STUDIES

Researching commuting to work using the methods of complex network analysis

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In the current paper the possible utilization of complex network analysis in spatial researches was investigated. The organizational and developmental regularities of networks were demonstrated from the aspect of regional development planning. The reviewed regularities provide a new approach of the regional developments.

The dependencies of settlements were analysed with the application of disparity method on the basis of the commuting matrix of the census from 2011. The disparity of out-commuting exceeded the level of in-commuting in all population categories, producing a more significant dependency relation in case of out-commuting. In general, the value of disparity increases with decreasing population number in settlements and dependency grows. This can be related with decrease in the level of degree and commuting distance. According to detailed results, the method of disparity might be effectively used in additional spatial analyses as well.

The community detection procedures of the complex network analysis were also applied for spatial division. Modularity optimization with the Louvain method was successfully used in the delimitation of larger territorial units. Smaller units can be created by the increase of the resolution but modularity stability deteriorates. At the same time the composition of the units changes. In the light of the results, it could be stated that regions formed by commuting relations (according to the process of regionalism) did not match the Hungarian NUTS2 statistical regions, but natural borders and NUTS-3 level administrative boundaries could be detected in more cases. The differences between the results and NUTS-3 boundaries are not unique distortions caused by the methodology but these reflect real commuting relations (the local labour system units were discussed in a previous study). The methodology might be appropriate to detect the hierarchical order of the local labour system's units. The method is adaptable for additional analysis of spatial interactions.

Keywords:
network analysis,
commuting,
disparity,
dependency,
regionalization,
community detection

Introduction

Spatial research, apart from studying the characteristics and dynamics of spatial units, is focused on processes (innovation, migration and labour migration) between spatial units (settlements and public administration units) and resistance (accessibility via public roads). More detailed knowledge regarding flow and the increase of intensity of connections may help in reducing regional unevenness.

Regarding flow between settlements, only a few databases are available with data that were collected using united methods and suitable for settlement level analyses. Although the data series of commuting to work obtained in the course of the censuses meet the requirements, they are not used frequently (Kiss–Szalkai 2014). For further analyses, a new methodological approach was explored in international literature. For analysing commuting data, complex network analysis (Russo et al. 2007; De Montis et al. 2010; Caschili–De Montis 2013) is used mostly apart from spatial interaction models (Patuelli et al. 2007; LeSage–Fischer 2010). The primary aim of the present research is to analyse commuting relations using complex network analysis, presenting the possible applications of the method, its limits and further potentials.

Description of network analysis

The toolbar of complex network analysis is used frequently in international literature. Its popularity is based on its approach towards problems as differing from the widely used analytical and contextual data network analysis, which uses relational data. Analytical data are information related to a settlement that cannot be separated, such as unemployment ratio. Contextual data compare a parameter of a given settlement to a similar parameter of its surroundings, so that it can be decided whether, for example, the unemployment ratio in the settlement is better than in the region. Relational data, however, indicate a relationship between two settlements and sometimes the strength of this relationship (e.g. commuting to work and traffic relations; Letenyei 2005). This method is based on graph theory. Scientists simplify reality to nodes and edges, connecting them during the application of the method. Nodes of the graphs could be the given settlements, while flow between them could be the edges of the graphs. Several ways are available to plot real processes. Networks can be directed so that edges are not lines but arrows pointing from one node (source node) towards the other (destination node). Basically, the presence or lack of connection between the given nodes is recorded using binary coding (value of 0 or 1 – dichotomous network). Edges can be weighted based on the volume of material or information flow, the capacity of the infrastructural element or the length of the edge. The geographical space modelled by nodes and edges can be analysed using the methods of graph theory, linear algebra (Dusek 2013) and network analysis.

Network analysis and spatial research

Applying network analysis in spatial research can be regarded as a renaissance. Papers analysing spatial interactions on graph theory basis were published as early as the 1960s and 1970s (Dusek 2013, Klapka et al. 2013). The methodological background for the present work was taken mostly from studies in physics and biology. Analogies and methods are frequently taken from physics in spatial studies, such as gravitational models (Dusek 2003) and the spring-block model (Máté et al. 2013).

Network analysis was developed in numerous disciplines – simultaneously in many cases – in recent decades according to the challenges in the given scientific fields. It has become increasingly widespread in the Hungarian social geographical and regional geographical literature, besides being used physics, medical sciences, biology, ecology (Szabó et al. 2012) and sociology (Letenyei 2005). Its application in spatial research is justified as the intensity, volume and balance of spatial relations can be considered as development indicators: developed, dynamic regions have complex and intensive inner and outer relations, while in peripheral regions, relations are weak and one-sided, indicating the presence of problems (Nemes Nagy 2009). Companies prefer settlements with a developed network of connections (e.g. good accessibility; Kozma 1998).

Space categories and terms of spatial science can be interpreted in network research as well (Vida 2013), and this method can be applied to – beside others – the delimitation of peripheral areas (regarding methods of identification, see Pénzes 2014) and areas of attraction. According to Hungarian literature, network analysis has been applied to studying scientific cooperation (Vida 2012), tourism (Madarász–Papp 2013), interbank accounting transactions (Pál 2014), creation of polycentric urban regions (Fleischer 2009), traffic (Géber 2007, Pálóczi–Pénzes 2011, Szabó et al. 2013), social networks (Lengyel et al. 2015) and subregional commuting (Letenyei 2000). In the future, the methods could be applied successfully to studying online spaces and notoriety networks (Jakobi–Lengyel 2014) or global value chains (Molnár 2012).

Nodes of networks represent geographical locations in spatial research. Considering the national level, they would be settlements, while at the settlement level, they would be road junctions or parts of settlements. Edges would represent elements of the linear infrastructure (e.g. roads and railways) or material and information flow along them (Dusek 2013).

Applied data – adjacency matrix

This study is based on the commuting to work data of the census in 2011. The database involves data on daily commuting between the place of residence and workplace in order to carry out work. Settlements represent the nodes, whereas commuting between settlements represents the edges of a network. Data were sorted into an adjacency matrix and the following modifications were carried out:

- data of those commuting to abroad and variable destinations were removed;
- connections of the districts of Budapest were aggregated; that is, Budapest is adjacent to every settlement in our matrix with which any of the districts were in connection regarding employment, (weighing factors were of course summed);
- applied parameters cannot handle the connection of the settlements with themselves (local employees); therefore, in the diagonal of the matrix, the value is zero and
- the symmetric version of the directed network matrix was prepared as well; that is, values according to the direction of commuting between the settlement pairs were summed, and the obtained value was used for both in- and out-commuting.

The modifications are in harmony with the data processing described in the literature (Pénzes et al. 2014; De Montis et al. 2007).

Nodes of the network – in the case of directed networks – can be characterised best by the number of edges running in (in-degree) and out (out-degree) of them. There are 128,610 edges among the 3,154 nodes in the network. The highest number of edges belongs to Budapest (2,162), while Gagyapáti is an isolated inclusion and connected to no settlements. The weight of an average edge is 18; that is, 18 people are commuting in an average relation, whereas more than 13,000 people are commuting between Budapest and Budaörs. A strong, positive connection was detected between the number of residents and grade (r=0.73).

Characteristics of the commuting system as a network

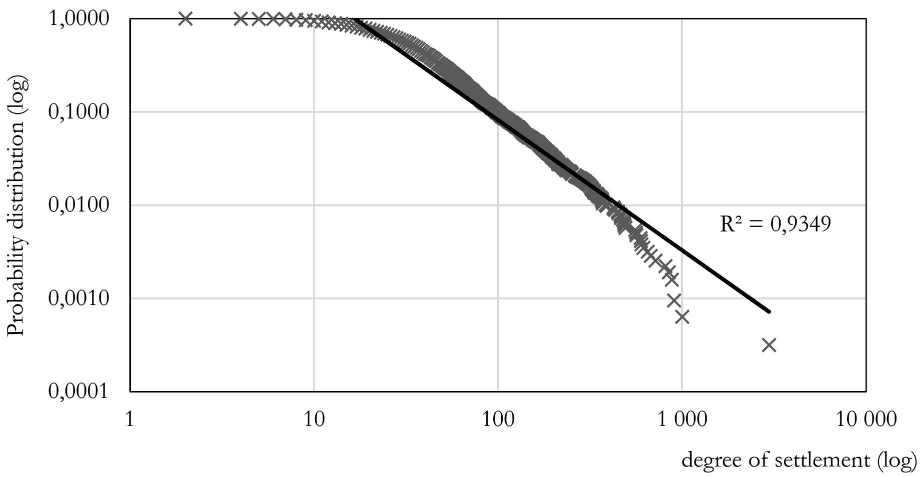
Numerous universal regularities have been identified when studying the complex networks, which are the result of the structure of networks and are independent of the subject of the study. However, the behaviour of networks can be understood better on the basis of their investigation. Fundamentally random and scale-free networks can be identified. Most networks present in nature and in society are scale-free and have the following characteristics (Barabási 2006):

- Degree distribution corresponding to the power law;
- Short-average (network) distance;
- Preferential attachment;
- High level of clusters.

The degree distribution of scale-free networks corresponds to the power law, that is, such networks are composed of a high number of nodes having a small number of connections and a small group of nodes with a very high degree. (A special case of the power law, the Pareto distribution, is well known in social sciences. In this distribution, 20% of the households have 80% of the income, and the rank-size rule of settlements is similar; Czaller 2012.) Upon depicting the cumulative probability distribution of degree on a logarithmic scale, it is clear that the majority of the values fit well with the power trend line. Accuracy of this fit is $R^2=0.9349$; that is, the degree distribution of the settlements of the network can be described by the power function with an accuracy of 93% (Figure 1). Most of the settlements have labour market connections with less than 50 other settlements.

Figure 1

Cumulative probability distribution of the degree (log-log plot), 2011



Source: Author's own construction based on data of the Hungarian Central Statistical Office (HCSO).

Short-average distance indicates that any two nodes of the network – despite the high element number – can reach each other with a few steps via a series of edges; that is, information (e.g. innovation and labour market effects) can flow very rapidly between any two nodes. The idea of a contact network among people appeared first in a novel by Frigyes Karinthy entitled *Láncszemek* (Chain-links). Milgram was the first to try to prove it with experiments. According to his results, any person in the United States is only five to six handshakes away from each other ('six degrees of separation', Milgram 1967). Upon selection of the participants, the experiment was proved to be false (Kleinfeld 2002), but the presence of a so-called 'small-world' in numerous networks remained – social networks among them (e.g. Backstrom et al. 2011). The number of steps increase with the logarithm of the number of elements at the most (Barabási 2006).

In the Hungarian commuting network, the average shortest way among the settlements is 2.37. The number of settlements in Hungary is 3154, the logarithm of which is 3.49. The magnitude of the two values is the same; therefore, the commuting network in Hungary in 2011 can be regarded as a small world. The characteristic presence of small-worlds in commuting networks was proved (De Montis et al. 2007). In the case of commuting, small-world characteristics are limited in space due to the cost of commuting (travel time and financial costs).

The model of scale-free networks sets the rules of the formation of new nodes and edges. According to this, new nodes and new edges of old nodes connect to nodes with higher degree with more probability (preferential attachment). Based on this statement, it can be assumed that job seekers probably search for and find jobs in areas to which more people commute. Distribution corresponding to the power law and preferential attachment together contribute to the phenomenon of 'the rich become richer'; that is, nodes with a special role in the topology of the network retain and even increase their position and have a hand in the development of the network (Barabási 2006). Apparently, the analytic criteria of networks influence their development; that is, the network topology does not determine the development of particular settlements. Different conditions of the nodes can be fit into the models, describing the development of scale-free networks by introducing the variable of 'fitting' (Bianconi–Barabási 2001a). Based on the results of the studies, the competition of nodes attributed with the fitting characteristic is comparable to the movement of particles of the Bose gas in quantum mechanics (Bianconi–Barabási 2001b). No studies using this result for modelling social conditions were found in the literature, but this could be another interesting chapter in the social scientific analogies of features in physics.

High clustering indicates that nodes were close to each other regarding the topology in the groups of nodes (cliques), and cliques were connected via some nodes characterised by very high degrees, that is, based on a degree in which some type of a hierarchy of the nodes could be determined (Watts–Strogatz 1998). This characteristic is associated with the regularity exposed in the course of the diffusion of innovation, that is, innovation with a hierarchy character across adjacent connections (Nemes Nagy 2009).

Certain characteristics of scale-free networks described above may affect several social-economic fields (political relations, company cooperation, flow of innovation, commuting, migration and certain fields of traffic), as a result of which the population of settlements may show a distribution characteristic for scale-free networks – in harmony with Zipf's law – in the course of their development.

Knowing the nature of networks, regional development measures could be evaluated. For example, the effects of the major road network belonging to the group of random networks – the development of which could improve the development of a balanced settlement network (Fleischer 2009) – were reduced by the development of an extremely Budapest-centric highway network (Tóth 2005) that contributed to unbalanced regional development with its quasi-star topology.

Dependency of the commuting relations of settlements

Regarding commuting relations, the key question is how dependent are the inhabitants of the given settlements on the employment conditions of a single settlement or whether they live in a stable environment as part of a polycentric settlement network. In order to answer the question, the strength of the nodes was calculated first using the following formula:

$$s(i) = \sum_{j \in V(i)} w_{ij},$$

where w_{ij} is the weight of the edge between nodes i and j.

The parameter indicates the number of those commuting in and out of a node in the case of undirected networks. In the commuting network in 2011, the minimum and the maximum values were two and 273,421 (Budapest), respectively, while the average was 753 people.

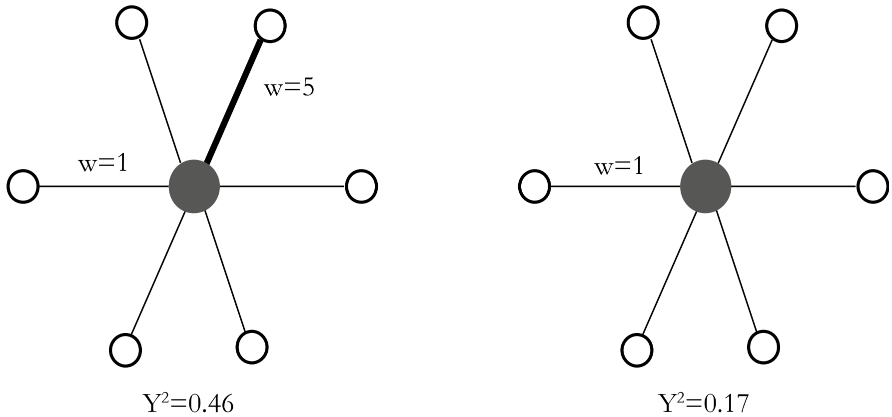
In order to study dependency conditions, the disparity (Y2) parameter (Barthélemy et al. 2005) was calculated. It was developed to measure the heterogeneity of weighted relations as follows:

$$Y_2(i) = \sum_{j \in V(i)} \left(\frac{w_{ij}}{s_i} \right)^2$$

The Y2 parameter shows the distribution of the commuting people of a given settlement among all of the connections. If the number of commuters is the same for all settlements, the value of the parameter will equal the root of its grade (Y2 ≈ 1/k). If one settlement dominates, Y2 will equal to 1 (Figure 2).

Figure 2

Illustration of the disparity indicator in two different cases



Source: De Montis et al. 2007, page 6.

Differing from the literature (De Montis et al. 2007), disparity was calculated in relation to not only undirected but also directed graphs; that is, dependency of in-commuting and out-commuting people were also studied for each settlement (Table 1).

