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EFFICIENCY OF DELINEATION OF ADMINISTRATIVE REGIONS: A FUNCTIONAL REGION APPROACH

EFEKTIVITA VYMEZENÍ ADMINISTRATIVNÍCH REGIONŮ: FUNKČNĚ REGIONÁLNÍ PŘÍSTUP

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Annotation
The paper deals with the issue of administrative regions from the point of view of their spatial efficiency. This approach takes the concept of a functional region as the basis for the assessment of spatial efficiency, particularly the self-containment of a functional region. In this respect the paper analyses three systems of administrative regions of the Czech Republic at lower hierarchical level and compares them to three systems of natural functional regions and two systems of approximated functional regions. The paper uses daily travel-to-work flows for the analysis. Spatial distribution of self-containment for administrative regions is commented and the suitability of functional region approach for administration of a territory is supported.

Key words
administrative regions, functional regions, regional hierarchy, spatial efficiency, self-containment of regions, Czech Republic

Anotace
Článek se zabývá problematikou administrativních regionů z hlediska jejich prostorové efektivnosti. Jako základ pro hodnocení prostorové efektivnosti je použit koncept funkčního regionu, zejména jeho uzavřenost vzhledem k denním tokům obyvatelstva. Analyzovány jsou tři systémy administrativních regionů České republiky na nižší hierarchické úrovni a jsou srovnávány se třemi systémy přirozených funkčních regionů, resp. se dvěma systémy aproximovaných funkčních regionů. Článek využívá pro analýzu data o denní dojížďce obyvatelstva do zaměstnání. Součástí je hodnocení prostorového rozložení uzavřenosti administrativních regionů a posouzení jejich vhodnosti z hlediska přístupu funkční regionální taxonomie.

Klíčová slova
administrativní regiony, funkční regiony, regionální hierarchie, prostorová efektivnost, uzavřenost region, Česká republika

***JEL classification**: J01, J40, R10, R12*

Introduction

An efficient functioning of public administration requires a correct definition of administrative units, administrative regions. These regions usually serve also the statistical purpose, the allocation of financial means, the identification and analysis of regional disparities, and planning purpose. Basic rules and characteristics for the definition of administrative regions can vary depending on their hierarchical level, but it can be generally claimed that the administrative regions should maximally follow the natural differentiation of space, particularly relevant spatial flows and interaction. The objective of this paper is to assess the spatial efficiency of administrative regions of the Czech Republic at lower hierarchical levels (administrative districts of municipalities with authorised local authority – *správní obvody pověřených obecních úřadů* in Czech, administrative districts of municipalities with extended powers – *správní obvody obcí s rozšířenou působností* in Czech, districts – *okresy* in Czech) in relation to basic rules of functional regional taxonomy. The self-containment of administrative regions with regard to daily population movements will be assessed primarily and the comparison to optimised functional regions will be carried out.

1. Theoretical background

The definition of administrative regions should take into account three basic principles: the principle of spatial efficiency, the principle of spatial equity, and the principle of spatial stability (Bezák, 1997; Michniak, 2003). The first two principles stress a space, the third stresses a time (spatial stability requires the stability of regional borders in a time, i.e. they should not be changed very often). From the point of view of a communication network the spatial efficiency is centred around a high-quality and rapid connection of central urban regions with high population density, while the spatial equity urges the fact, that even the most peripheral areas should have at least a minimal connection to communication systems (Monzón et al., 2013). If the problem of the definition of functional regions is raised, the principle of spatial equity is quite clear; its basic postulate is that for all administrative regions of the same level their most peripheral areas should have similar distance or accessibility to their respective centres. However the definition of spatial efficiency is somewhat more difficult. Goodall (1987) claims, that spatial efficiency expresses the relationship between spatial location, spatial organisation, and economic efficiency. For the purpose of this paper it can have two possible explanations:

a) The principle of spatial efficiency should in strictly econometric terms find such administrative delineation, when for a given number of regions the sum (weighted by population). However this is an extremely nomothetic view, which does not necessarily need to conform to the existing distribution of spatial movements and interaction in reality. The quantification of "min-sum" (Hansen et al., 1985) is too simplifying and because of heterogeneity of a space the regional science does not use it very often.

b) More suitable view of the principle of spatial efficiency takes into account the comparability of administrative division to actual distribution of spatial flows and interaction, at lower hierarchical levels flows and interaction with a daily periodicity. The reason for this is the fact that people traveling to work, school, services, etc. should have also the possibility to run their errands in offices, authorities, etc.; even though this requirement can be weakened in future because of e-government).

