Inner structure of functional regions: relationships between proto-centres

Martin Tomáš
Pavel Klapka
Marián Halás
Martin Erlebach
Concept of a Functional Region

- Based on the heterogeneity of geographic space (horizontal flows of people, goods, energy, information…)

- A functional region should aim to maximize:
  1) internal cohesiveness
  2) external separation

- Correctly delineated functional regions can serve as a powerful planning tool:
  - assessment of regional disparities
  - labour market policies
  - distribution of subsidies
  - public transport planning, etc…
Inner Structure of a Functional Region: basic theory

- J. Von Thünen, W. Christaller, A. Lösch, W. Isard:
  - conceptualised simple inner structure of a functional region (centre-hinterland-periphery)

- P. Haggett:
  - identifies a crucial role of direction, orientation, pattern of interaction flows as well as an existence of several centres at different hierarchical levels

Based on these inner characteristics, various types of functional regions can be identified:

- functional urban regions
- daily urban systems
- travel-to-work areas
- local labour market areas
Centres of a Functional Region

- The centre is the key trait in the inner structure of a functional region

- Existence of at least 1 centre (instances of a region with no core are possible but very scarce)

- Existence of several cores implies four types of relationships based on incident interaction:
  - 1) indifference
  - 2) cooperation
  - 3) complementarity
  - 4) competition
Centres of a Functional Region: method

- **Data basis:** daily travel-to-work flows (2001 census)

- **Output:** 160 functional regions delineated using the CURDS measure

- **Same source provided also so called „proto-centres“ as a result of the first step of the multi-stage regionalisation algorithm**
Definition of Proto-centres

In order to qualify as a proto-centre, a BSU has to fulfil two limiting conditions:

1) the labour function of a proto-centre

\[
\frac{\sum_j T_{ji}}{\sum_j T_{ij}} > 0.8
\]

2) residence-based self-containment of a municipality

\[
\frac{T_{ii}}{\sum_j T_{ij}} > 0.5
\]
Definition of Proto-centres

- Both conditions are very modest – the municipalities that fulfil them cannot be denoted as centres but rather proto-centres

- 667 proto-centres have met both restricting conditions

- The analysis comprises all municipalities fulfilling these conditions for two reasons:
  
  1) this set has been tested in the first step of the regionalisation algorithm

  2) larger number of proto-centres enables us to capture better the inner structure of a region according to distribution and intensity of commuting flows
Hierarchy of Proto-centres

- Hierarchy of proto-centres has been determined by the number of jobs which is the sum of all in-commuting flows into municipality $i$ plus employed residents in $i$.

$$\sum_k T_{ki}$$

- Four hierarchical levels have been identified

<table>
<thead>
<tr>
<th>Hierarchical level</th>
<th>No. of jobs</th>
<th>No. of (proto-)centres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100,000 and more</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>30,000 – 99,999</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>10,000 – 29,999</td>
<td>52</td>
</tr>
<tr>
<td>4</td>
<td>Less than 10,000</td>
<td>600</td>
</tr>
</tbody>
</table>

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

Source: own calculation
Relationships between Proto-centres

To assess relationships between proto-centres of functional regions several steps have been taken:

1) the CURDS measure has been calculated for all pairs within each functional region

2) maximum and minimum values for the CURDS measure have identified the strongest and the weakest flow

3) a filter has been used to rule out flows not meeting the relevance criterion
   - statistical evaluation of the set of the CURDS measure
   - the critical threshold has been set to 0.1
   - the number of flows was reduced from 1,942 to 1,132 flows

In order to compare individual intensities, the flows have been relativized according to the strongest flows recorded in the Czech Republic (which was considered as 100 %)
Fig. 2: Flow intensities between proto-centres in functional regions

Source: own calculation
Final identification of the relationship type between proto-centres has been based on:
1) the values of the CURDS measure between a pair of proto-centres
2) their hierarchical level

The CURDS measure has been decomposed into two parts, one for direction $ij$, and one for the opposite direction $ji$:

\[
\begin{bmatrix}
\frac{T_{ij}}{\sum_k T_{ik}} + \frac{T_{ij}}{\sum_k T_{kj}} \\
\frac{T_{ji}}{\sum_k T_{jk}} + \frac{T_{ji}}{\sum_k T_{ki}}
\end{bmatrix}
\]

let $X = \frac{T_{ij}}{\sum_k T_{ik}} + \frac{T_{ij}}{\sum_k T_{kj}}$ and $Y = \frac{T_{ji}}{\sum_k T_{jk}} + \frac{T_{ji}}{\sum_k T_{ki}}$.

Variables $X$ and $Y$ provide relativized data for both directions of interactions between two proto-centres and are used to sort the relationships into types.
Relationships between Proto-centres: evaluation

- If both values of variables $X$, $Y$ are lower than 0.1 it means that the relationship between two proto-centres is **indifferent**

- 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 $Y$:

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

where $P$ is the average deviation of $X$ value from mean values for $X$ and $Y$
Relationships between Proto-centres: evaluation

- The cooperative relationship is determined by the level of 0.25

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

Source: own calculation
Relationships between Proto-centres: results

- The strongest relativized interaction between proto-centres was recorded for the pair Ústí nad Labem and Trmice
- The weakest interaction was recorded for the pair Dobříš and Říčany

- Limiting values, as have been discussed above, have produced out of 1,942 pairs:
  - 1,018 cases of indifference
  - 220 cases of cooperation
  - 704 cases of complementarity

- 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 equal
Relationships between Proto-centres: results

- 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
Thanks for your attention