Based on the data, in the case of any population category in 2011, the disparity value of out-commuting is greater than that of in-commuting; that is, the dependency is more characteristic in the case of out-commuting (Table 1). One of the reasons for the significant – twofold or threefold – difference can be the great gap between the values of in-degree and out-degree. Apparently (assuming similar settlement density), in- and out-commuting people have to travel further in case of settlements with higher grade[1]; that is, the weight of the edges decreases. Many edges with small intensity result in a decreasing disparity value as well.

Disparity of in-commuting is basically balanced regarding the population categories. Dependency is more characteristic of the labour market of settlements smaller than 1,000 people (Y_2>0.3); one reason for this could be that in-commuting had become occasional. Effects of employment in small and tiny villages affect only a few nearby settlements, and due to the small number of in-commuting people, certain commuting relations become dominant with a higher chance.

Regarding the disparity of out-commuting, the value of out-degree is decisive as well. The grade of dependency is significantly smaller in case of settlements larger than 50,000 inhabitants, while it is more-or-less similar (Y_2>~0.3) in case of settlements smaller than 50,000 inhabitants.

Table 1

Disparity of settlements by categories of the population number, 2011

Category of population	In-commuting		Out-commuting		Disparity of undirected graph
	Disparity	In-degree	Disparity	Out-degree	
Budapest	0.012	2088.00	0.044	876.00	0.014
100,000 – 999,999	0.029	534.88	0.069	258.75	0.029
50,000 – 99,999	0.043	380.30	0.108	179.60	0.068
20,000 – 49,999	0.089	211.52	0.306	118.62	0.164
10,000 – 19,999	0.105	122.35	0.290	83.49	0.194
5,000 – 9,999	0.126	64.76	0.324	58.32	0.229
2,000 – 4,999	0.176	34.07	0.360	38.26	0.293
1,000 – 1,999	0.198	21.46	0.352	27.34	
1 – 999	0.307	9.73	0.343	14.04	
Total	*0.246*	*26.87*	*0.344*	*26.87*	

Source: Own calculation on the basis of census data, HCSO.

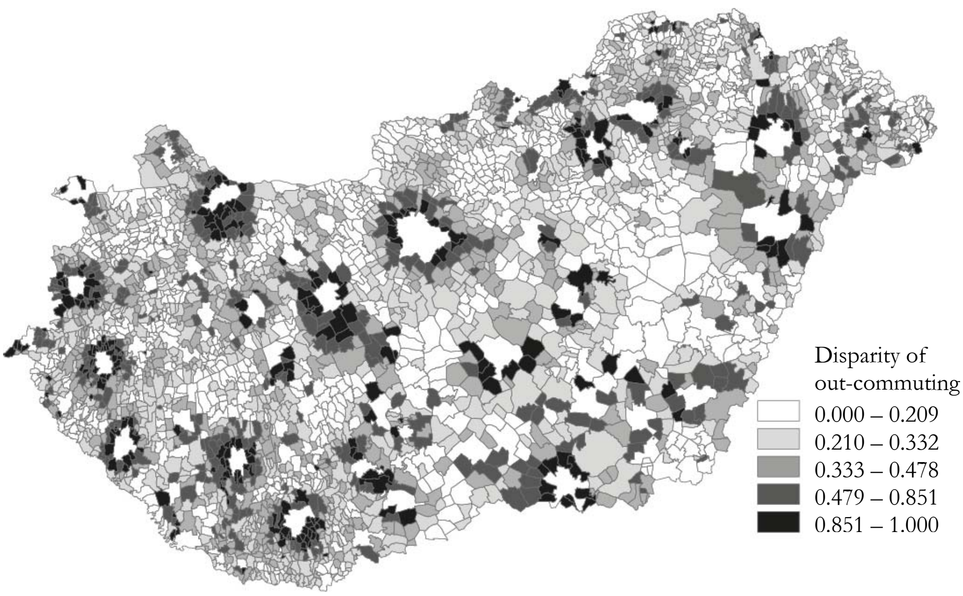
[1] From settlements smaller than 5,000 inhabitants, the commuting people make a beeline towards a 15–20 km area on average. This value in the case of settlements with 5,500 and more than 50,000 inhabitants is 20–30 km and 40–50 km, respectively. In contrast, from Budapest, people commute up to only 30 km (Pálóczi et al. 2014).

The data of the undirected graph shows that aggregation of the data covers the characteristics among groups; that is, modification of the method in the literature (De Montis et al. 2007) contributed to a more detailed analysis. In general, with the decreasing number of inhabitants, one-sided dependency increases and the direction of out- and in-commuting becomes increasingly concentrated. It is worth noting that dependency is not disadvantageous in itself and it can be interpreted while considering other factors as well (e.g. economic activity, unemployment and commuting intensity).

By studying the spatial distribution of the disparity of commuting, two statements can be made (Figure 3). The grade of dependency of out-commuting is high in the regions of the employment centres. The greatest continuous regions can be found around Győr, Székesfehérvár and Budapest.

Figure 3

Disparity of out-commuting, 2011



Source: Own construction based on the census data, HCSO.

The extent of dependent areas is influenced by the drawing effect of employment centres besides the settlement network factors. A fine example of it can be observed in the limited extent of the region in the Sajó Valley (Kazincbarcika) depending on Miskolc or the mangled appearance of the southwestern part of the agglomeration around Budapest due to the effects of economic suburbanisation (Budaörs, Törökbálint). Cross commuting in these regions may have a positive effect on the grade of utilisation of the traffic network, and the profitability of mass transport as opposite traffic may become significant in peak time periods.

This method may help in exposing the reasons behind the regional wage curve (wage difference in case of employees with similar parameters is formed in accordance with unemployment in the vicinity of their workplace; for more information, see Kertesi–Köllő 1998) and in planning measures. Disparity regions characterised by high ratio of unemployment could be classified into settlements from which commuting is possible only to the closest town due to travel costs and insufficient traffic relations.

Disparity could also be applied to classify peripheries of commuting where settlements with poor commuting intensity and low disparity are found (small-scale, branching commuting). The results could be used for studying the spatial pattern of social marginalisation (Nagy et al. 2015).

Spatial division procedures

Identifying spatial units in which real spatial relations and processes operate presents a problem for several scientific fields (e.g. public administration, spatial science, and geography). Spatial units cannot be regarded as natural entities as they are designated via classification based on objective and subjective criteria (Nemes Nagy 1998; Hajdú 2005); therefore, there are no universal methods for designating spatial units. A fine example is the debate regarding the agglomeration around Budapest (Tóth–Schuchmann 2010). Criteria are selected based on their own considerations and purpose of the research. Delimitations using commuting datasets belong to the attraction district-based type (Barancsuk et al. 2014; for details on labour market district delimitations see Pénzes et al. 2014).

In the present study, a social-physical method of the complex network analysis was applied instead of the more widespread – associated with commuting – spatial division mechanisms. In the course of the network analysis, techniques suitable for spatial division are called locally dense partial graph search (Tibély 2011) or simply community detection (Kovács et al. 2012). Henceforward, partial graph search and community detection are used as synonyms.

Although there is no precise, generally accepted definition of network tangles (in other words, groups, clusters, modules and communities; Tibély 2011), they could be described as 'dense' partial graphs of the network within which nodes connect to each other more frequently and – in the case of weighted networks – more intensively than in the other parts of the network (Derényi et al. 2006).

Within group searching procedures, three categories – based on local, global, and nodal similarities – can be identified (Fortunato 2010). In the *local* approach, tangles of sub-graphs and their adjacency conditions are in focus while other parts of the graph are ignored. The *global* definition treats sub-graphs as structural units of the graph; that is, identifiable characters of the sub-graph become recognisable when the sub-graph is compared with the whole graph. Definitions based on *nodal* similarity select sub-graphs as a group of nodes similar to each other. The criterion of similarity is the presence or lack of an edge between node pairs (De Montis et al. 2013).

Results of partial graph search performed on non-weighted graphs can identify the modules based on topology. In contrast, when weighted networks are analysed, clusters are determined by not only topology but also the weight of the given edges. As a result, commuting was studied as a weighted network in our study.

For searching groups of nodes, there are numerous methods and algorithms available in the literature. Fortunato 2010 identifies three major classes:

- divisive algorithms,
- optimisation methods and
- spectral analysis.

Methods that cannot be categorised in the above three are also known, such as Q-state, Potts model, clique percolation (Derényi et al. 2006), random walk, Markov cluster algorithm, maximum likelihood and the L-shell method (Fortunato 2010).

Although there is extensive literature on the procedures developed for different disciplines, intensive, detailed and careful evaluation and comparison of the given indexes and procedures besides the extensive method development are missing (Tibély 2011). In the present paper, the results of two methods are mentioned and one is presented in detail using the example of a Hungarian dataset.

Structural equivalence analysis

In a previous study, the possibilities of one of the methods being based on node similarities – CONCOR (CONvergence of iterated CORrelations) analysis – were discussed (Pálóczi–Pénzes 2015). Using this method, structurally equivalent members can be identified. Structurally equivalent members belong to a group that is connected to the same settlements with similar intensities (for details, see Kürtösi 2005). According to our hypothesis, this method is suitable for identifying settlement groups that connect to similar employment centres with similar intensities; that is, it can be assumed that their employment conditions and number of available jobs via commuting would change in the same way in cases of both recession and economic boom. (Of course, the qualification of employees and their industrial branch would cause differences.) Based on the results, this method cannot be applied successfully to complex, branching connection systems such as a commuting dataset. Although the analysis based on the method detected the intensive attraction districts of the major employment centres and exposed their inner conditions, classification of the majority of the settlements was not possible. The number of groups depended on the subjective decision of the scientists, and this influenced the final results significantly (Pálóczi–Pénzes 2015). Furthermore, in the case of networks with higher number of elements, the method requires significant computer aid.

Clique percolation algorithm

The clique percolation algorithm identifies groups among whom overlapping is possible. Using this method, groups will comprise of the densest elements of the network, called cliques. Within a clique, every node is connected to every other node and the groups are continuous chains of such cliques (for description of the method, see Derényi et al. 2006).

In the case of real networks, there seem to be overlaps among the groups. For example, in contact networks, one person can be a member of several groups that know each other well (e.g. family, colleagues and friends), and overlapping is possible among groups (e.g. classmate and friend). If overlap-free groups are searched (see the results of Louvain optimisation), then members who do not 'know' each other may be included into designated groups (false positive) and several nodes may be included into different clusters (false negative) despite their apparent interdependence. In theory, the clique percolation algorithm is suitable for avoiding such mistakes. This is why the commuting dataset was analysed using this method; however, the analysis was not successful as it identified 5,000 groups. Although it reduced the number of groups in weighted networks, we did not find it suitable for spatial research; therefore, the results are not discussed in detail here.

Modularity optimisation using the Louvain method

The Louvain algorithm for optimisation (Blondel et al. 2008) was chosen because it was used successfully in commuting research (De Montis et al. 2013). The method is based on maximisation of the objective function called modularity (Q_w; Newman–Girvan 2004). The value of the function shows the number of edges within a given community – comparing it with the number of edges outside the community. The value makes it possible to compare how a partial graph suits the criteria in relation to every other possible variation. This value may vary between -1 and +1. It can also be zero if no more partial graphs can be formed within the given sub-group. A negative value indicates that there is no point in further dividing the network: the best division is the given group. The function can be defined in the case of weighted networks as follows:

$$Q_w = \frac{1}{2W} * \sum_{ij} \left(w_{ij} - \frac{S_i S_j}{2W} \right) * \delta(c_i, c_j)$$

where w_{ij} is the weight of edges connected to nodes 'i' and 'j', $S_i = \sum_j w_{ij}$ (node strength): sum of the weight of edges connected to node '', $W = \frac{1}{2} \sum_{ij} w_{ij}$ sum of the weight of all edges, and $\delta c_i, c_j$ is a function that equals one if nodes 'I' and 'j' belong to the same community and are not connected to any other at all.

The greatest advantage of the Louvain method is that the number of partial graphs comes from the algorithm. Without an ordered number at the beginning, it avoids the subjectivity of scientists in contrast to other methods. The algorithm is based on the following iterative steps (Table 2):

Table 2

Iterative process of the modularity optimisation

Step	Task
1	Each node is assigned to a unique single community.
2	Neighbour nodes of each target node are preferentially included in the same community if the variation of the modularity (ΔQ_W) is positive.
3	This aggregation process proceeds until the modularity function Q_W reaches a maximum.
4	A new network is then built in which nodes correspond to the communities obtained in step 3; each link connecting a pair of communities is featured by a weight equal to the sum of the weights of the external links originally between them. The internal links are represented by a self-loop, whose weight is equal to the sum of their internal weights.
5	Step 1 applies to the last network.

Source: Blonde et al. 2008: Table 1, referring to: De Montis et al. 2013.

The function ΔQ – applied in step 2 – measures the volume of change caused by the separation of the given node from 'C' community and the connection of the given node to 'C' community.

The study was performed on a symmetric, undirected weighted graph (web link: 1) using the software Pajek. Besides the original algorithm, the software enables the control of the level of community resolution using the resolution parameter (for description of the procedure, see Arenas et al. 2008). In case the value of the resolution is 1, the algorithm runs in an unchanged version. If the value is increased, the software carries the iteration and produces several smaller modules or, if resolution is decreased, fewer but greater modules are produced.

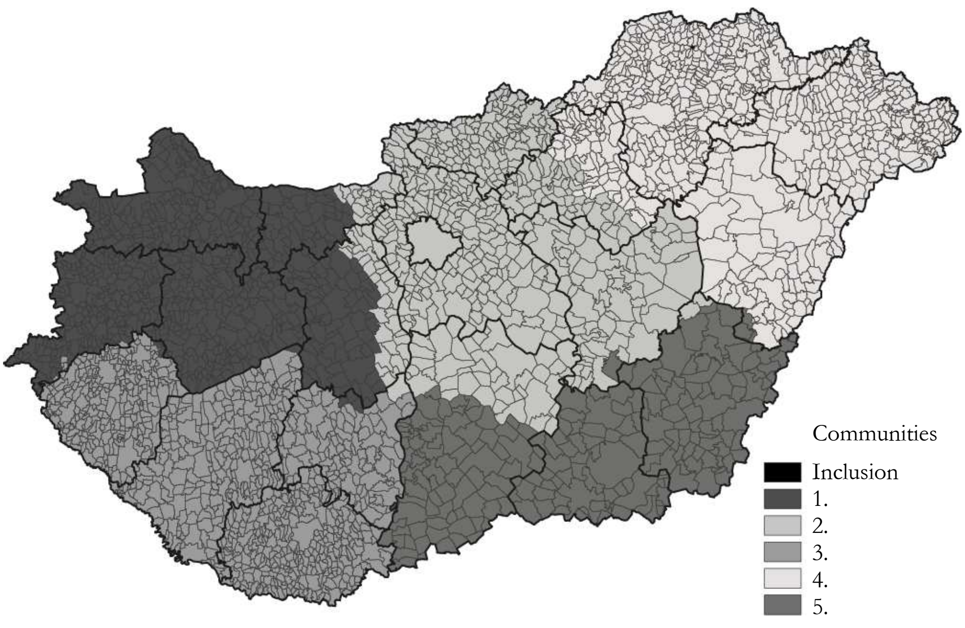
Based on experiences, running the algorithm once frequently results in an unstable module structure; therefore, significant differences may occur among the modules at similar parameters. Consequently, the algorithm was run several times at the same resolution value. Spatial divisions belonging to the same resolution values were tested using the recommended correlation analysis (web link: 1). In conclusion, the stability of the modules belonging to resolution values of 0.2 and 1 exceeded the Cramer's V value of 0.99.