The relevance of the latter explanation is greater for regional science, but in this case the principle of spatial efficiency can be in conflict with the principle of spatial equity. Larger regional centres with stronger economic base have larger tributary areas as compared to smaller centres, and the distance of the most peripheral municipalities to an administrative centre could be considerably different in both types of regions. Therefore it is necessary to find a compromise between both principles – spatial efficiency and spatial equity.

2. Method

The methodical approach comes from the assessment of the self-containment of an administrative region, which is the basic parameter for the definition of a functional region (for greater detail see e.g. Klapka et al., 2013, Halás et al., 2015). This parameter is closely related to spatial efficiency, because higher values of self-containment mean lower values of cross-border flows, i.e. more correct affiliation of municipalities to a region. Traditionally the functional regionalisation tasks have used the lower value out of two unidirectional self-containments (Coombes, Openshaw 1982; Coombes et al. 1986); Casado-Díaz, 2000; Papps, Newell, 2002; Newell, Perry, 2005). This can be noted as:

$$SC' = \frac{T_{jj}}{max\left(\sum_k T_{jk}; \sum_k T_{kj}\right)},$$

where T_{jj} are intra-regional flows, $\sum_k T_{jk}$ are outgoing flows, and $\sum_k T_{kj}$ are ingoing flows; $T_{jj} \subset \sum_k T_{jk}$; $T_{jj} \subset \sum_k T_{kj} \Rightarrow 0 \leq SC \leq 1$. However it is more suitable to take into account bidirectional self-containment (Klapka et al., 2014; Halás et al., 2015):

$$SC = \frac{T_{jj}}{\sum_k T_{jk} + \sum_k T_{kj} - T_{jj}},$$

where intra-regional flows are rated against all flows incident to a region (intra-regional, outgoing, ingoing flows). Simultaneously both types of unidirectional self-containment can be also used (supply-side self-containment, demand-side self-containment), which are noted as follows:

$$SC_{SS} = \frac{T_{jj}}{\sum_k T_{jk}} \; ; \; SC_{DS} = \frac{T_{jj}}{\sum_k T_{kj}}.$$

The above-mentioned parameters of self-containment can be expressed for each region individually, but it is possible to calculate the total self-containment of a system according to:

$$TSC = \frac{\sum_j T_{jj}}{\sum_j \sum_k T_{jk}}.$$

The total self-containment of a system determines the portion of intra-regional flows in all flows for the whole Czech Republic.

The analysis of the self-containment of administrative regions of the Czech Republic was based on the daily travel-to-work data from the 2011 census, which is the most frequent and representative statistical information on the daily movements of population.

3. Results

An outline of attributes and their values for all variants of regional systems and for all types of self-containment is given in tables 1 and 2. This paper is particularly interested in the pairs of regional systems, when the pair is made by an administrative regional systems and respective approximated functional regional system. The approximation is based on the number of regions in both regional systems, that is comparable for both cases. With decreasing hierarchical level of a spatial unit these are districts and administrative districts of municipalities with extended authorities. The level of administrative districts of authorised local authorities is assessed separately because it has not counterpart in approximated functional regions.

Tab. 1: Attributes for bidirectional self-containment of regional systems of the Czech Republic

Attribute for regional system	Functional regions					Administrative regions		
	FRD 1	FRD 2	FRD 3	AFRD 1	AFRD 2	districts	DMEP	DALA
Number of regions	142	125	95	201	80	77	206	394
Area (km^2, mean)	555.4	630.9	830.2	392.4	985.8	1024.2	382.8	200.2
Area (km^2, var. coeff.)	0.585	0.579	0.568	0.600	0.471	0.373	0.619	0.674
Self-containment (mean)	0.802	0.820	0.841	0.776	0.860	0.841	0.757	0.689
Self-containment (median)	0.809	0.824	0.857	0.778	0.866	0.867	0.769	0.698
Self-containment (max)	0.981	0.981	0.981	0.981	0.981	0.981	0.981	0.913
Self-containment (min)	0.612	0.645	0.694	0.601	0.726	0.514	0.435	0.406
Self-containment (var. coeff.)	0.097	0.079	0.076	0.073	0.061	0.101	0.123	0.156
Self-containment of reg. system	0.908	0.916	0.926	0.896	0.930	0.905	0.872	0.850

