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INNER STRUCTURE OF FUNCTIONAL REGIONS: RELATIONSHIPS BETWEEN PROTO-CENTRES

VNITŘNÍ STRUKTURA FUNKČNÍCH REGIONŮ: VZTAHY MEZI PROTOJÁDRY

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Annotation
The paper deals with the issue of inner structure of functional regions in the Czech Republic and it is based on the analysis of spatial distribution of daily travel-to-work flows between so called proto-centres. 160 functional regions based on the CURDS measure and 667 proto-centres provided by the first step of the regionalisation algorithm have been used. The result shows spatial distribution of flow intensities between proto-centres and their typology. Out of four basic relationships between proto-centres of a functional region (indifference, cooperation, complementarity, competition) the first three have been identified, while for cooperation and complementarity the hierarchical level of proto-centres is also taken into account.

Key words
functional region, regional hierarchy, centre, proto-centre, travel-to-work flows, cooperation, complementarity, Czech Republic

Anotace
Článek se zabývá problematikou vnitřní struktury funkčních regionů České republiky z hlediska prostorového rozložení denních toků do zaměstnání mezi protojádry. Jako základ pro hodnocení je použito vymezení 160 funkčních regionů dle míry CURDS a 667 protojader z prvního kroku algoritmu tohoto vymezení. Výsledkem je zachycení prostorového rozložení intenzity toků mezi protojádry a jejich typologie. Ze čtyř základních vztahů mezi protojádry funkčních regionů na základě intenzity toků (indiference, kooperace, komplementarita, konkurence), byly v příspěvku identifikovány první tři, přičemž při kooperaci a komplementaritě je ve výsledné typologii srovnávána i hierarchická úroveň protojader.

Klíčová slova
funkční region, regionální hierarchie, jádro, protojádro, dojížďka do zaměstnání, kooperace, komplementarita, Česká republika

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

Introduction

Functional regions are based on the analysis of spatial flows and interactions. The basic rule for their definition is that majority of incident flows should occur within a region and only minority should cross its border (Smart, 1974; Fischer, 1980; Karlsson, Olsson, 2006; Farmer, Fotheringham, 2Q011; Klapka et al., 2013). Correctly defined functional regions can serve better as a geographical tool for a normative use. The can also be used for an assessment of regional disparities, labour market policies, distribution of subsidies, public transport planning, etc. The inner structure of functional regions can be very varied. The main objective of this paper is to assess the inner structure of functional regions in the Czech Republic defined by daily travel-to-work flows and to analyse their distribution between centres and proto-centres. Their hierarchy according to the number of jobs will be also taken into account. A complementarity and cooperation between the proto-cores are studied in detail.

1. Theoretical basis

A study of inner structure of regions has a long tradition in geography and spatial science dating back to the first localisation theories of von Thünen (1875; original publication is from 1826) and to the following grand localisation theories of Christaller (1933), Lösch (1940) and Isard (1956). All these authors conceptualised a simple inner structure of a functional region, which consists of a centre, its hinterland and a periphery. These parts are identified on the basis of different intra-regional interaction intensities, which basically follow the distance from a centre (Halás et al., 2014, 2015). A more complex approach to the development of the inner structure of a functional region is presented by Hagget (1965, 2001), who besides the interaction intensity sees a crucial role of direction, orientation and pattern of these flows with a region and an existence of several centres at different hierarchical levels. Based on these characteristics various types of functional regions can be identified (Klapka, et al., 2013). They are for instance functional urban regions (e.g. Berry, 1973; Halás et al., 2015), daily urban systems (e.g. Berry, 1973; Coombes, et al., 1979), travel-to-work areas (e.g. Ball, 1980; Coombes, Openshaw, 1982), and local labour market areas (e.g. Casado-Díaz, 2000; Casado-Díaz, Coombes, 2011). These regional types are based particularly on qualitative character of interactions, their regularities and orientation.

The centre of a functional region is one of the most significant traits in its structure, it influences spatial distribution of flows within the region. Theoretically, the functional region does not necessarily need to have a core (distribution of flows is random), however very often the functional region has one or several cores in practice. If there are several cores, four types of relationships based on incident interaction can be defined: indifference, cooperation, complementarity, and competition. The identification of relationships between cores is not unambiguous in every case (see for details Erlebach, et al., 2014).