Based on the results, the method produced spatially continuous settlement groups that can be interpreted professionally. Thus, the method is suitable for regionalising commuting connections (Figures 4 and 5).

Results revealed that labour market settlement groups are not in harmony with the NUTS2 level regions of Hungary (Figure 4). The most significant modification to the regions is caused by the complex and intensive connection system of Budapest, determining central Hungary. The spatial extent of module 2 (Figure 4) is much less towards the west due to the marked employment role of Northwestern Hungary. The borderline of the Komárom-Esztergom and Fejér counties is the same as the borderline in Figure 5. This stable borderline indicates the balance of the attraction of employment centres. County-sized areas are connected to settlement group 2. At this resolution (0.2), county borders and natural barriers (Balaton and certain sections of the Danube) play important role. Regarding settlement groups, number 5 seems to be most similar to the NUTS2 region (except for northern Bács-Kiskun).

Figure 4

Network communities based on the Louvain modularity (resolution=0.2), 2011



Source: Own construction based on census data of HCSO.

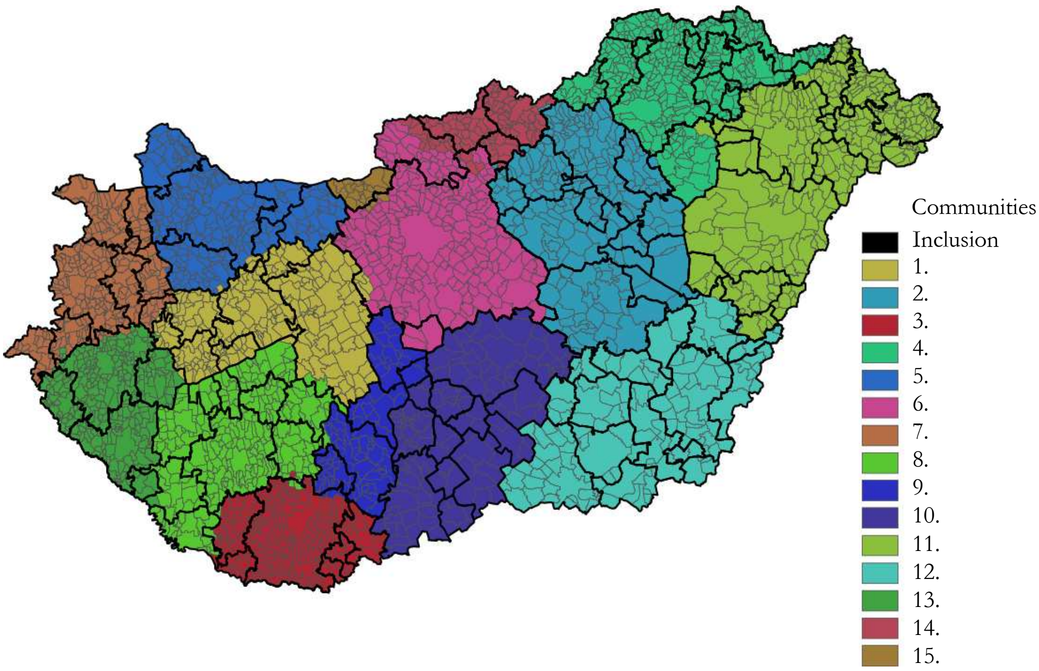
Results were interpreted together with a former local labour market attraction district delimitation (Local Labour System [LLS]); thus, the advantages and disadvantages of the applied method became more visible. The other spatial delimitation was made using the same dataset, however, with a completely different methodical approach (Pénzes et al. 2014). In general, the LLS yielded more detailed results that could be interpreted easily, whereas with the network analysis system, level relationships could be recognised more easily, and the relationships of LLS districts with each other could be understood as well.

Unfortunately, comparison of the two studies is limited due to differences in magnitude between the numbers of spatial units (15 and 123); however, comparison of the modules and LLS districts yielded information (Figure 5). In numerous cases, the border of modules and LLS districts is the same and modules are composed of several LLS districts, so that these modules represent higher hierarchy levels. In order to overview the results, they are compared with the well-known county borders (Figure 6).

In cases in which the attraction of an LLS centre crosses its county border, the adjustment of the module border to the LLS district is expected (LLS districts of Mezőkövesd, Tiszaújváros, Szeghalom, Szarvas, Kecskemét, Dunaújváros, Dombóvár, Tamási, Nagykanizsa, and Keszthely-Hévíz). In contrast, certain LLS districts are connected to the module of the neighbouring county (LLS districts of Kunszentmárton, Solt, Csurgó, Sopron and Kapuvár).

Figure 5

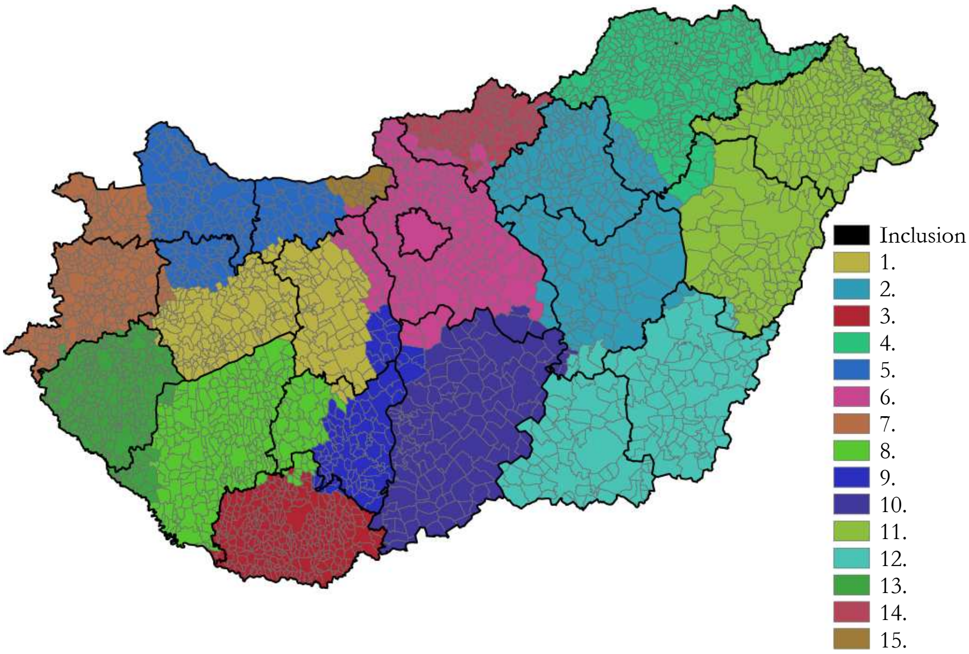
Network communities based on the Louvain modularity (resolution=1), 2011



Source: Own construction based on census data of HCSO.

Figure 6

Network communities based on the Louvain, modularity (resolution=1), 2011



Source: Own construction based on census data of HCSO.

Module 5 (Győr) is composed of more than half a dozen LLS districts, and module 9 is located in the eastern parts of Fejér and Tolna counties and on the left side of the Danube, thanks to the bridges at Dunaföldvár and Pentele in M8 motorway, which are conglomerates that differ from the rest of the small-border modifications due to their size. In their cases, the settlement groups differ significantly from their counties.

Conclusions

In the present study, the application possibilities of graph-theory-based network analysis in spatial research were studied. The most important characteristics of random and scale-free networks were presented based on national and international literature. When characteristics are presented, their role in studying features in spatial research is also discussed. Conclusions from the theoretical description may contribute to better understanding of the regularities of flow of resources between settlements and ways to strengthen or reduce these regularities according to the purpose of regional development.

Dependency conditions of out- and in-commuting people in settlements were analysed based on the commuting data of the census in 2011. Out-commuting generates stronger dependency relationships in the case of all settlement categories than in-commuting. In general, the decreasing population of settlements results in stronger dependency relationships. According to the results, the disparity index could be used successfully in other spatial research as well.

Attempts were made to apply the group forming procedures of network analysis to spatial division. Using previous research, the evaluation of three methodological applications was performed. By applying the CONCOR analysis, delineation of structurally equivalent elements can be made. This procedure is less suitable for analysing a complex, branching relation system such as commuting. It can be used successfully to identify groups in the attraction districts of only the most significant employment centres. Objectivity of the method is reduced if the researcher decides the number of groups to be formed.

The other group identifying procedure described was clique percolation. By applying this method, detecting the overlaps in the attraction districts of commuting becomes possible. However, the procedure delineated too many groups at the national level, even when the parameters were modified. This method could be suitable for carrying out district- or county-level analyses.

Modularity-optimisation conducted using the Louvain method proved to be suitable for delineating greater spatial units as well. Based on the results, settlement groups (regions) formed according to employment relations – that is according to regionalism – adjusted less to NUTS2 regions and resembled the county borders more. Differences from the county system are not single differences caused by specialities of the method; they reflect real commuting relations proven with the LLS districts taken from our previous study. The method could be used to determine the hierarchy of local labour-market attraction districts and to study further spatial interactions.

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WEB LINKS

http://mrvar.fdv.uni-lj.si/pajek/community/CommunityDrawExample.htm

Attempts to delineate functional regions in Hungary based on commuting data

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The issue of defining functional regions in Hungary is presented in this paper, which contains detailed methodological description with the help of relevant studies from the Czech Republic and Slovakia. The use of Smart's measure together with the CURDS algorithm and the relatively new concept of trade-off constraint function with four different sets of parameter values provided four optional solutions for this issue, based on the analysis of daily travel-to-work flows from the 2011 census. The resulting regions correspond to the micro-regional level and give valuable additions to the discussion about regionalization. The paper provides basic descriptive statistics for each of the four variants of functional region systems, which enables their overall evaluation (seeing advantages and disadvantages) and mutual comparison (seeing similarities and differences), and thus facilitates an informed debate on future work in functional regionalisation in Hungary carried out with respect to different purposes.

Keywords:
functional regions,
commuting,
census data,
Hungary

Introduction

Delineation of territorial units is one of the most important and crucial issues for experts of human geography, regional science or regional development planning. Numerous approaches and methodologies were developed and invented in order to create formal and functional regions. The term of functional region has been introduced into human geography by American geographers such as Philbrick (1957) and Nystuen–Dacey (1961).

The challenge of delineating functional regions is well expressed by Hartshorne (Hartshorne 1939: 275 – cited by Paasi 2009: 4736):

'The problem of establishing the boundaries of a geographic region presents a problem for which we have no reason to even hope for an objective solution. The most that we can say is that any particular unit of land has significant relations with all the neighbouring units and that in certain respects it may be more closely related with a particular group of units than with others, but not necessarily in all respects'.

Functional, nodal regions can be regarded as open systems. Investigation of the build-up of such systems would first require an analysis of movements (channels along which movements occur), networks, nodes and their hierarchical organisation, acknowledging that this complex system ultimately forms surfaces. According to the orientation of the flows and interactions, four types of functional regions can be identified (oriented, channelled, circular and nodal) besides the random structure (Klapka et al. 2013a).

The objective of the delineation of functional regions is to maximise the ratio of within-region and between-region flows, so the analysis is based on relational dataset (Haggett 1965). During the delimitation process, the horizontal functional relations should be maximised within a region and minimised across its boundaries in order to fulfil the principle of internal cohesiveness and external separation (Smart 1974; Karlsson–Olsson 2006; Farmer–Fotheringham 2011; Klapka et al. 2014).

Administrative or political territorial divisions are not able to reflect the rapid changes in geographical reality, thus correctly defined functional regions can be more appropriate as a geographical tool for normative use (Haggett 1965) than administrative regions.

The interactions most commonly used in functional region delineations are travel-to-work flows, particularly the daily ones. Commuting to work or labour commuting is one of the most frequent and regular movement of the population with daily or rare periodicity. Functional regions based on these relations and flows are referred to as local labour market areas (LLMA) or travel-to-work areas (TTWA).

This study contributes to the discussion of the functional regional system in Hungary by applying a sophisticated regionalisation algorithm using daily travel-to-work flow data. A significant part of the current study emphasises the filtering process of the dataset. Current delimitation is the first attempt to delineate functional units based on the census data with the help of this methodology.

Methods of functional regionalisation

A functional region is an abstract spatial concept, which is why there is no sole correct method for the delineation of functional regions and why different analyses of the same data can provide considerably different results (Laan–Schalke 2001).

From all possible combinations, the literature tends to favour three approaches to functional regional taxonomy: clustering methods using numerical taxonomy (e.g. Smart 1974) or graph theory procedures (e.g. Nystuen–Dacey 1961; Karlsson–Olsson 2006; Benassi et al. 2015) and the multistage (or rule-based) procedures (e.g. the approach developed by the Centre for Urban and Regional Development Studies [CURDS] in Newcastle, UK – see Coombes et al. 1986 and Coombes–Bond 2008 for more information).

The approach developed by the research team at CURDS became one of the most successful and acknowledged approach to functional regional taxonomy. Considerable European experiences are available from Italy (Sforzi 1997), Slovakia (Bezák 2000; Halás et al. 2014), Spain (Casado-Díaz 2000; Flórez-Revuelta et al. 2008), Belgium (Persyn–Torfs 2011), Poland (Gruchociak 2012), and the Czech Republic (Klapka et al. 2013b; Tonev 2013).

The measure proposed by Smart (1974) [1] is the most frequently used as, mathematically, it is the most appropriate way for the relativisation and symmetrisation of statistical interaction data. It was also used by the second and third variants of the CURDS algorithm (Coombes et al. 1986; Coombes–Bond 2008); its notation is as follows:

Smart's measure: $$\left[\frac{T_{ij}^2}{(\Sigma_k T_{ik} * \Sigma_k T_{kj})} + \frac{T_{ji}^2}{(\Sigma_k T_{jk} * \Sigma_k T_{ki})}\right], \qquad [1]$$

where T_{ij} denotes the flow from spatial zone i to spatial zone j and T_{ji} denotes the flow from j to I; $\sum_k T_{ik}$ denotes all outgoing flows from i; $\sum_k T_{kj}$ denotes all ingoing flows to j; $\sum_k T_{jk}$ denotes all outgoing flows from j; and finally $\sum_k T_{ki}$ denotes all ingoing flows to i.

The second interaction measure was proposed by Coombes et al. (1982) in the first variant of the CURDS algorithm [2], and its notation is as follows:

CURDS measure: $$\left[\frac{T_{ij}}{(\Sigma_k T_{ik})} + \frac{T_{ij}}{(\Sigma_k T_{kj})} + \frac{T_{ji}}{(\Sigma_k T_{jk})} + \frac{T_{ji}}{(\Sigma_k T_{ki})}\right], \qquad [2]$$

In the current analysis, the adjusted and simplified second variant of the CURDS algorithm is applied (Coombes et al. 1986). The objective of the investigation is to apply the adaptability of the methodology and parameters tested in the Czech (Halás et al. 2015) and Slovak (Halás et al. 2014) case studies to the Hungarian settlement network. This version of the second variant of the algorithm is favoured over the more recent one for several purposes. First, it provides the possibility for some international comparability of the procedure and results. Second, it might be appropriate to identify a set of potential regional cores, a possibility that the newest variant (Coombes–Bond 2008) does not provide.

Regionalisation attempts in Hungary

It is important to emphasise that the methodology used in the current analysis represents a new approach among the Hungarian regionalisation attempts even though numerous considerable delimitations were published during the last few decades. This is why it is relevant to overview the previous studies and methods to delineate functional regions in Hungary (some part of these were briefly summarised in a preceding paper about Local Labour Systems – Pénzes et al. 2015).