Note: FRD 1, 2, 3 are three variants of regional system consisting of functional regions according to daily travel-to-work flows; AFRD 1, 2 are approximated variants of regional system, when the approximation regards the number of administrative districts of municipalities with extended authority and the number of districts; DMEP (SO ORP in Czech) is an administrative district of municipality with extended authority; DALA (SO POÚ in Czech) is an administrative districts of authorised local authority.
The table does not include a zero value reached by the administrative district of authorised local authority that is constituted by the Březina military area with only one individual person going out.
Source: Klapka, Halás (2016); own calculation

Tab. 2: Attributes for two types of unidirectional self-containment of regional systems of the Czech Republic

Attribute for regional system	Functional regions					Administrative regions		
	FRD 1	FRD 2	FRD 3	AFRD 1	AFRD 2	districts	DMEP	DALA
Supply-side self-cont. (mean)	0.867	0.881	0.897	0.848	0.910	0.893	0.831	0.774
Supply-side self-cont. (median)	0.878	0.892	0.910	0.847	0.920	0.914	0.846	0.784
Supply-side self-cont. (max)	0.989	0.989	0.989	0.989	0.989	0.989	0.989	0.973
Supply-side self-cont. (min)	0.704	0.710	0.752	0.642	0.784	0.585	0.541	0.464
Supply-side self-cont. (var. coeff.)	0.079	0.067	0.061	0.081	0.051	0.087	0.108	0.14
Demand-side self-cont. (mean)	0.912	0.922	0.930	0.900	0.939	0.933	0.892	0.860
Demand-side self-cont. (median)	0.913	0.923	0.938	0.906	0.941	0.949	0.901	0.877
Demand-side self-cont. (max)	0.992	0.992	0.992	0.992	0.992	0.992	0.992	0.976
Demand-side self-cont. (min)	0.728	0.825	0.825	0.728	0.871	0.767	0.669	0.538
Demand-side self-cont. (var. coeff)	0.044	0.032	0.034	0.042	0.026	0.050	0.058	0.095

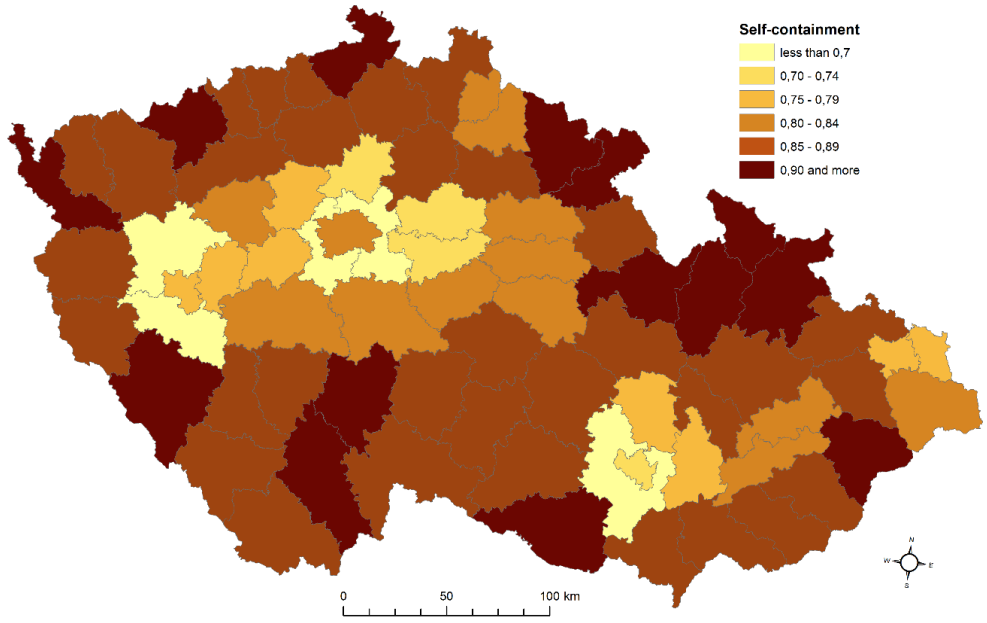
Note: FRD 1, 2, 3 are three variants of regional system consisting of functional regions according to daily travel-to-work flows; AFRD 1, 2 are approximated variants of regional system, when the approximation regards the number of administrative districts of municipalities with extended authority and the number of districts; DMEP (SO ORP in Czech) is an administrative district of municipality with extended authority; DALA (SO POÚ in Czech) is an administrative districts of authorised local authority.
The table does not include a zero value reached by the administrative district of authorised local authority that is constituted by the Březina military area with only one individual person going out.
Source: Klapka, Halás (2016); own calculation