2. Method

The paper uses 160 functional regions based on daily travel-to-work flows to identify inner structures (version FRD 1 in Klapka, et al., 2014). These regions were defined by the CURDS measure. The same source has provided also so called proto-centres, which result from the first step of the multi-stage regionalisation algorithm. In order to qualify as a proto-centre, a municipality has to fulfil two limiting conditions. The first is the labour function of a proto-centre, which is a share of all in-commuting flows into a municipality in all out-commuting flows from a municipality:

$$\frac{\sum_j T_{ji}}{\sum_j T_{ij}} > 0.8 .$$

The second condition is a residence-based self-containment of a municipality, which is a share of employed residents in all out-commuting flows from a municipality:

$$\frac{T_{ii}}{\sum_j T_{ij}} > 0.5 .$$

Both conditions are very modest, therefore the municipalities that fulfil them cannot be denoted as centres but rather as proto-centres. The analysis comprises all municipalities fulfilling these conditions for two reasons: this set has been tested in the first step the regionalisation algorithm, larger number of proto-centres enables us to capture better the inner structure of a region according to distribution and intensity of commuting flows. 667 proto-centres have fulfilled both conditions.

Hierarchy of proto-centres has been determined by the number of jobs, i.e. as $\sum_k T_{ki}$, which is the sum of all in-commuting flows into municipality *i* plus employed residents in *i*. Four hierarchical levels have been identified (tab. 1, fig. 1).

In order to assess relationships between proto-centres of functional regions, the CURDS measure (for notation see below) has been calculated for all pairs within each functional region. In the next step maximum and minimum values for the CURDS measure have identified the strongest and the weakest flow. In the next step a filter has been used to rule out flows not meeting the relevance criterion. This criterion has been set after statistical evaluation of the set of the CURDS measure values and the critical threshold has been set to 0.1, which reduced 1,942 flows to 1,132 flows that were graphically depicted. In order to compare individual intensities, the flows have been relativised according to the strongest flows recorded in the Czech Republic (this was considered as 100%) – see fig. 2.

Final identification of the relationship type between proto-centres has been based on the values of the CURDS measure between a pair of proto-centres and their hierarchical level. The CURDS measure has been decomposed into two parts, one for direction *ij*, and one for the opposite direction *ji*:

$$\left[\frac{T_{ij}}{\sum_k T_{ik}} + \frac{T_{ij}}{\sum_k T_{kj}} + \frac{T_{ji}}{\sum_k T_{jk}} + \frac{T_{ji}}{\sum_k T_{ki}}\right]; \text{ let } X = \frac{T_{ij}}{\sum_k T_{ik}} + \frac{T_{ij}}{\sum_k T_{kj}},\ Y = \frac{T_{ji}}{\sum_k T_{jk}} + \frac{T_{ji}}{\sum_k T_{ki}}.$$

Variables *X* and *Y* provide relativised data for both directions of interactions between two proto-centres and are used to sort the relationships into types. If both values are lower than 0.1 it means that the relationship between two proto-centres is indifferent. The value 0.1 has been estimated empirically for the regional system of the Czech Republic. Identification of cooperative relationship has been more difficult, particularly because both sets of values (*X* and *Y*) have different minima and maxima. The cooperation is determined on symmetric relationship between proto-centres. In order to identify this relationship values *X* and *Y* have to be numerically close. As an absolute comparison is not possible, the numerical distance between proto-centres has been expressed by an average proportional deviation from mean values of *X* and *Y*:

$$P = \frac{\left| X - \frac{(X+Y)}{2} \right|}{\frac{(X+Y)}{2}}$$

where *P* is the average deviation of *X* value from mean values for *X* and *Y*. The cooperative relationship is determined by the level of 0.25, i.e. all lower values indicate the cooperative relationship. In the next step the hierarchical relationship between two proto-centres has been assessed and cooperative relationships between proto-centres of the same and different levels identified. The same has been done for complementary relationships. All types are presented in the fig. 3.