The issues of territorial division in Hungarian literature are generally discussed by Dusek (2004), Nemes Nagy (2009), and Barancsuk et al. (2014), among others.

As early as the 1960s, the definition of functional regions appeared in the Hungarian human geography (Mendöl 1963), followed by additional researches focusing on the spheres of influences of larger towns (Beluszky 1967). However, this approach avoided the utilisation of commuting data. Functional urban regions were delimited for the whole of Hungary by using commuting relations that assigned each settlement to a single centre and conforming to the hierarchical scheme of the national development concept (Lackó et al. 1978). The country's territory was segmented based on the public transport connections forming spheres of influences (Szónokyné Ancsin–Szinger 1984) that could also be regarded as functional units. Commuting to work purposes was used as the basis for the dynamic examination of catchment areas (Erdősi 1985). Numerous functional analyses were made for the limited extent of the area – typically for towns and their hinterlands, for example, with the help of inter-urban telephone calls (inter alia Tóth 1974), commercial relations (Kovács 1986) or complex approaches (Timár 1983; Bujdosó et al. 2013).

After the year 2000, as a part of the Regional Polycentric Urban System (RePUS) project, local labour market systems, or the Local Labour Systems (LLSs), were delineated based on the commuting for work data of the 2001 census (Radvánszki–Sütő 2007). Functional Urban Districts (Sütő 2008) were aggregated by utilising these results. The LLS delimitation was updated and modified according to the last census data from 2011 (Pénzes et al. 2015). This approach provided a two-stage model in which the centres were assigned first and then the catchment areas were identified. In this approach, employment centres were in the core of the delimitation, and commuter's flows were simplified to those oriented towards them. In this respect, the methodology can be regarded as appropriate to identify nodal regions (Klapka et al. 2014). Complex and combined aspects were applied in an extended case study comprising gravity-based theoretical investigations (Hardi–Szörényiné Kukorelli 2014).

It is important to emphasise that alternative approaches also appeared besides the utilisation of the dataset of commuting to work. Commuting to school was also analysed to discover the inter-municipal relations by the example of the agglomeration of Budapest (Keserű 2013). The investigation of road traffic played an outstanding role in the study of inter-municipal relations (e.g. Szalkai 2010 and Tóth 2013). Some recent analyses delineated the functional regions based on the online social network (Lengyel et al. 2015).

Methodology of the applied functional regionalisation and parameters during the procedure

The current delimitation analysis is the first attempt to adapt a methodology tested previously in other Central European countries listed above. This is why we disregarded the detailed description of the methodology. See Klapka et al. (2014) and Halás et al. (2015) for more information on this. However, some of the steps of the calculation need to be reviewed in order to understand the current analysis.

The process of the algorithm's application can be separated into three stages, which includes four steps and other operations. As part of the first stage, the process starts with the identification of proto-regions (by critical values of the interaction measure), followed by the assignment of remaining spatial zones and finally the assessment of the validity of the solution.

A potential regional core – as part of the interaction measure – must fulfil the criteria of job ratio function (the ratio of total ingoing flows of commuters and total outgoing flows above 0.8) and supply-side (or residence-based) self-containment (ratio of the inner flow and total outgoing flows above 0.5). If these potential cores do not fulfil the criteria, they are identified again based on the mutual relations between them and the value of the interaction measure. This iterative process is repeated until every basic spatial zone is attached to some of the proto-regions. The resulting set of cores and multiple cores is considered as a set of the proto-regions.

Constraint function is used in the following step to set a minimum size and self-containment criteria for the resulting regions. The constraint function is an essential part of the regionalisation algorithm and determines which regions will be maintained and will appear in the resulting regionalisation through the optimisation of the size and self-containment. The constraint function controls these two parameters of the resulting regions and the so-called trade-off between them.

At the same time, the *minimum size* of the functional region is modifiable. The size of a region can be defined by different criteria. The most general feature of a region is its population size, which is a standard and easily accessible indicator.

The self-containment definitions produced significantly differing values, and the index of unidirectional self-containment in some cases (when its value is lower than 0.66) resulted in inadequate concepts that did not conform to the basic definition of a functional region (Halás et al. 2015). Self-containment is a critical parameter, and its value cannot be allowed to drop under 0.5 – this means that at least 50% of all interactions (commuters) to a region should occur within the region.

The constraint function applied in the current research has the form of a continuous curve (Figure 1), and its shape is determined by four parameters that can be easily set by the user: the upper and lower size limits and the upper and lower self-containment limits (Klapka et al. 2014). The referred methodology of the continuous constraint function is a modified version of the formula –see Halás et al. (2015) for details.

Plotting the resulting regions on a graph is the following step as part of the delineation process. Each region, according to the values of its size and self-containment, can be plotted on an x–y graph as a point (β_1 and β_2 are lower and upper limits of the self-containment; β_3 and β_4 are lower and upper limits of the size in Figure 1). Regions will appear in the upper-right part of the graph from the curve of the constraint function. In practice, the plotting of regions on the graph provides a refinement tool that can help identify more appropriate values for the parameters.

Figure 1

Continuous constraint function

Source: Halás et al. 2015, Figure 3.

The refinement process of testing parameters should start with lower values of size and self-containment. The algorithm produces more regions when smaller parameter values β_1–β_4 are used, but their position on the x–y graph and knowledge of the settlement and regional system of a given territory help to make an informed decision as to which regions should be eliminated by setting the size and self-containment parameters to higher values. A graphical assessment of the results can help identify the course and position of the constraint function on the graph. If there is a significant gap in the field of points, that is an area with relatively small density of points, then it is the area of discontinuity of the size and self-containment values of the individual regions, in which a new trade-off constraint function can be located without placing it too close to the size and self-containment values of too many regions. This concept is similar to the one behind the graphical cluster analysis methods or behind the methods for identification of natural breaks in data distribution (e.g. for choropleth map intervals).

Dataset and data corrections within the analysis

The analysis was based on the commuting dataset of the Hungarian census in 2011 carried out by the Central Statistical Office (for the characteristics of the commuting, see Kiss–Szalkai 2014). The survey was realised using harmonised international methodology in which commuting data were derived from the residence and locality of the workplace. The dataset contains aggregated data for the level of settlements (not personal microdata).

Some modifications were necessary. First of all, employees working abroad (83,822) and in more or changing localities (153,410) were filtered out. The districts of Budapest and existing commuting relations were unified. The dataset contains relations that do not conform to the possibility of daily commuting, because of great geographical distance and inadequate transport connections (similar errors were indicated in the Czech dataset as well – see Tonev 2013). In order to use an appropriate value as criteria, the relating literature was necessary to be overviewed.

There is characteristic distribution in the time of travelling, with daily periodicity regarded as constant in time and space since the Neolithic period (Marchetti's constant), apart from the location, way of travelling and other different conditions in the lifestyle. Regional scale analyses since the 1960s defined the characteristic travel time as 1.1–1.3 hours per day (e.g. Zahavi 1976). This suggests that increasing travelling speed is accompanied by increasing travelling distance instead of time-saving. Newest results tend to confute theories about travel time budget (Barthélemy 2011). As a consequence, universal travelling distance or time cannot be determined expressly as a threshold for daily commuting in a given relation.

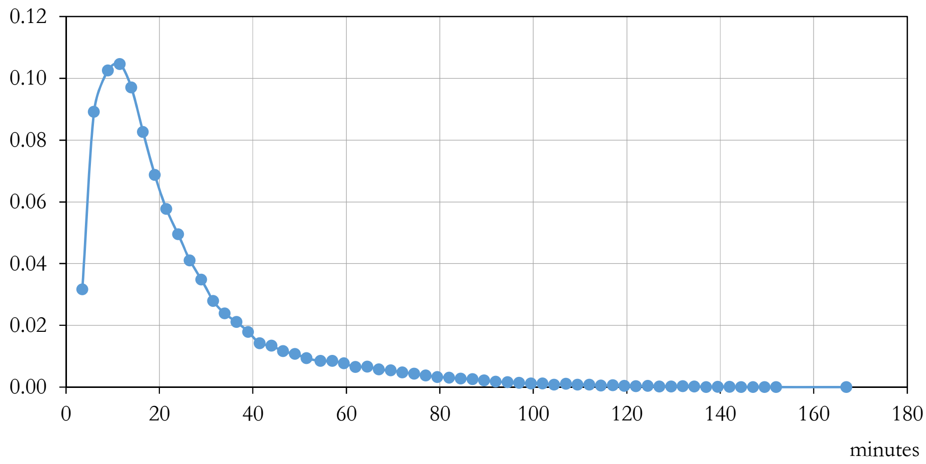
Commuting with outstanding distance or time is called extreme commuting. The definition of extreme commuting is varied country by country – it is 100 miles (167 km) for the United States, 50 miles (83 km) for the United Kingdom, 100 km for Sweden and Norway, according to the European long-distance travel mobility survey (Vincent-Geslin–Ravalet 2016). Five to ten per cent of the active European population is assumed to commute more than two hours per day, at least three days a week on average (Lück–Rupperthal 2010).

Different thresholds can be found in Hungarian literature. The lowest value – 45 km – appeared in the case of commuters with minimum wage for whom travel costs mean the difference between available wage and the amount of social transfers (Bartus 2012).

It is important to emphasise that modelled travelling time is generally lower than the real values, as the optimised conditions were calculated using the maximum legal speed, and quality of road infrastructure or traffic jams were not considered. At the same time, commuters using public transport facilities must necessarily expect even greater travelling time (disregarding some main railways where public transport is competitive against individual transport).

Figure 2

Relative frequency of travelling time and number of relations



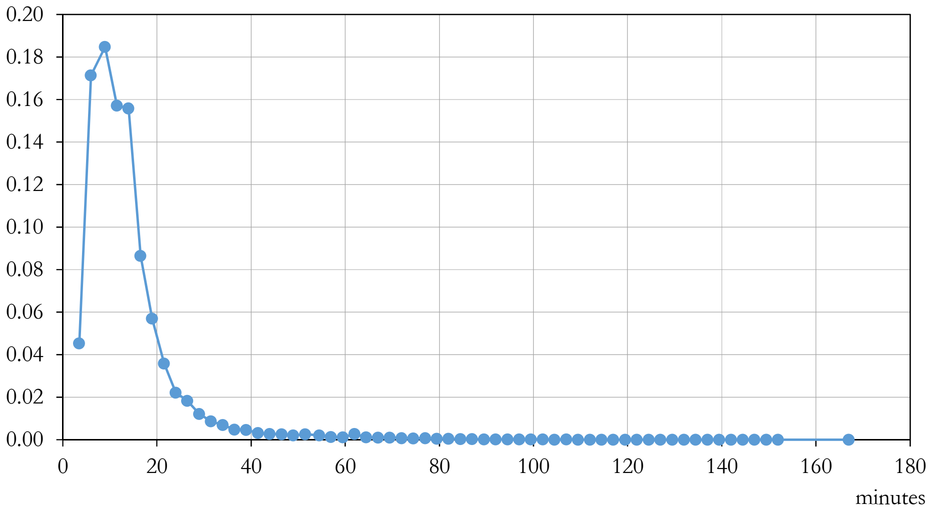
Source: Calculated by the authors based on the census dataset.

In order to separate the daily and weekly commuting, the relative frequency of the relations between settlements and number of commuters was analysed in the context of travelling time and distance. Travelling time and the number of relations represent a characteristic peak at five minutes of travelling time in the frequency followed by a steep increase (Figure 2). The curve flattens at 40 minutes of travelling time, and commuting became incidental from 90 minutes. Additional features regarding commuters are provided by the numbers in the context of travelling time. It is clear that large-scale commuting radically decreases between the 15 and 20 minutes interval of travelling time and becomes marginal after 40 minutes of travelling time (Figure 3). The most intensive sphere of employment centres can be generally delimited at the 20 minutes travelling time isochron.

Travelling distance was also analysed. The relative frequency of the relations represented a similar distribution to the previous ones. The maximum distance value was 10 km, presenting a steep increase after. However, the number and ratio of relations was regarded as significant between 50 km and 100 km (Figure 4). At the same time, the number of commuters was negligible over 50 km (Figure 5).

Figure 3

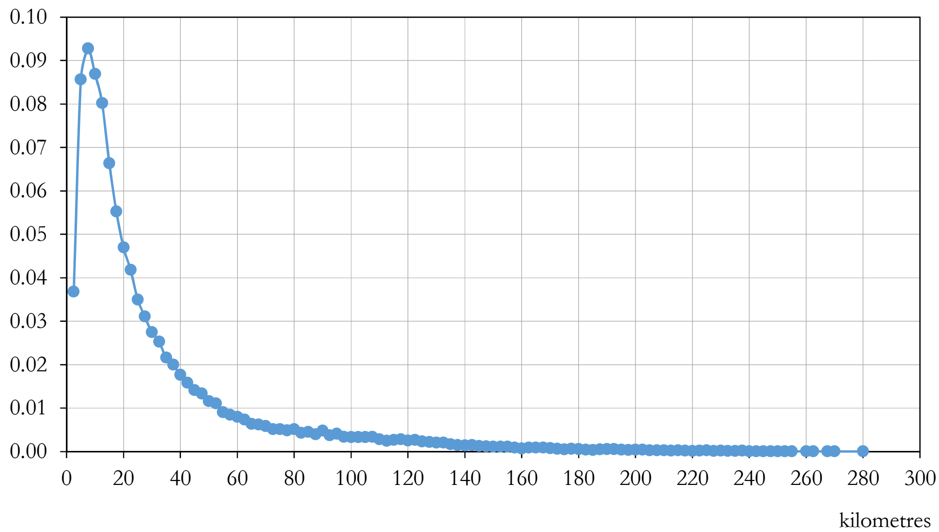
Relative frequency of travelling time and number of commuters



Source: Calculated by the authors based on the census dataset.

Figure 4

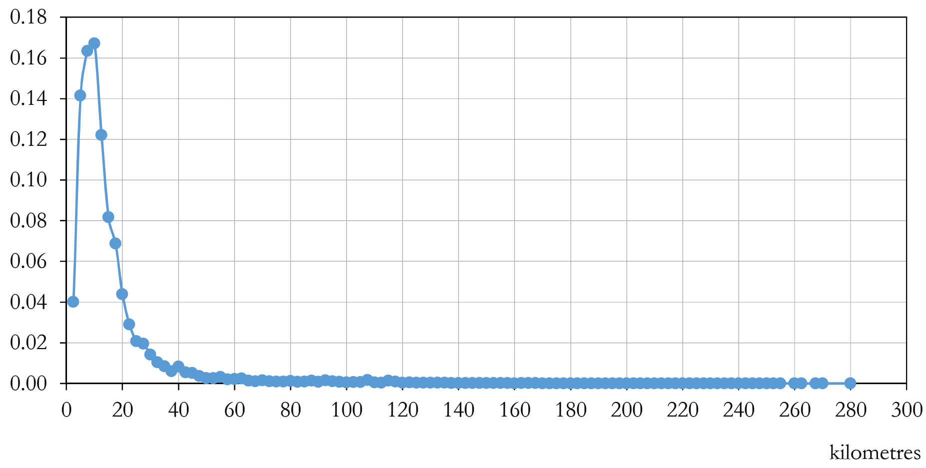
Relative frequency of travelling distance and number of relations



Source: Calculated by the authors based on the census dataset.

Figure 5

Relative frequency of travelling distance and number of commuters



Source: Calculated by the authors based on the census dataset.