It can be generally concluded for the above-mentioned pairs of regional systems that better spatial efficiency can be seen in both variants of approximated functional regions, though the difference is sometimes minute. Both approximated variants of functional regions shows higher average values for both bidirectional and unidirectional self-containment. Therefore these variants show also higher level of spatial efficiency. A range of values of the self-containment for the set of regions is lower for both approximated variants, similarly as the values of variability measure (variation coefficient). Approximated functional regional systems consists of regions, which show lower values for the

deviation from average for the whole regional system and the regional system is more suitable from the point of view of spatial efficiency and the total self-containment. All variants of regional systems (except from DALA) have the same maximum of self-containment – it is the Jeseník region, which is a promontory surrounded significantly by the state border. The lowest values for the self-containment were recorded for DALA (see fig. 1 and further comments).

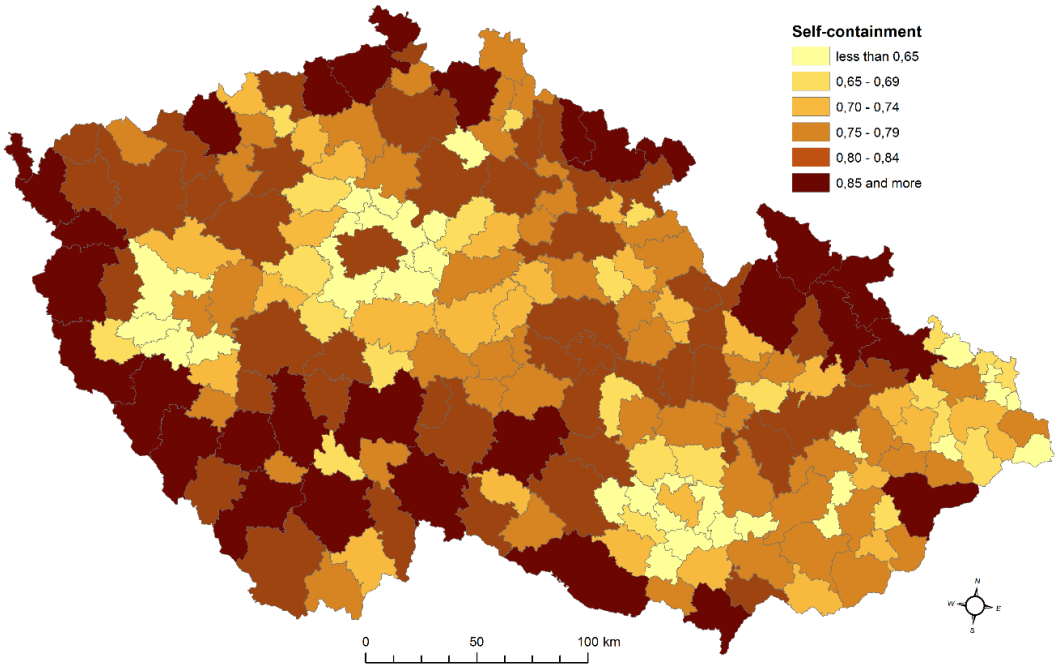
Spatial distribution of the values for self-containment for the administrative regions of the Czech Republic is presented in figures 1, 2, and 3. From the point of view of spatial efficiency the areas with lower degree of this efficiency can be identified in the hinterlands of the largest centres (Prague, Brno, Ostrava, Plzeň) in all three variants with a different detail, which is caused by the spatial design of respective administrative systems and also by the number of regions. High values of self-containment are characteristic of border regions, which is quite logical because of limiting effects of state border, and is some peripheral areas (the Českomoravská vysočina highland, northern part of the South Bohemia region).

