slope of the linear regression between the logarithm of position in the rating and logarithm of population, the slope of the linear regression between the logarithm of position in the rating and logarithm of turnover, the primacy calculated for population and the primacy calculated for turnover) create an image on the morphological polycentricity of the South-East Region. Once the four indicators determined, the question is whether they can be aggregated into a composite indicator of the morphological polycentricity. One way to do this is provided by the ESPON Project 1.1.1 (ESPON, 2004, pp. 72). Thus, one can transform the values of these indicators into utilities. More precisely, first, for each indicator, the thresholds corresponding to values 0 and 1 of utility are established. Then, the values obtained for each indicator are transformed into utilities by linear interpolation. Finally, after the establishment of the weights for the four indicators, their multiplicative or additive weighted aggregation is carried out to obtain an index of morphological polycentricity.

Unfortunately, the above methodology cannot be applied in this article because establishing those thresholds and weights can be done only if we consider a large number of regions.

To determine the polycentricity potential, we need the population and the turnover of functional urban areas' centers (Table 2) and the travel times between these centers. Calculations have been performed with the travel times between these cities, obtained by moving on national roads (Annex).

Table 2. Population and turnover of the functional urban areas' centers in the South-East Region

Functional urban areas centers	Population	Turnover (in euros)
Constanța	296,823	4,676,482,219.00
Mangalia	39,037	306,908,695.20
Medgidia	42,967	113,730,203.50
Hârşova	10,442	50,623,553.41
Galați	284,986	4,159,649,876.00
Tecuci	41,685	165,270,117.10
Tulcea	88,458	795,932,384.40
Măcin	10,514	35,534,559.25
Brăila	203,355	1,336,605,746.00
Ianca	10,860	44,116,190.98
Buzău	127,837	2,034,784,864.00
Râmnicu Sărat	38,448	144,268,857.70
Nehoiu	10,964	27,602,577.65
Focşani	96,713	735,676,525.10
Adjud	18,259	49,468,830.34

Source: The data in the table have been determined by the author based on the information provided by the National Institute of Statistics (http://statistici.insse.ro/shop/index.jsp?page=tempo3&lang=ro&ind=POP102D) and the National Bank of Romania (http://www.bnr.ro/ Cursul-de-schimb-3544.aspx)

On the basis of these data, the intensities of influences F_{ij} of the pairs of functional urban areas' centers (L_i, L_j) which satisfy the condition that the distance between L_i and L_j (d_{ij}) is up to 120 minutes have been calculated, using the formula (2), and expressing the sizes of these centers by their populations and turnovers. In the case of population is obtained

$\overline{F}$ =5.662377

σ_F =0.822184

CV_F =0.145201

$IPP_{pop} = 1 - 0.145201 = 0.854799$

In the case of turnover is obtained

$\overline{F}$ =13.202777

σ_F =1.079882

CV_F =0.081792

$IPP_{turn} = 1 - 0.081792 = 0.918208$

Therefore, the polycentricity potential is

$$PP = \frac{IPP_{pop} + IPP_{turn}}{2} = \frac{0.854799 + 0.918208}{2} = 0.886503$$

The great value obtained above shows a high polycentricity potential for the South-East Region.

4. Conclusions

The concept of polycentricity does not have a universally accepted definition. This is due to the scale of analysis: city level (especially metropolis), a subdivision of the region level (e.g. county), regional level, country level etc. We must also take into account the fact that the

official territorial units of countries vary greatly from state to state. We must also keep in mind the important aspects of polycentricity: morphological and relational or functional.

In this paper, four indicators of morphological polycentricity have been proposed. In the case of the South-East Region, for population, the slope of the rank-size regression has a small absolute value (0.81), indicating a low level of polycentricity, and the primacy is relatively small (2.99), which is characteristic of polycentric regions. For turnover, the modulus of the rank-size regression slope is smaller (0.48), and the primacy has a higher value (5.08), which is characteristic of regions with an average polycentricity. Not being able to achieve an aggregation of the four indicators into an index of morphological polycentricity, we appreciate the morphological polycentricity at a medium level. Instead, the polycentricity potential of the South-East Region, which is defined as average of two indicators, has a great value, close to 1 (0.89). Therefore, the region has a high polycentricity potential.

Among the cities in the South-East Region, the ones which can generate balanced development within their areas of action, i.e. a polycentric development, are only Constanța, Galați and, to a lesser extent, Brăila and Buzău. For this reason, large areas of the region are less influenced by the economic expansion of these large cities. Besides, if we consider the typology of county residences according to the ESPON 1.1.1 Programme, among the four cities only Constanța is a National City, because it meets the Population, Industry, Tourism and Knowledge activities criteria at national level, and the Transport criterion even at European level, others are included at regional level for all criteria at the most (Tache et al., 2016).

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Annex. Travel times between functional urban areas' centers (in minutes)

	Constanța	Mangalia	Medgidia	Hârșova	Galați	Tecuci	Tulcea	Măcin	Brăila	Ianca	Buzău	Râmnicu Sărat	Nehoiu	Focșani	Adjud
Constanța	0	41	35	68	163	210	100	120	140	131	156	172	229	203	235
Mangalia	41	0	65	96	168	234	168	151	165	157	181	198	254	229	260
Medgidia	35	65	0	57	150	196	107	124	128	119	143	157	216	191	222
Hârșova	68	96	57	0	105	151	78	81	82	74	117	115	190	146	177
Galați	163	168	150	105	0	70	107	58	23	59	108	91	182	78	108
Tecuci	210	234	196	151	70	0	169	116	76	86	86	61	155	31	38
Tulcea	100	168	107	78	107	169	0	67	108	145	191	180	264	176	206
Măcin	120	151	124	81	58	116	67	0	47	83	133	119	206	118	149
Brăila	140	165	128	82	23	76	108	47	0	37	86	74	160	77	107
Ianca	131	157	119	74	59	86	145	83	37	0	49	42	123	73	105
Buzău	156	181	143	117	108	86	191	133	86	49	0	28	76	60	91
Râmnicu Sărat	172	198	157	115	91	61	180	119	74	42	28	0	99	36	67
Nehoiu	229	254	216	190	182	155	264	206	160	123	76	99	0	130	162
Focșani	203	229	191	146	78	31	176	118	77	73	60	36	130	0	37
Adjud	235	260	222	177	108	38	206	149	107	105	91	67	162	37	0

Source: prepared by the author based on travel times picked up on site http://www.viamichelin.com/