According to the listed features, commuters who were non-daily commuters with place of residence further than 100 km and travelled 90 minutes by car from their place of work were filtered out of the matrix. These thresholds ensured the involvement of not only the most intensive part of the commuting but also the considerable relations assumed as daily periodicity. As the result of this approach, weak connections in terms of network analysis were also involved in the investigation. Relations of over 90 minutes (hypothetically, three hours of travelling per day) and a 100-km distance were assumed as non-daily commutes.

The accessibility and distance matrix was created based on the road network layer of Geox Ltd. from 2013. Travelling time and distance were optimised to the quickest solution between settlements based on the maximum speed of personal cars by running the ArcGIS Network Analyst application (Tóth 2014). Before filtering, the commuting matrix contained 84,747 flows (directional pairs of settlements between which at least one person commutes) and 3,705,491 interactions (commuters); after the filtering, it contained only 70,459 flows (83.14%) and 3,660,953 interactions (89.80 %), of which the inner (within a settlement) commuting amounts to only 3,151 flows (0.04 % of the filtered matrix), but up to 2,545,198 interactions (69.52 % of the filtered matrix), i.e. persons having both residence and employment in the same settlement.

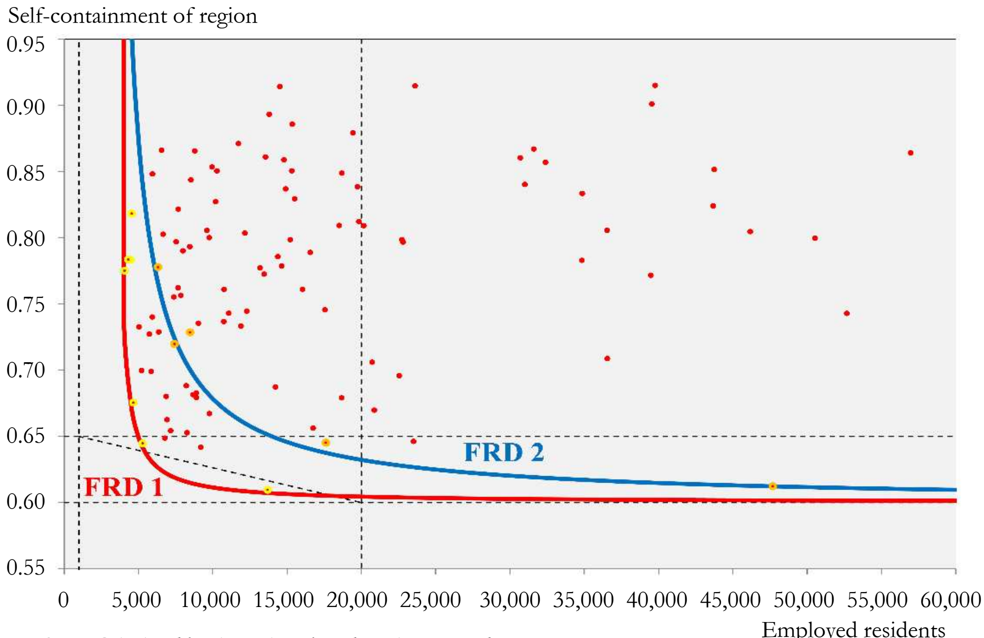
Daily and non-daily periodicity commuting could be detected using microdata of the census, but it was not possible to analyse this case in this way.

Results of the analysis by the case study of Hungary

The algorithm was run four times (1, 2, 3a and 3b versions) based on the commuting dataset using four different sets of parameter values pertaining to the size and self-containment of the regions – in the following, the resulted variants of the regional system are denoted as 'FRD' standing for functional regions based on daily interactions (Figure 6). The first run resulted in a general overview of the features of potential functional regions in the Hungarian settlement system due to the set of very small parameter values. During subsequent runs of the algorithm, regions that did not meet the criteria set by the constraint function were dissolved into individual settlements/municipalities and then assigned to other regions (a small village – Gagyapáti – was not assigned to any region because of its local labour isolation). The decrease in the number of functional regions resulted in an increase in their average size regarding the number of settlements and number of employed residents (Table 1).

Figure 6

Use of the constraint function on x–y graph by the example of FRD 1 and 2



Source: Calculated by the authors based on the census dataset.

The algorithm provides contiguous regions without the need for further adjustments with several insignificant exceptions (the step of elimination exclave and enclave settlements is not part of the present analysis).

In the second variant, the constraint function is moved up and right to the most distinct visual gap within the red dots in the graph (Figure 6). The modification of the parameters in creating a new trade-off constraint function curve (blue line in Figures 6 and 7 with parameters β_1=0.60, β_2=0.65, β_3=3,000 and β_4=125,000) served as basis for the new functional region system FRD 2 with medium-size regions (blue dots in Figure 7). Twenty-four functional regions were present between the red and blue curves. The heuristic character of the methodology is indicated by the fact that Tokaj FR and Szentgotthárd FR (the two orange-red dots closest to the blue line in the left part of Figure 6) might have made it to FRD 2 and/or Komárom FR, Tiszavasvári FR and Vác FR (the other three orange-red dots relatively near the blue line in Figure 6) might have not made it to FRD 2, only if slightly different parameters for the new trade-off constraint function curve were chosen. Subjective decisions appear during the acceptance of the parameters.

Table 1

Parameters of the constraint function in the case of variants

	FRD 1	FRD 2	FRD 3a	FRD 3b
Self-containment lower limit (β_1)	0.60	0.60	0.60	0.60
Self-containment upper limit (β_2)	0.65	0.65	0.65	0.65
Size lower limit (β_3)	3,500	3,000	10,000	11,000
Size upper limit (β_4)	20,000	125,000	125,000	125,000
Self-containment (average)	0.780	0.811	0.829	0.832
Self-containment (median)	0.789	0.814	0.846	0.849
Self-containment (variation coefficient)	0.101	0.083	0.086	0.086
Number of employed residents (average)	32,114	40,677	52,299	53,837
Number of employed residents (median)	14,017	18,199	25,079	25,762
Number of employed residents (variation coefficient)	3.255	2.892	2.523	2.484

Source: Calculated by the authors based on the census dataset.

Table 2

Basic features of the function regions in the case of variants

Feature	FRD 1	FRD 2	FRD 3a	FRD 3b
Number of functional regions	114	90	70	68
Average number of settlements in the FRs	28	35	45	46
Maximum number of settlements in the FRs	129	137	201	201
Minimum number of settlements in the FRs	1	1	5	5
Average number of employed residents	32,504	41,172	52,935	54,492
Maximum number of employed residents	1,190,256	1,196,851	1,196,851	1,196,851
Minimum number of employed residents	3,689	5,917	12,185	13,586
Weight of the centre (average, %)	60	58	54	53
Weight of the centre (maximum, %)	100	100	88	88
Weight of the centre (minimum, %)	13	20	24	24

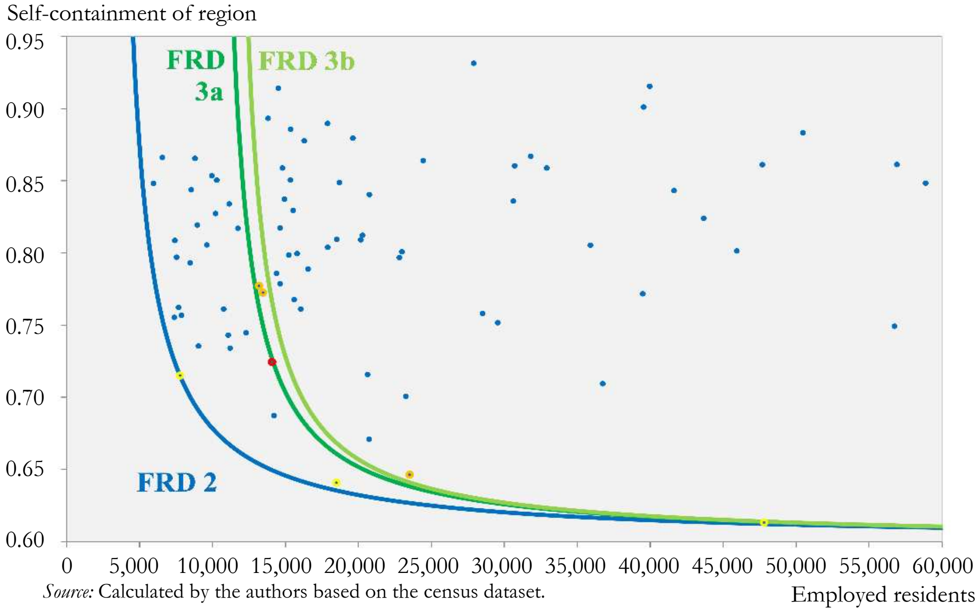
Source: Calculated by the authors based on the census dataset.

According to the third variant, the constraint function is moved up and right to the most distinct visual gap again (just slightly to the right of the red-blue dot representing Kunszentmárton FR in Figure 7). As the most distinct visual gap has two dots (representing the Mezőkövesd FR and Nyírbátor FR orange-blue dots in Figure 7) in its centre this time, two variants of the FR system with large-sized regions are proposed (FRD 3a and 3b). FRD 3a preserves the two mentioned functional regions (dark green line with parameters β_1=0.60, β_2=0.65, β_3=10,000 and β_4=125,000), whereas FRD 3b (light green line with parameters β_1=0.60, β_2=0.65, β_3=11,000 and β_4=125,000) does not contain these two functional regions (Cegléd FR, represented by the third orange-blue dot near the green lines in Figure 7, remained undissolved). Settlements from Mezőkövesd FR were primarily included into Eger FR and partly into Tiszaújváros FR. Settlements from Nyírbátor FR became part of Mátészalka FR (except for Ófehértó; Figures 10 and 11).

The largest functional regions integrating more than 100 settlements were Budapest FR and Pécs FR as the result of the first variant (FRD 1; Table 3). The modified parameter caused a significant increase in the size of the functional regions in the territories with micro and small villages. Zalaegerszeg FR in the second variant (FRD 2) and Miskolc FR and in the third and fourth variants (FRD 3a and 3b) also surpassed the number of 100 settlements. Pécs FR was the largest region by number of settlements after integrating the remaining parts of Komló FR, Szigetvár FR, and Siklós FR.

Figure 7

Use of the constraint function on x–y graph by the example of FRD 2, 3a and 3b



Source: Calculated by the authors based on the census dataset.

Table 3

Distribution of the functional regions and participation of persons employed locally categorised by number of persons employed locally

Categories by number employed residents	Number of functional regions				Percentage of the total number of employed residents in Hungary			
	FRD 1	FRD 2	FRD 3a	FRD 3b	FRD 1	FRD 2	FRD 3a	FRD 3b
1,000,000–	1	1	1	1	32.1	32.3	32.3	32.3
100,000–999,999	3	3	5	5	8.9	8.9	14.9	14.9
50,000– 99,999	9	11	10	10	18.0	21.9	19.5	19.8
20,000– 49,999	21	22	27	27	18.8	18.9	21.6	22.0
10,000– 19,999	36	37	27	25	14.2	14.7	11.7	11.0
– 10,000	44	16	0	0	7.9	3.3	0.0	0.0
Total	*114*	*90*	*70*	*68*	*100*	*100*	*100*	*100*

Source: Calculated by the authors based on the census dataset.

Budapest FR was unambiguously the largest territory in light of the number of employed residents followed by Debrecen FR, Székesfehérvár FR, and Miskolc FR (in the first parameter variant – FRD 1). The size of Pécs FR and Szeged FR also exceeded 100,000 employed residents in the FRD 3a and FRD 3b variants. The number and proportion of the smaller functional regions (less than 20,000 employed residents) shrank significantly as the critical parameter values increased from the first to the fourth variant.

Debates about the most appropriate version of these delimitations and comparative spatial analysis with other territorial divisions (administrative or statistical units) were not involved in the current study. These issues might be the most important objectives of further studies.

Conclusions

The objective of the current analysis was to implement the broadly applied methodology in Hungary in order to delineate functional regions based on daily commuting to work. The international experiences – especially those from Central Europe (Czech Republic and Slovakia) – provided valuable information to adapt the methodology. Several attempts could be detected in the Hungarian literature to delimit functional regions; however, the CURDS algorithm employing Smart's measure was not used so far to utilise the travel-to-work flows for regionalisation. Filtering was necessary in order to receive daily commuting data from the dataset. The chosen thresholds regarding the commuting time and distance were investigated accurately.

In the analysis, the Smart's measure and second variant of the CURDS algorithm were used. Optimisation and tests could be conducted using the modification of the size (number of employed residents) and self-containment of regions. The usage of the continuous constraint function allowed the consideration of the trade-off between the two parameters. The only subjective components within the whole complex procedure were the choices of the exact position of gap within points on the graph and of the exact position of the trade-off function curve within that gap. Except for that, the method provided precise quantitative results that facilitated informed decisions with respect to the desired scale of functional regionalisation. The Hungarian results provide the possibility to continue the discussion about the delimitation of micro-regional level territorial units.

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Figure 8

Functional regions in 2011 by the FRD 1 variant

Source: Edited by the authors based on the census dataset.

Figure 9

Functional regions in 2011 by the FRD 2 variant

Source: Edited by the authors based on the census dataset.

Figure 10

Functional regions in 2011 by the FRD 3a variant

Source: Edited by the authors based on the census dataset.

Figure 11

Functional regions in 2011 by the FRD 3b variant

Source: Edited by the authors based on the census dataset.

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Internal migration transition in Romania?

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market-transition,
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This paper is an overview of the shifts in the internal migration patterns in Romania for the last six decades. In the first part a literature-based brief overview of the trends and patterns of internal migration during communism will be presented. In the second (more extensive) part, a statistical-data based analysis of the internal migration trends and patterns over the last 25 years will be provided.

On internal migration during communism

The breakdown of the Romanian communist regime (in December 1989) was the beginning for a major change in the general demographic and socio-economic context of the internal migration and regime of the Romanian internal migration control.

In terms of the demographic context, the period of the communist regime was characterised by relatively high (though territorially significantly differentiated) fertility rates and overall population increase. In socio-economic terms, industrialisation and the subsequent urbanisation give rise to a significant and dynamic context of migratory opportunities and subsequent flows of internal mobility. Nevertheless the migratory processes emerged in this particular demographic and socio-economic context were to large extent controlled by the state, and, since external migration was very limited, occurring within the national territory.

The means of internal migration control during communism

During the communist period, the state closely controlled the labour market, and via economic investment policies and by various administrative procedures, not just stimulated but to some extent pointed the tracks for the internal mobility paths. Especially in the initial phase of the communist industrialisation process, major industrial settings were established in regions with existing infrastructure. Since these customarily were not located in regions with high fertility rates, substantial migratory movement from less developed to more prosperous regions were induced (Turnock 1970).

Beside industrial investments, migration management used other administrative tools too. The flux towards some of the major cities was limited by administrative means (by restraining the possibility to administratively relocate there). In addition, for new graduates of universities, a system of compulsory first-job allocation was implemented, compelling many to relocate to (and compulsorily spend a four-to-five-year period in) places to which they never intended to move. Thus, the state selectively directed certain categories towards remote rural areas or small cities. Therefore, is not an exaggeration that the control of internal mobility processes was part of a larger set of tools of social engineering, pursuing various economic, administrative and also ideological goals promoted by the regime (Turnock 1991, p. 256).

On the other hand, possibilities of external migration where very limited, though (especially during the 1980s) the propensity for external migration was considerably high (Horváth–Anghel 2009). In due course, special mobility processes occurred mostly within the national boundaries. This situation dramatically changed beginning with 1990, when migration became an intricate interplay of internal and external spatial mobility processes.