Fig. 1: Bidirectional self-containment of the districts of the Czech Republic



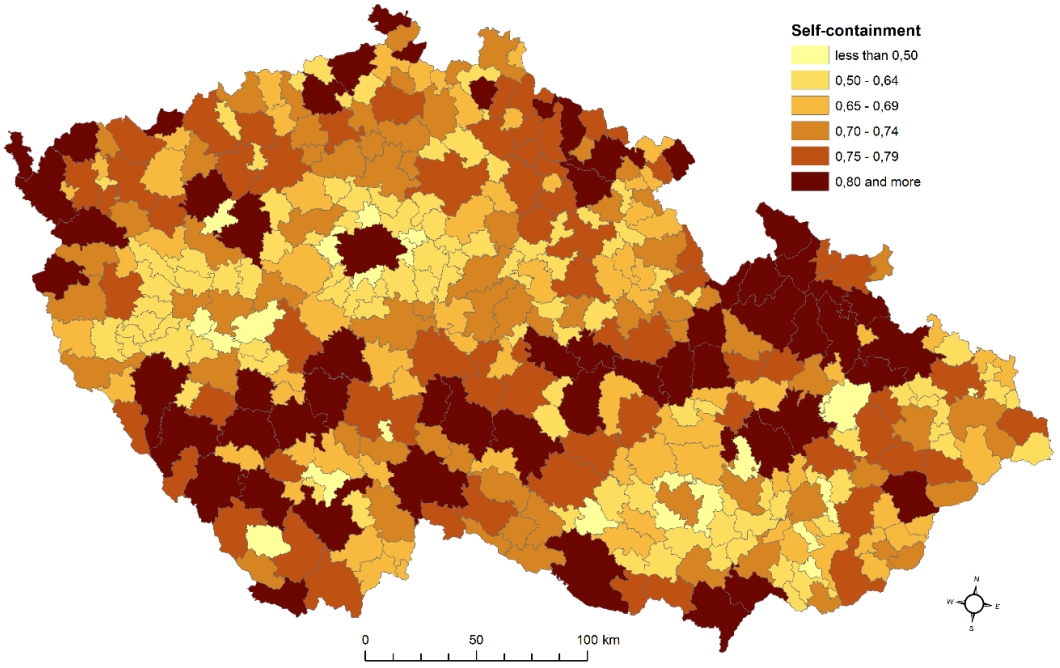
Source: own calculation

Fig. 2: Bidirectional self-containment for the administrative districts of the municipalities with extended authority of the Czech Republic



Source: own calculation

Fig. 3: Bidirectional self-containment for the administrative districts of authorized local authorities of the Czech Republic



Source: own calculation

4. Conclusion

The paper has assessed spatial efficiency of the administrative region of the Czech Republic at lower hierarchical levels in comparison to the functional regions. The hypothesis that functional regions represent a suitable basis for the definition of administrative regions has been corroborated by the comparison of the values of self-containment or regions in each analysed regional system, and by the comparison of the values of total self-containment for each regional system. Both these characteristics proved to be suitable for the assessment of spatial efficiency of different regional systems. Two pairs of regional systems (approximated functional and administrative) have shown higher values of two above mentioned characteristics for approximated functional regions and it can be concluded that they are spatially more efficient than administrative regions.

Spatial distribution of self-containment of region is influenced by several factors. Firstly, a hierarchical level of regions, i.e. their size, matters, which is in fact a part of modifiable areal unit problem. Secondly, a hierarchical level of settlement system centres plays its role at each level, and this hierarchy has a somewhat fractal nature as the hierarchical level descends. Thirdly, geographical context, particularly effects of state border, intensity of contacts (i.e. interactions) and different economic level of different areas influence the values of self-containment. At the level of districts the lowest values of self-containment are recorded in the hinterlands of the largest centres, and then in some important agglomerations and conurbations. At the lower hierarchical levels (DMEP, DALA) this rule is also valid, but the hierarchical position of centres, whose hinterlands have lower values of self-containment, can be also lower. Thus the spatial pattern is more complex with the increasing detail, even though hinterlands of the largest centres are distinct at each hierarchical level. Higher values of self-containment are recorded either for economically successful regions or for regions, which lack contacts with their neighbours. The latter occur rather in peripheral and less economically successful areas.