3. Results

The regionalisation algorithm ensures that each region has at least one core (23 regions). Two proto-centres are recorded for 19 regions, and three and more proto-centres for remaining 118 regions (fig. 1). In the hierarchical structure of proto-centres first three categories can be conceived as true centres, the fourth category includes both centres and proto-centres. The first category is made up by Prague, Brno and Ostrava, the second category approximately corresponds to the level of regional capitals (tab. 1, fig. 1).

Tab. 1: Hierarchy of centres and proto-centres of functional regions in the Czech Republic according to the number of jobs

Hierarchical level	No. of jobs	No. of (proto-)centres
1	100,000 and more	3
2	30,000 – 99,999	12
3	10,000 – 29,999	52
4	Less than 10,000	600

Source: own processing

The strongest relativised interaction between proto-centres was recorded for the pair Ústí nad Labem and Trmice, on the contrary the weakest interaction was recorded for the pair Dobříš and Říčany. The distribution of commuting flows reflects relatively well the settlement and regional system of the Czech Republic (fig. 2). Limiting values, as have been discussed above, have produced out of 1,942 pairs 1,018 cases of indifference, 220 cases of cooperation and 704 cases of complementarity (fig. 3.). Out of 220 cooperative relationships 172 (78%) occurred at the same hierarchical level and 48 (22%) at different hierarchical levels. The cooperation is more frequent if the hierarchical level of proto-centres is the same. Out of 704 complementary relationship 356 (51%) occurred at the same hierarchical level and 348 (49%) at different hierarchical levels. The former case regarded particularly the relationships between proto-centres at lower hierarchical levels.