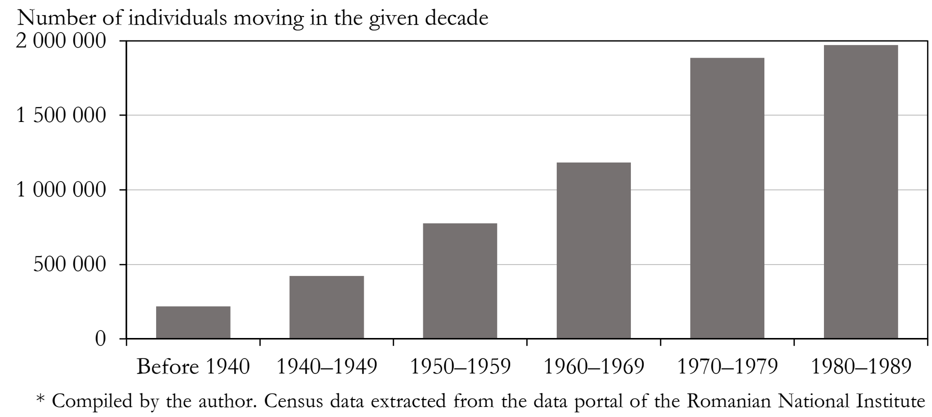
The extent of internal migration during communist period

In assessing the magnitude and dynamics of internal migration during communism, we rely on stock data and analyse data from the 1992 census regarding the previous residence of the population.

At the time of the 1992 census, approximately more than one-third of the resident population declared having a previous place of residence other than their place of domicile in 1992. Thus 7.7 million persons declared that they moved before 1990 from another locality to their current locality of residence.

Figure 1

Movement to the current locality of residence from another locality at the time of the 1992 census (number of individuals moving in the given decade)*

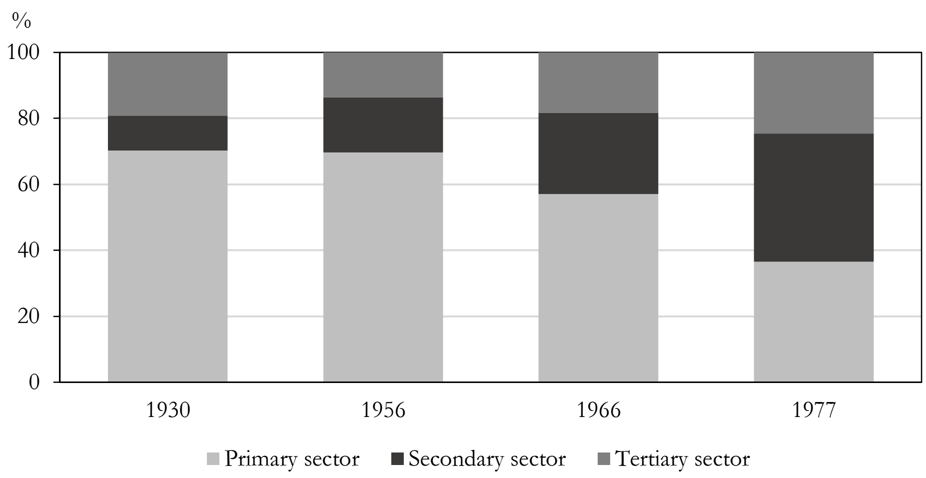


* Compiled by the author. Census data extracted from the data portal of the Romanian National Institute for Statistics *Population and Households Census Application* (http://colectaredate.insse.ro/phc/aggregatedData.htm) Table: POPULATIA CARE SI-A SCHIMBAT DOMICILIUL, DUPA PERIOADA STABILIRII IN LOCALITATEA DOMICILIULUI ACTUAL (accessed 12.04.2016).

The bulk of these residence changes occurred in the period 1970–1989, and this is in relation to the industrialisation policies initiated during the 1960s (Chirot 1978, Ronnås 1984). In just one decade (1966–1977), the economy, overwhelmingly dominated by the agrarian sector, turned into one slightly dominated by industry.

Figure 2

Share of employed population in the different sectors of the Romanian economy 1930–1977



Data source: Ronnås 1984, p. 143.

Consequent to the rapid industrialisation, a large-scale urbanisation process emerged (see Figure 3), marking the trend of internal mobility, both in terms of yearly values of rates and patterns of internal migration.

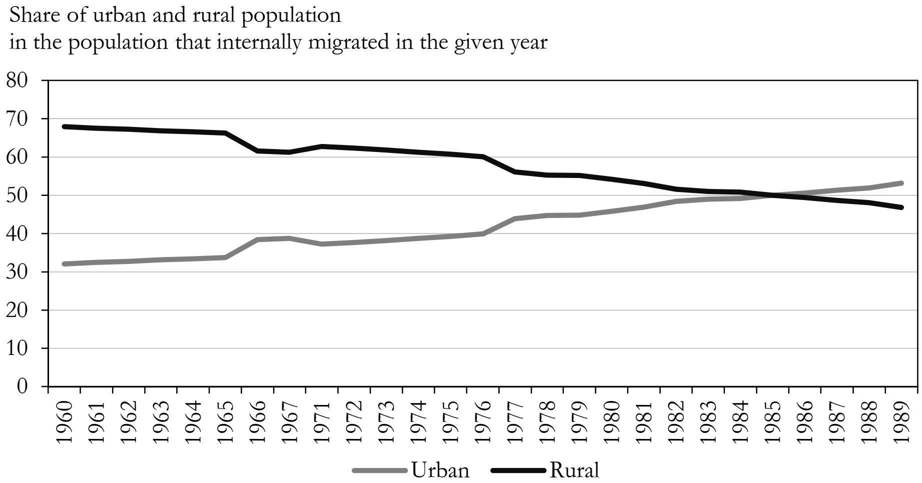
The rate of internal migration significantly rose during the seventies from 14.5‰ in 1970 reaching its peak (for the period of communism) in 1973 when gross internal migration was 375 thousand and rate of internal migration was 18‰. In spite of such ascending dynamic and notable peaks, compared with international and regional trends, Romania had relatively low rates of internal migration (Brown–Neuberger 1977). However, starting with the second half of the 1970s until the end of 1989, a slow, unsteady decrease of the yearly gross migration (and internal migration rates) began.

Patterns of rural-urban migration

At the beginning of the 1960s, the rural areas represented the prevalent area of origin of internal mobility processes. However, in terms of the destination of the streams originating from rural areas, the urban areas were only slightly overrepresented. A considerable segment of the internal migrants were engaged in rural-rural, customarily short-distance mobility (Kupiszewski, et al. 1997, p. 5.). Thus, the patterns of internal migration before the 1970s where only slightly dominated by the attraction of the urban areas. This pattern changed at the beginning of the 1970s, and the prevalent stream of the internal migration in the 1970s–1980s was rural to urban migration, with a significant increase in long-distance (between counties or even regions) migration (Kupiszewski, et al. 1997, p. 6.).

Figure 3

Changes in the share of urban and rural population during 1960–1990



Compiled by the author. *Data source:* INS (2006) p. 44.

Regarding the territorial patterns of internal migration, it was already mentioned that only somewhat less than half of the migration occurred within the county level. With the emerging industrialisation beginning in the 1960s, county, distant and intraregional mobility increased. Such development was heavily influenced by differentiated regional fertility rates and territorial inequalities of the economic development. At the beginning of the communism in the least industrialised regions of Romania (mostly the Eastern region), 38% of the population lived in a region where only 12% of the entire industrial capacity was located (Turnock 1970, p. 552.). Although some efforts towards a more balanced territorial distribution of the industrial manufacturing facilities were made, regional imbalances persisted during the whole period of communist rule. This aspect was doubled due to the differentiated fertility rate of the regional population; in the most-industrialised areas, a decline in fertility was observable at the beginning of the 1960s. The antiabortionist measures only temporarily stopped this decline. Whereas in less industrialised regions, the fertility levels barely decreased significantly in this period. In due course, the territorial patterns of internal migration in regional terms were predominantly from

East to West (from the historical province of Moldova to Southern Transylvania and Banat) and partially from East to South (from Moldova to the capital city of Bucharest and partially to the other industrialised zones of Walachia).

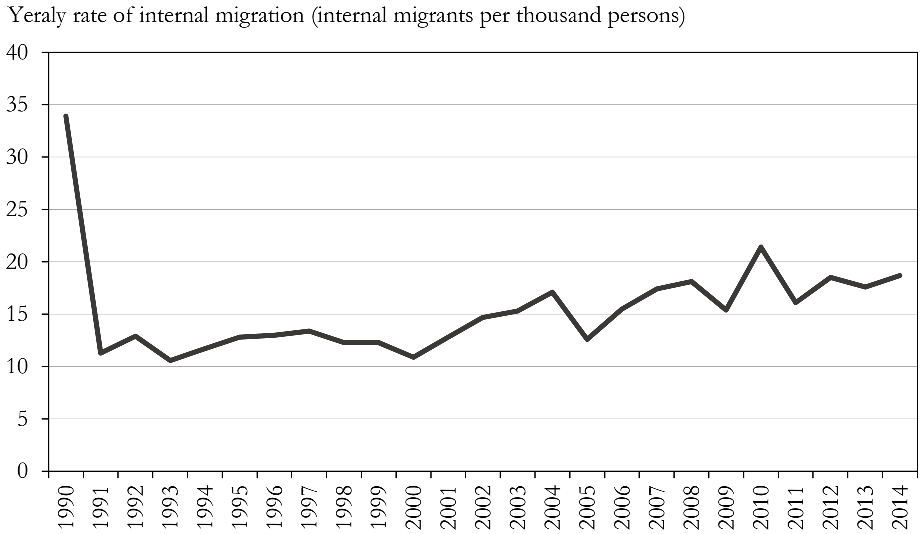
Internal migration from 1989 to 2014

Intensity of internal migration

The intensity of measured internal migration, the crude internal migration rate, had a particular dynamic during approximately the last quarter of the 20th century. It is measured as the total number of internal migrants in a given time period as a percentage of the resident population (Bell, et al. 2002); here expressed as internal migrants per thousand residents, it was rather fluctuant (see Figure 4).

Figure 4

Internal migration rate in Romania for 1990–2014 (‰)



Compiled by the author. *Data source:* INS TEMPO-online database. Accessed 10. 03. 2016.

The first remarkable aspect is the incredible peak of the value of the indicator for 1990, when the gross internal migration value reached the unprecedented volume of 786.5 thousand and the internal migration rate was 33.9‰. As a term of comparison in 1989, the gross internal migration was 193 thousand. An increase of almost four times the gross internal migration can be explained by the radical change in the regime of internal migration after the breakdown of communism. Various administrative constraints that imposed or limited the movement of certain categories were abolished, and those that were affected sought to relocate to more desirable locales.

The administrative limitations to relocate to larger cities were abolished, and persons compelled by the system of compulsory first workplace allocation to serve in certain settlements for a considerable period of time were exempted from fulfilling the obligations imposed upon them.

After this exceptional peak, during the 1990s, the rate of internal migration was somewhat similar to the trends (in terms of intensity at least) of the 1980s and somewhat below the average values of the 1970s (a peak decade after the end of the Second World War). Still, the first decade of the new millennium brought a somewhat hectic, but in a larger perspective, a definitely increasing tendency of the dynamic of the Romanian internal migration. Starting with 2006, the value of the rate of internal migration has been constantly above 15‰. For the last five years analysed, it seems that the intensity of the phenomenon is comparable with the intense internal migration of the 1970s generated by the large-scale urbanisation process. Such high rates are persisting in spite of the radical decrease in fertility starting with the very beginning of the 1990s (Gheţău 2007) and very high volumes of external migration.

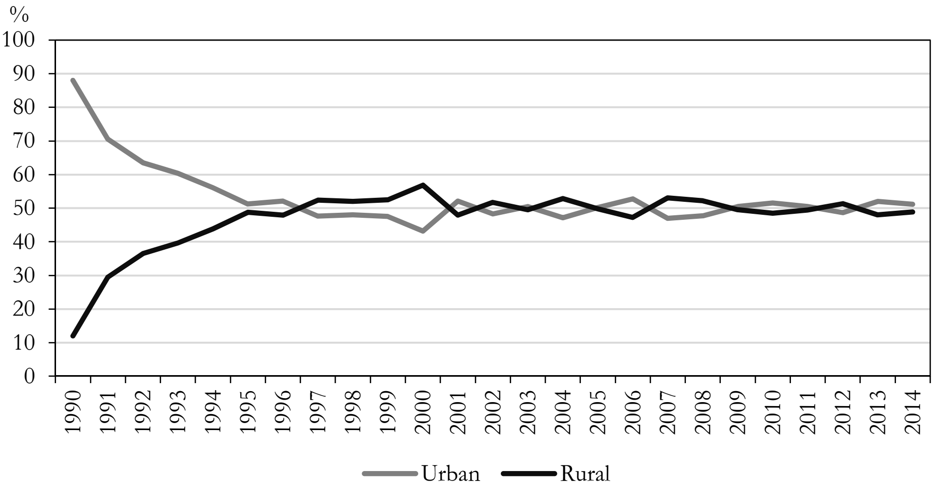
It is noteworthy to highlight the relationship between the intensity of internal migration and intensity of international outmigration. The stock of registered foreign residents with Romanian citizenship was 287 thousand in 1990, increasing to approximately 470 thousand in 2000 and 2.8 million in 2010 (Horváth 2012, p. 214.). Major increases in flows were registered starting with 2002 (when Romanian citizens where exempted visas in the Schengen area) and in 2007 (when Romania joined the European Union). The parallel increase of both internal and external migration in the first decade of the new millennium reveals an unprecedented economic and social transformation in Romania. Based on the figures revealing the magnitude of both internal and external migrations (based on a minimalizing estimate), a minimum of 4 million Romanian citizens can be identified as being 'on the move' (engaged in some form of spatial mobility). Thus, only in this decade (2000–2010) one out of five Romanian citizens relocated, mostly (though not exclusively) in search of a more adequate place in an increasingly expanding and dynamically restructuring world of labour opportunities. Just as term of comparison, in the seventies, the number of persons engaged in (internal and rather reduced external) mobility processes barely reached two million, meaning that one out every 11 persons was involved in a territorial mobility process.

Dynamic patterns of rural-urban migration

The intensity is the only element similar to that period, because the structure of migration in terms of source and destination (rural or urban) types of settlement significantly changed in the last 25 years. Early 1990s was characterised by high rates of urban destinations originating both from rural and other urban sources. However, starting with mid-1990s (1995), flows heading towards rural and urban areas become roughly equal (see Figure 5 and Figure 6).

Figure 5

Distribution of internal migrants according to destination: urban or rural settlements in the period 1990–2014



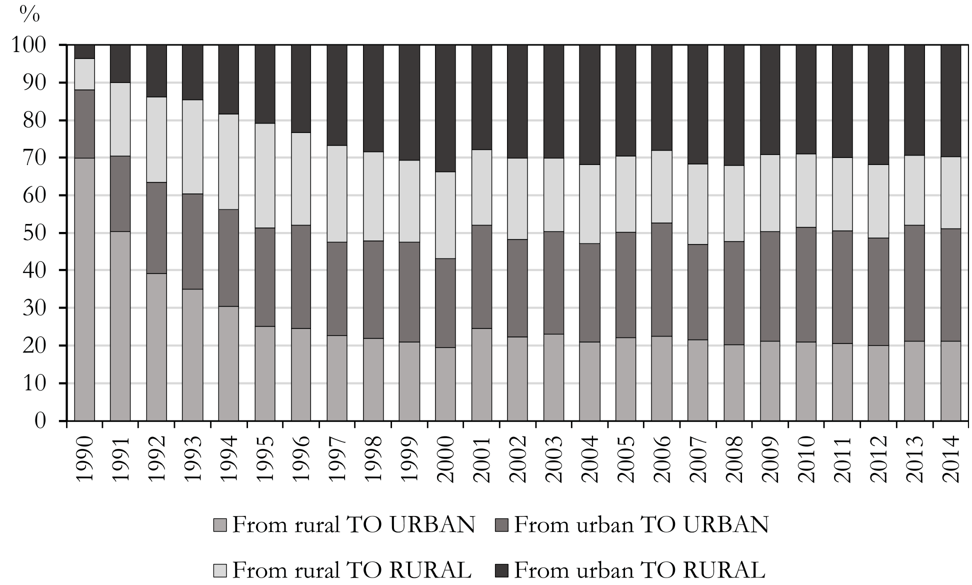
Compiled by the author. *Data source:* INS TEMPO-online database. Accessed 10. 03. 2016.