Literature

[1] BEZÁK, A., (1997). Priestorová organizácia spoločnosti a územno-správne členenie štátu. *Acta Universitatis Matthiae Belii, Geografické štúdie,* no. 3, pp. 6-13.

[2] CASADO-DÍAZ, J. M., (2000). Local labour market areas in Spain: a case study. *Regional Studies*, vol. 34, no. 9, pp. 843-856. ISSN 0034-3404. DOI10.1080/00343400020002976.

[3] COOMBES, M. G., GREEN, A. E., OPENSHAW, S. (1986). An efficient algorithm to generate official statistical reporting areas: the case of the 1984 travel-to-work areas revision in Britain. *The Journal of the Operational Research Society*, vol. 37, no. 10, pp. 943-953. ISSN 0160-5682. DOI 10.1057/jors.1986.163.

[4] COOMBES, M. G., OPENSHAW, S., (1982). The use and definition of travel-to-work areas in Great Britain: some comments. *Regional Studies*, vol. 16, no. 2, pp. 141-149. ISSN 0034-3404. DOI 10.1080/09595238200185161.

[5] GOODALL, B. (1987). *The Penguin dictionary of human geography.* Harmondsworth: Penguin.

[6] HALÁS, M., KLAPKA, P., TONEV, P., BEDNÁŘ, M., (2015). An alternative definition and use for the constraint function for rule-based methods of functional regionalisation. *Environment and Planning A*, vol. 47, no. 5, pp. 1175-1191. ISSN 1472-3409. DOI 10.1177/0308518X15592306.

[7] HANSEN, P., PEETERS, D., RICHARD, D., THISSE, J.-F., (1985). The minisum and minimax location problems revisited. *Operation Research,* vol. 33, no. 6, 1251-1265. ISSN 0030-364X. DOI 10.1287/opre.33.6.1251.

[8] KLAPKA, P., HALÁS, M., NETRDOVÁ, P., NOSEK, V., (2016). Efficiency of areal units in spatial analysis: assessing the suitability of functional and administrative regions. *Moravian Geographical Reports*, vol. 24 (ahead of print). ISSN 1210–8812.

[9] KLAPKA, P., HALÁS, M., TONEV, P., (2013). Functional regions: concept and types. In *XVI. mezinárodní kolokvium o regionálních vědách. Sborník příspěvků.* Brno: Masarykova univerzita, pp. 94-101. ISBN 978-80-210-6257-3. DOI 10.5817/CZ.MUNI.P210-6257-2013-11.

[10] KLAPKA, P., HALÁS, M., ERLEBACH, M., TONEV, P., BEDNÁŘ, M., (2014). A multistage agglomerative approach for defining functional regions of the Czech Republic: the use of 2001 commuting data. *Moravian Geographical Reports*, vol. 22, no. 4, pp. 2-13. ISSN 1210–8812. DOI 10.1515/mgr-2014-0019.

[11] MICHNIAK, D. (2003). Dostupnosť okresných miest na Slovensku. *Geografický časopis*, vol. 55, no. 1, pp. 21-39. ISSN 1335-1257.
[12] MONZÓN, A., ORTEGA, E., LÓPEZ, E. (2013). Efficiency and spatial equity impacts of high-speed rail extensions in urban areas. *Cities*, vol. 30, no. 1, pp. 18-30. ISSN 0264-2751. DOI 10.1016/j.cities.2011.11.002.
[13] NEWELL, J. O., PERRY, M. (2005). Explaining continuity in New Zealand's local labour market areas 1991 to 2001. *Australasian Journal of Regional Studies*, vol. 11, no. 2, pp. 155-174. ISSN 1324-0935.
[14] PAPPS, K. L., NEWELL, J. O. (2002). *Identifying functional labour market areas in New Zeland: A reconnaissance study using travel-to-work data.* IZA Discussion Paper No. 443. Bonn: Institute for the Study of Labor.

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