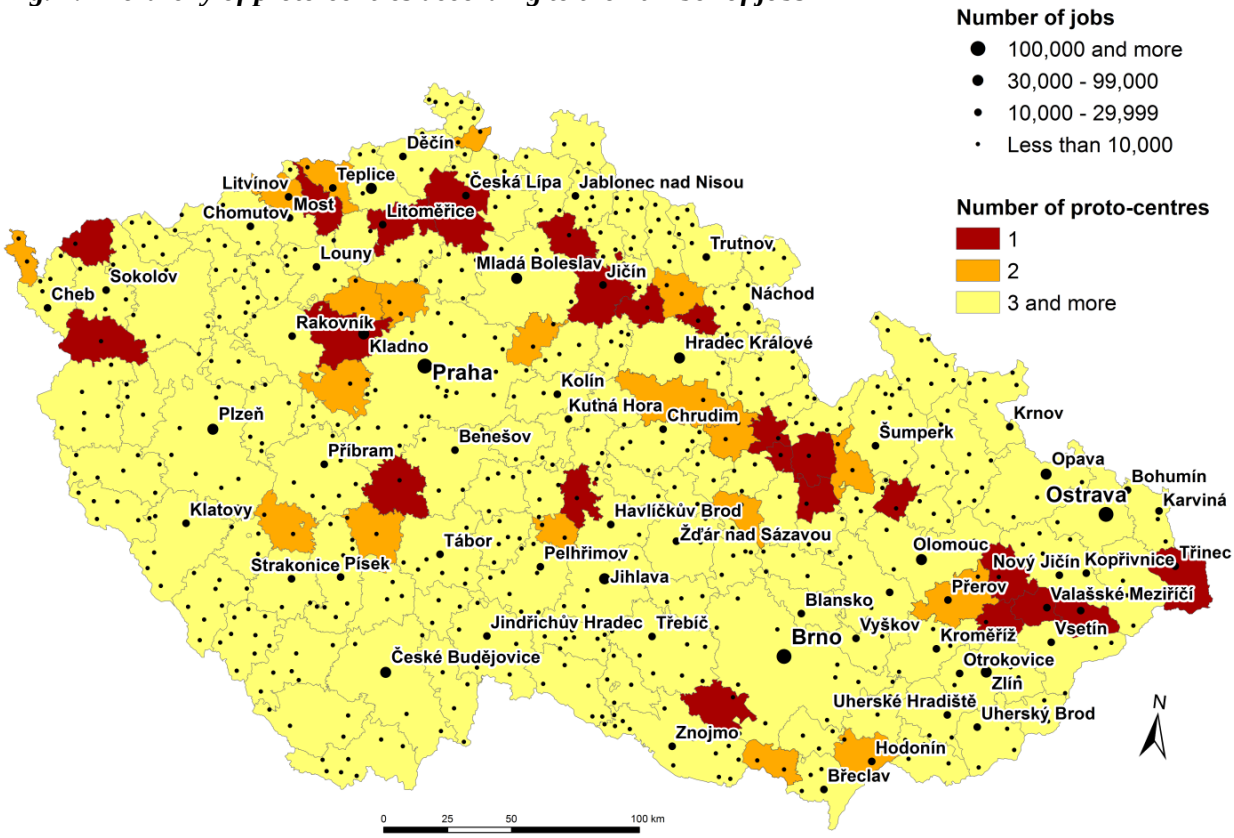
4. Conclusion

Municipalities have been qualified as proto-centres on the basis of their labour function and self-containment. For 160 functional regions 667 proto-centres have been identified. The use of proto-centres for the identification of inner structure of functional regions based on spatial distribution of inner flows proved to be relevant. Quantitative results and particularly graphical presentation are significantly more transparent than if all the municipalities were taken into account. On the contrary the setting of modest values for the identification of proto-centres enhances the value of the results than if only flows between true centres of functional regions were analysed. The estimates for the number of true centres vary between 150 and 250 according to given criteria.

Out of four basic types of relationships between proto-centres of functional regions based on the intensity of flows given by the interaction measure (indifference, cooperation, complementarity, competition), the first three types have been identified. The cooperation and complementarity is assessed also by the hierarchical position of proto-centres. Identification of competing relationships remains out of the scope of this paper, because its quantification has to be based not only on the analysis of flows between proto-centres, but also on the detailed analysis of flows between all municipalities and proto-centres. In this case the inclusion of only true centres would appear to be more suitable.

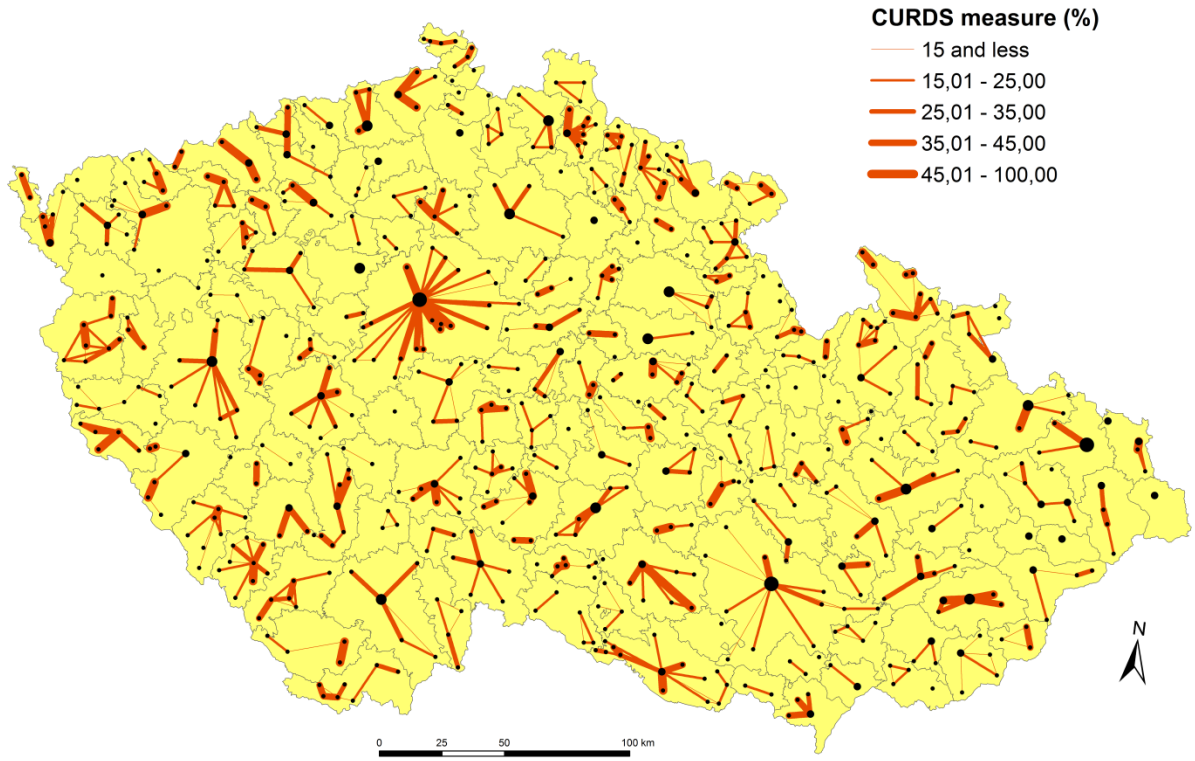
Finally it should be noted that the resulting number of relationships is determined by preset coefficients and can be adjusted for further research purpose. It is understandable that each relationship type between the pair of proto-centres does not need to reflect the real situation in a comprehensive detail. These results can be considered as a basic foundation for further research based on sophisticated quantitative methods.