The equalisation of the flows heading to urban and rural areas had a varying causality for different periods in the last 25 years. The increase of the urban to rural flows is to be judged against the market transition processes. During the 1990s, in the context of rather hesitant and prolonged market transition (Dãianu 2001, Earle 1997), the labour market, and especially the industrial sector, decreased drastically. Within a decade, almost three million jobs vanished from this sector, resulting in genuine deindustrialisation of the Romanian economy (Berevoescu–Stãnculescu 2003, Horváth 2008, 2012). On the other hand, in the same period, the process of land restitutions was started, and transformation of the property structure of the land opened some windows of opportunities in farming (Rizov, et al. 2001, pp. 1259–1261.). In due course, many people who had migrated to cities during 1970s–1980s, after losing their industry jobs during the 1990s, viewed the process of land property restructuring as an opportunity and 're-migrated' to the rural regions from which they originated and became engrossed in the expanding strata of subsistence farmers (Gheţău 2009, pp. 36–37.).

Even though in the first decade of the new millennium, the patterns of migration between rural and urban areas were not significantly altered, in reality, the driving causes had significantly changed. Opportunities for external migration radically changed in 2002 when Romanian citizens received visa exemption for the Schengen area, and the stock of Romanian citizens registered as foreign residents in various European Union countries ran high (Horváth 2012, p. 214.), many originating from the rural areas of the economically backward regions (Sandu 2005). Various segments of the workforce, upon becoming unneeded after the deindustrialisation processes of the 1990s, migrated to rural areas and, in the new millennium, turned towards external migration.

Figure 6

Distribution of internal migrants according to source and destination types of settlement (urban and rural) during 1990–2014



Compiled by the author. *Data source:* INS TEMPO-online database. Accessed 10. 03. 2016.

On the other hand, at the end of the 1990s, the Romanian economy stabilised and a slow and steady growth started. In 2004, for the first time after the collapse of the communist regime, the gross domestic product exceeded that of 1989. However, the economic growth was rather uneven in terms of territorial distribution, being regionalised and concentrated in several major cities and envisioned by analysts and policy planners as poles of Romanian economic growth (Ionescu-Heroiu, et al. 2013). Such changes again resulted in a different structural context for internal mobility. Besides these growth poles attracting internal migration, their urban development was increasingly characterised by a process of urban sprawl (suburbanisation), which involved considerable segments of population relocating to the rural areas surrounding these cities (Grigorescu, et al. 2012). For example, in the period 2002–2011, in six rural municipalities directly neighbouring one of the major 'poles of growth', the city of Cluj-Napoca/Kolozsvár, the population increased by 6.1% even though there was a general decrease by 2.7% in the population of Cluj county and 7.2% decline in the country's overall population.

Thus, the decline of the internal migration pattern of the rural areas being the dominant source and urban areas being the dominant destination region of internal migration surfaced (in mid-1990s) and continued in the new millennium in two rather different socio-economic contexts. In the first phase, the economic decline and deindustrialisation induced a remigration to rural areas by those who had relatively recently migrated (one or two decades before) to urban centres. However, starting with the mid-2000s, in the context of expanding economies of some major urban centres, heading to (some selected) rural areas became an option because of cheaper housing and/or a different quality of life.

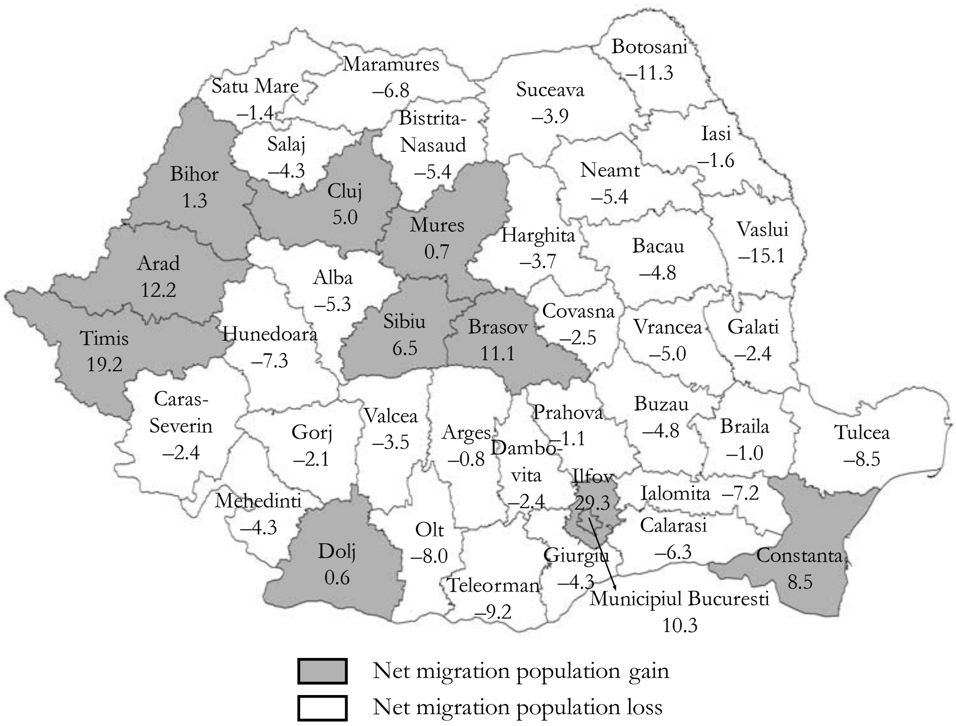
Regional patterns

The regional patterns of internal migration in Romania during the communist period were in relation to the existing regional disparities in terms of economic development. In spite of the efforts of the communist regime to induce a more balanced regional distribution of economy, regional economic differences persisted. Moreover, this path dependency resurfaced in the new millennium. The successful economic recovery and development was specific to regions having an above-average economic situation. In the last 25 years, these regions attracted internal migrants and they were successful in upholding some demographic stability (both in terms of volume and age structure of the population) in spite of the nationwide demographic decline (Gheţău 2007) and lower fertility rates of the given region compared with the economically less successful areas. The prevailing share of the post-1989 internal migration was intercounty, long-distance migration (especially during the 1990s), and after 2000, the short-distance, regional migration rate increased. This was in relation to the fact that starting with 2002, with the liberalisation of the entrance of Romanian citizens to the Schengen area, migration from the traditional source regions, especially from Eastern Romania, shifted the spatial horizon: from internal to external migration (Sandu 2006, p. 16.).

The regional trends in terms of source and destination regions of internal migration are well reflected by the available data as well. The cumulated county (NUTS 3) level yearly net migration data (for 1990–2014) was measured against the given county's population, resulting in an indicator at the county level for internal migration-related population gain or loss, expressed as a share (%) of the county's population as registered in the 2002 census (see Figure 7).

Figure 7

County level, cumulative (1990–2014), internal migration-related population gain or loss, expressed as share (%) of the county's population as registered in the 2002 census



Compiled by the author. *Data source:* INS TEMPO-online database. Accessed 10. 03. 2016.

Example of reading: The cumulated net migration of the Harghita county was –3.7%. This means that the gathered net migration values for the period 1990–2014 resulted in a population loss that represented 3.7% of the county's population, as registered in the census from 2002.

The regional directions of internal migration persisted in time. There is the attractive capital city region largely benefitting from internal mobility processes (originating especially from Southern and North Eastern regions). Constanţa county, both an industrial and maritime centre at the Black Sea was successful in attracting a significant volume of internally mobile persons. The South Western region of Banat (Arad and Timiş counties) represented other significant regions of attraction (attracting internally mobile persons from both the neighbouring counties and the North East), in line with Romania's centrally positioned counties of Sibiu and Braşov and the core region of the historical province of Transylvania: Cluj county. Most of the Northern, Eastern and Southern peripheries of Romania were source counties for internal migration. Some counties such as Vaslui and Botoşani lost a significant share of their populations in the last 25 years (15.1% and 11.3%, respectively).

Conclusions

The post-1989 system of the Romanian spatial mobility was marked by four major processes: a) shift of the political regime in 1989, b) market transition of the 1990s, c) incorporation of Romania in the European Union and free movement of the labour force and d) economic stabilisation and growth beginning in the first decade of the new millennium.

The shift of the political regime ended the administratively regulated internal mobility system promoted by the communist regime, resulting in a process of readjustment mobility (giving rise in 1990 to the highest internal mobility rate ever recorded in Romanian mobility statistics).

The market transition and subsequent deindustrialisation of the 1990s determined a slow yet steady and prolonged remigration to rural areas of a considerable segment of the population that had moved to urban areas during 1970s–1980s. However, such movement proved to be a transitory coping strategy, as the legal opportunities of working in the European Union were unlocked (in 2002 and 2007) and many people engaged in various forms of external migration.

The high rates of external migration did not lead to a decrease in the internal migration. The economic growth started at the mid-2000s, and in late 2000s, showed results that were rather uneven in spatial terms. The regional disparities of economic development, conjoined with a general demographic decline (boosted by the demographic consequences of high external migration), resulted relatively high rates of internal mobility and various regional poles of development sustaining at least two types of internal mobility processes: immigrants from outside their region and urban sprawling (suburbanisation).

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Group-specific analysis of commuting in the most disadvantaged areas of Hungary

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The study aims to examine the commuting opportunities of the most disadvantaged job seeker groups living in Hungary's most disadvantaged regions, as well as Hungary's spatial and group-specific boundary conditions. The study also aims to develop and present an indexation process (fMFÁ model), allowing the measurement of the mobility degree of different territorial units (in this case, the municipalities) and effects of certain factors determining commuting (transport subsidies, individual choices and options). The index measures the degree of mobility by considering individual and several types of public transport, expenses and expected time of commuting. The present document defines mobility for territorial units, separating its objective and subjective types. The group-specific analysis of boundary conditions is implemented through a questionnaire survey and logical models, the aim of which is twofold. On one hand, the model specifies the maximum commuting distance, which would be accepted rationally for the most disadvantaged job seekers. On the other hand, it presents a decision-making dilemma, namely the choice between commuting to work and local employment. Thus, the study provides insights into the specific features of labour market mobility of the target group. The Average Mobility Level Model and the Adjusted Mobility Index also evaluate the regional structure of the group-specific features of commuting. Through all these, the present study may promote a more efficient spatial allocation of employment policy measures. Strengthening of local employment in areas where group-specific mobility degrees are lower and support to improve commuting opportunities and employment centres where the mobility degrees are appropriate can contribute to the decrease of unemployment.

Keywords:
commuting,
unemployment,
disadvantaged groups,
disadvantaged areas,
regional mobility,
Adjusted Mobility Index

Introduction

In Hungary, the dynamic rise of work-related commuting began in the 1960s. In this year, approximately every seventh, and by the 1980s, every fourth active wage earner had been commuting. Following this dynamic growth, the *growth in the number of commuters* became slightly moderated, but the national share remained nearly constant or even increased (Szabó 1998). As regards the regional specificities, concerning work-related commuting, the location of the place of residence was more and more significant; however, the dividing line did not lie primarily between villages and cities but the more advanced agglomerations and peripheral areas (Bihari–Kovács 2006).

In accordance with the spatial analysis of mobility, the need for clarifying the conceptual system arose as early as the early 1990s (Iván 1994, Illés 1995, Nemes Nagy 1998). In line with the approach of the present study, the most convincing statement is one that looks at commuting as a type of labour movement and searches its driving force in the concentration of residences and workplaces in different settlements (Kapitány–Lakatos 1993).

Research at the end of the 1990s conducted detailed analyses on the general forming factors of daily commuting (village-city duality, release of agricultural labour, administrative network, suburbanisation and the role of motivation), spatial characteristics of daily commuting, related socio-economic processes, and effects of some sub-policies. There were several points to address the difficult situation of the disadvantaged areas, the binding immobility due to low estate prices, and the weighing constrains of commuting. It was pointed out that peripheral villages and cities struggle to become involved in the inter-municipal labour flow (Szabó 1998). Therefore, questions arise from the perspective of nearly 20 years: has the situation been resolved and has the development of infrastructure and improvement of the accessibility of assets made the labour market dynamisation of the most disadvantaged job seeker group possible?

At the turn of the millennium, Gábor Kertesi analysed the factors affecting village commuting. The chalked up participation model and its empirical analysis pointed out the roles of those who completed the highest level of education and the adverse selection in labour market, including the residential effects of the type of commuting, role of family, travel expenses, housing prices and the questions related to employment discrimination (Kertesi 2000).

Tamás Bartus emphasised that the former approaches focused primarily on settlements instead of individuals; therefore, his objective was to highlight the role of expenses at a personal level. He raised the question of how travel distances affect the possibility of commuting. He stated that an employee – in the absence of travel allowances – is likely to choose to travel to work. Besides the limit values for distance, Bartus also included statements based on time and expenses (Bartus 2003). Moreover, it is also pointed out that travel expenses especially affected and restricted the work-related chances of women and others with low levels of education (Kertesi 1997, Bartus 2003).

In the mid-2000s, articles focused on the different roles of means of transport, stating that settlements with better vehicle supply have lower unemployment rate and that the intensity of transport services and connections have a significant impact on the development of the labour market's local situation. The differences in supply, since the change in the political system, have become dramatically aggravated (Köllő 2006).

Although it is proven that after the change in the political system, the Hungarian labour market went through several transition stages; the most common forms of work-related migration remained the daily or weekly and short- or long-distance commuting (Kulcsár 2006). This upholds the relevancy of the questions, especially in the depressed areas and in cases of disadvantaged groups of which the nature and special characteristics of mobility issues have not fully been discovered yet. It is assumed that the transport situation of the disadvantaged areas, hindered by the highly limited opportunities of each social group, is less suitable for the dynamisation of the labour mobility. These effects have not been investigated yet; therefore, their analysis, focusing especially on the inner spatial differentiation of the disadvantaged areas, is one of the objectives of the present work.

The territorial investigations that address the identification of the labour market districts, the spatial segments of commuting that are also known as Local Labour Systems (LLSs), form the basis of the present work. Thus, the group-specific indexing of the mobility levels can be carried out. In the absence of an employment centre[1], the socio-economic situations worsen and the subject area may become sidelined, thus increasing its peripheralisation. The weak, local labour market forces people to commute to greater distances (Radvánszky–Sütő 2007). The latter phenomenon is highly significant from the conceptual perspective of the analysed spatial structure processes.