Fig. 1: Hierarchy of proto-centres according to the number of jobs



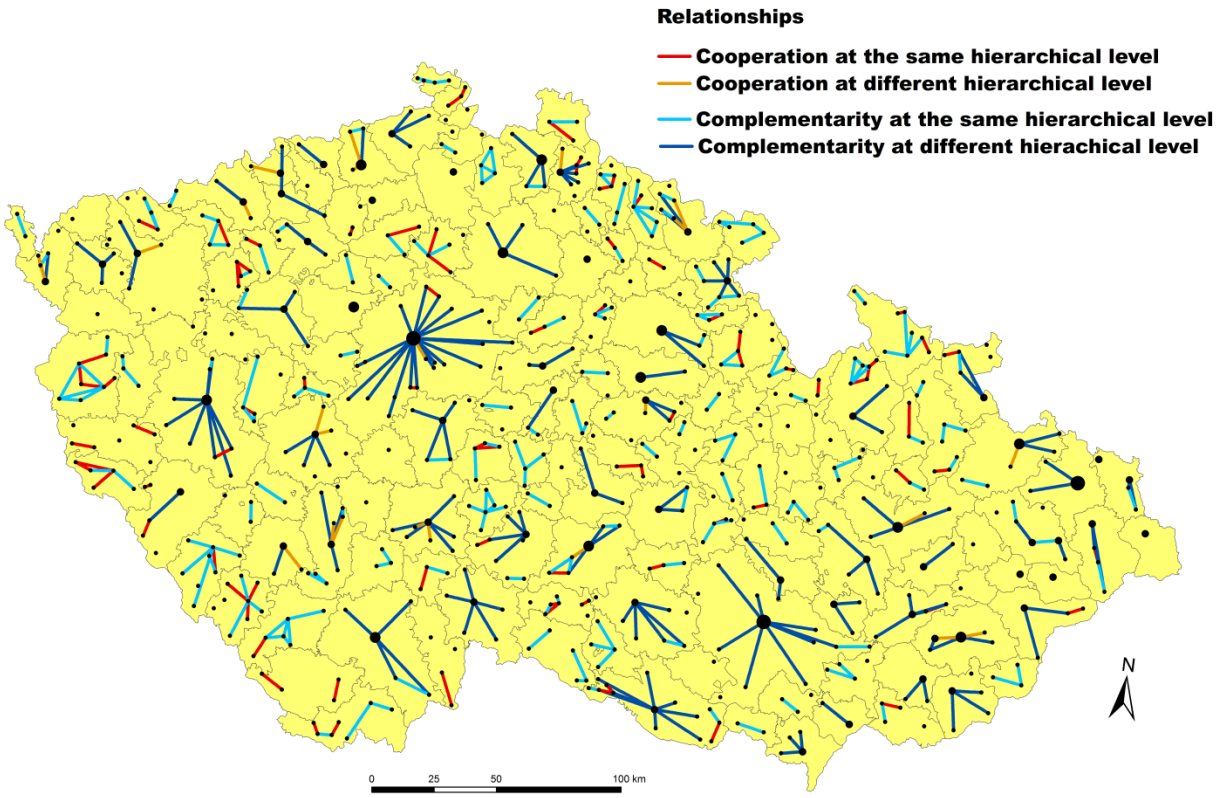
Source: own calculation

Fig. 2: Flow intensities between proto-centres in functional regions



Source: own calculation

Fig. 3: Typology of relationships between proto-centres in functional regions



Source: own calculation

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