The question of commuting is strongly connected to other possibilities of reducing spatial differences, because daily labour migration is a relevant solution only if the other available alternative is highly expensive. In Hungary, the rate of ownership of private apartments by their occupants is high; furthermore, buying a home despite the high costs comes with high risk factors (Hegedüs 2003). Accordingly, compared to relocation, daily commuting presumably plays a more significant role in the easing of unemployment in the less developed areas (Bartus 2012). At this time, it must be highlighted that the role of the housing benefit policy may trigger trends other than those stated above (e.g. the homemaker's scheme). Besides pointing out the role of travel allowance on the increase in mobility, the authors also look to identifying the

[1] The main settlement(s) where people commute to work.

settlements – where the labour is from – which makes it worth commuting to distant workplaces. Thus, the analysis delineates the scope of the available, not available and isolated settlements from which it highlights the outstanding rate of those in the latter group located in the depressed areas (Bartus 2012).

The present mobility model broadens the range of analysis, which is important because of, on one hand, the changes occurring in the circumstances and, on the other hand, the need to answer the questions that remain open. The first refers to the increasingly dominant role of public employment, the salary of which is available in the distant workplace; as a result, it 'must' compete with, not the amount of benefits, but the higher public employee wages. This reduces the marginal utility of income available through commuting. Extension of the analysis is needed for the expansion of the horizon of the means of transport, evaluation of opportunities of the passenger vehicle and rail transport, and simulation of spatial effects, which is the key objective of this present work. It is important to note the research finding that states that the improvement of availability would not overleap the limit values necessary for the enhancement of mobility (Bartus, T. 2012). Therefore, the following question arises: Which limit values are affecting the disadvantaged job seekers from a mobility point of view?

The weight of spatial aspects had significantly grown by 2010 in the independent research analyses. János Pénzes, in his 2013 work, analysed the correlation among employment, commuting and level of income for North East and North West Hungary; this analysis had been preceded by similar evaluation of the Northern Great Plain and Western Hungary (Pénzes 2010, 2013). The delineation of the employment centres and districts forms the core idea of this study. In connection to this, Pénzes lays down the 60-minute psychological and timely limit of commuting. He also points out how the level of employability and income are becoming distant from the central areas (Pénzes 2013), which is the key reason for the increase in the periphery's relative competitive disadvantages. In conclusion, he states that 'the employability's spatially differentiated deterioration followed a specific pattern which also strongly correlates with the phenomenon of commuting' (Pénzes 2013).

Furthermore, the scope of spatial analyses involves a research, which aims to delineate LLSs based on most recent data and provides the basis for selecting the commuting relations analysed in this study. The objective of the work of János Pénzes, Ernő Molnár and Gábor Palóczi is to identify districts based on their labour market attractiveness. Their results show the labour market centres' decreasing number and increasing sizes. Besides the stronger centres covering vast areas, the dominant roles of the centres of small and more closed districts could be observed at the periphery (Pénzes–Molnár–Pálóczi 2014). Their study not only forms the basis of the present analysis due to its topicality but its delineation criteria and resolution also comply with this article's objectives.

With regard to the analysis on mobility, the overview of the literature pointed out that daily commuting is a multicomplex, socio-economic phenomenon influenced by several factors; however, it has not identified the most specific reasons amongst the most disadvantaged job seekers that influence spatial relationships at the highest level. Moreover, what the magnitude of these factors represents remains an open question. The analyses have further involved the spatiality, but a study that specifically targets disadvantaged areas and their job seekers' spatial mobility at the municipal level has not been conducted yet. The objective of the present study is to, therefore, analyse the conditions of the disadvantaged job seekers' mobility within a given segment of space. This is approached theoretically by using two models, which is then followed by crosschecking the purpose of testing of the obtained limit values and models with the results of the questionnaires and identifying other subjective factors. The obtained parameters form the basis of indexing the analysed people's level of mobility at the municipal level.

Research methods

As regards this present analysis, both primary and secondary resources have been used. For primary analysis, specific attention was paid to a cumulatively disadvantaged group of job seekers, who were distributed a questionnaire survey during a year's time (2015–2016); 579 responses were recorded. The investigation defined disadvantaged job seekers as persons who had at least two drawbacks as listed below:

- age of over 50 years,
- young (under 18 years),
- primary school or lower level of education,
- large family (in a relationship, married or raising three or more children) or single with children,
- long-term job seeker (for over one year),
- young entrant and
- bad financial situation.

Statistical records about the target group were not available during the investigation; therefore, the survey focuses on persons receiving Employment Replacement Support (FHT) and job seekers returning from public employment. The survey was based in districts with a complex development programme and the most disadvantaged microregions. The sampling used the following procedure. The questionnaires were received by local government offices of 885 settlements located in all regions (sent to the e-mail address). The cover letter and complementary phone calls asked the local governments to complete and return the questionnaires digitally. Mayors of certain small settlements, based on their local knowledge, forwarded the questionnaires to disadvantaged job seekers who did not meet the above criteria. To increase the sample size, 113 South-Transdanubian settlements were involved during a field survey.

Some of the questions focused on mobility-related factors, especially stressing the analyses of affordable travel expenses and time frames. Besides the demographic questions, emphasis was given to wage-related elements and the availability of public means of transport. The restrictive factors of mobility were extracted using open questions. Among the factors limiting mobility, the present study distinguishes between the exogenous and endogenous elements depending on whether they are available to the individual and accessible by sensible efforts (inner factors), as well as elements according to the circumstances (outer factors) that may not be 'controllable' by the job seeker (or may only be controlled counter-selectively). The transition between the *endogenous and exogenous* elements is not clear, as it is affected by the range of available assets for the individual and variability of the socio-economic space. The exogenous and endogenous limits can be divided into those that are directly linked to daily commuting (travel expenses, availability of means of transport, travel time and resident commitment) and those that indirectly affect mobility (level of education, inclination to learn and marital status).

The input data of the models discussed below were collected in the second half of the investigation (January–March 2016). The data for the space/time matrix of the mobility model come from different sources according to the means of transport and transport relations. In the case of commuting by car, data come from the Google Maps route planner (https://www.google.hu/maps), whereas scheduling databases (http://www.volan.hu and http://www.mav.hu) were used for information in the case of public transport (bus and rail). Wage data (guaranteed public employment wages, minimum wages, guaranteed minimum wage, and employment replacement support) were determined based on the 'http://officina.hu/' portal and the Hungarian Gazette 206 of 2015 and 170/2011. (VIII. 24.) Government Decree.

The values refer to wage items applied from 1 January 2016. The calculation of overtime earnings was based on the values of Act I of the 2012 Labour Code and published in the 'https://jobline.hu/' portal. The analysis of transport subsidies was based on 39/2010. (II. 26.) Government Decree. In the present analysis, according to the above-mentioned sources, Mt = 86%, that is the aid covered 86% of the monthly cost of the journey. The amount of cost reimbursement calculated for cars (based on the same sources) is nine HUF/km. The average consumption for 100 km was fixed at six litres. The average unleaded gasoline 95 and diesel fuel prices during the period of data collection (January 2016) were published by the National Tax and Customs Administration of Hungary (http://www.nav.gov.hu/). The model was calculated using 21.5 working days per month.

In the analysis of the boundary conditions applied to the rational job seekers resulted in the formulation of two logical models. In the first case, the analysis of travel expenses is based on whether the individual acts and decides rationally, which then determines that the viable amount of money emerges from the relationship between the wage proposal, including travel expenses provided by workplaces accessible by travel, reduced by the time value of lost working hours due to commuting, and the locally available salary.

$$J = B_y - (k_u + k_i) - B_x, \qquad (1)$$

where B_y – Earning available at the new workplace, k_u – Travel costs, k_i – Time value of working hours lost by travelling, B_x – Locally available salary, J – Additional income available by commuting.

Tamás Bartus introduced a logic similar to the formulation above (Bartus 2007). If the additional income is positive with the above conditions, the individual is willing to commute. If J=0, the individual is indifferent towards commuting or staying in place; this is the limit value of mobility.

The other approach to the viable travel distance's limit value involves the job seeker taking the travel time as the working hour's increment; therefore, the additional input will be experienced as a specific earning reduction (the fixed monthly wage will be spread over longer periods of time). This means that the individual is willing to work as long as the hourly rate is higher than the average in the public employment sector. In this case, the following applies:

$$KMI = \frac{\sum_{i=1}^{a} \frac{K_e}{K_{össz}} * (KAérték_x + TAérték_x)}{n}, \qquad (2)$$

where t_x – Working time in the local workplace, t_y – Working time in the distant workplace, t_u – Travel time.

The approach formulated and explained in point [1] can now be used with the following changes to examine the effects of the internal factors:

$$J_f = Be_y - ke_u - B_x, \qquad (3)$$

where J_f – The remaining additional income due to travel commitments, Be_y – The probable value of the expected wage in the new workplace, keu – Travel expense, B_x – The probable value of the local income.

The value of lost time due to commuting k_i is omitted from the endogenous approach, because although the given factor expressly affects both the directly circumstance-affected, optimising individual and the job seeker with qualified rationality, the previous approach does not include its volume immanently. In this present situation, however, where the limit values are defined by individual expectations, Be_y also carries the value of k_i and thus the inclusion of k_i would lead to doubling.

The indexing of mobility levels was done with the assistance of the *folyamatos Mobilitási Fokok Átlaga* (fMFÁ)/Continuous Average Mobility Level and the *Korrigált Mobilitási Fokok Átlaga*/Adjusted Average Mobility Level (KMFÁ) models. The purpose of these models is the quantification of the mobility capability and skill defined along with variable factors. By 'mobility,' the present study means commuting to work. We distinguish two different types of mobility. By objective mobility degree, we mean the accessibility of settlements (with no group-specific effects) in relation to the employment centre/attracted village, that is their integration in the transport network. The value of objective accessibility is high, provided that the employment centre can be reached quickly and cheaply by car, train or bus – regarding the optimised model by at least one of the above. The subjective degree of mobility is the empirically corrected version of the objective mobility; here, the values are weighted by the ratio of the availability of certain means of transport within the target group. For example, if the objective accessibility by car is suitable but available only for a small proportion of the target group, the degree of mobility decreases.

The fMFÁ model shows the favourability of the village/town's objective accessibility by assuming the comprehensive availability of the public transport in the analysis (namely, whether it is available for everyone or whether any service runs to the settlement). The higher values refer to better mobility possibilities. The general model approach, on one hand, counts the unlimited availability of the means of transport and, on the other hand, assumes that the choice of freedom collectively affects the conditions of the work-related commuting.

The reality is, however, more nuanced in two respects; one, the availability of public means of transport is not fully comprehensive and, two, individuals do not use all three available options at the same time. The former clause is resolved by KMFÁ's determination of the values. The optimised fMFÁ model is the approach of the latter with regard to the real situation. This model looks to identify how the mobility level develops, assuming that the job seekers optimise their possibilities and, in every case, choose a means of transport that is the most advantageous for the purpose of commuting to work.

The backbone of the model was based on the simplified mobility graphs of the analysed area/relations. The peaks of these were given by the indexed area's 'attracted' towns, villages and settlements functioning (or possibly having the ability to function) as employment centres. In the analysis of the settlements, the study used the results of the most recent literature (Pénzes–Molnár–Palóczi 2014); therefore, the present research does not intend to target the re-evaluation of the employment centre/attracted village relations or identification of the employment centres. For determining the commuting corridors, the study takes into account routes that are combinations of, first, the expenses and, second, the time factor and require the least possible financial sacrifice from job seekers. Thus, the paid and 'detour' routes are not preferred; however, for longer travel distances, expenses may be accepted if the related direction saves significant amount of time for the commuter. The calculation is based on a questionnaire survey on the time and cost preference system. The cost and time values used in the quantification of the mobility degree are based on the following principles:

• Ktgn – *n*-th cost limit (in present work HUF, but currency choice can be free). The model calculates using four steps, defined by the cost limit values based on the questionnaires. Ktg1 is the tenth percentile of cost-taking, Ktg2 is the thirtieth percentile, Ktg3 is the sixtieth percentile, and Ktg4 is the 90th percentile.

• Tn – *n*-th time limit (in minutes), which also forms group-specific 'psychological' boundaries, in the form of a time factor (theoretical maximum commute time spent on a daily basis). The model again calculates using four steps, defined by the time limits determined by the values found in the survey. T_1 is the tenth percentile of time taking, T_2 is the thirtieth percentile, T_3 is the sixtieth percentile and T_4 is the ninetieth percentile.

In the case of the most disadvantaged, unemployed group studied, the related parameters were as follows: Ktg_1=1,000, Ktg_2=4,000, Ktg_3=8,800, Ktg_4=20,000, T_1=5, T_2=14, T_3=30 and T_4=50[2].

The definitions of percentile and tercile limits depend on the investigator's preference system in the relation to commuting. In this case, according to the calibration of the model, mobility opportunities are excellent if the commuting cost and time factors are appropriate for 90% of the job seekers. In contrast, within the limits of the survey, mobility is highly unfavourable when traffic conditions in terms of commuting are adequate for a maximum of 10% of the job seekers. If the full mobilisation of the examined group is a high priority, the increase of the limits is necessary and vice versa. The method used provides the option to simulate the effects of the differently principled travel support systems. In the case of the model, we examined the impact of the travel allowance (up to *86% of the monthly travel costs)* and mobility opportunities in the absence of transport subsidies separately.

The model provides an opportunity to examine the effects of carsharing/employee shuttling on the degree of mobility. However, this assessment is beyond the scope of this writing. Carsharing can be raised into the model by reducing the cost of commuting by car. Expanding the scope of the investigated means of transport with a secondary vehicle used by a number of job seekers allows for a more complex analysis. The model – in case of employee shuttles – can be further specified by the reduction of costs or addition of a secondary shuttle organised by a new employer.

Following the formulation of the basic parameters, as a first step the model we calculated (for all analysed means of transport and relations) the settlements cost baseline value (KA value) using the formula below:

[2] Ktg_x – Cost limits, T_x – Commuting time limits.

$$KAérték = \begin{cases} Ha\ x \le Ktg_1;\ 4 - x * \dfrac{1}{Ktg_1} \\ Ha\ x \le Ktg_2;\ 3 - (x - Ktg_1) * \dfrac{1}{Ktg_2 - Ktg_1} \\ Ha\ x \le Ktg_3;\ 2 - (x - Ktg_2) * \dfrac{1}{Ktg_3 - Ktg_2} \\ Ha\ x \le Ktg_4;\ 1 - (x - Ktg_3) * \dfrac{1}{Ktg_4 - Ktg_3} \end{cases}.$$

Similarly, the determination of the time baseline value (TA value) was included:

$$TAérték = \begin{cases} Ha\ x \le T_1;\ 4 - x * \dfrac{1}{T_1} \\ Ha\ x \le T_2;\ 3 - (x - T_1) * \dfrac{1}{T_2 - T_1} \\ Ha\ x \le T_3;\ 2 - (x - T_2) * \dfrac{1}{T_3 - T_2} \\ Ha\ x \le T_4;\ 1 - (x - T_3) * \dfrac{1}{T_4 - T_3} \end{cases},$$

where x always means the calculated travel time or distance in a given relation.

The resulting KA and TA values – in every relevantly taken means of transport (in this case, motor vehicle, bus and train) and reference direction (employment centres) – are averaged to obtain the fMFÁ value. In the fMFÁ model, it is possible to build in a particular entity (the subjective availability of means), whose value determines the KMFÁ. Subjective effects can be visualised by the correlation of the means of transports' frequency of availability ($K_e/K_{össz}$). According to the above mentioned, the average values of the adjusted mobility levels were calculated using the following formula:

$$KMI = \frac{\sum_{i=1}^{a} \frac{K_e}{K_{össz}} * (KAérték_x + TAérték_x)}{n},$$

where KMI – Adjusted mobility index, K_e – Number of people those who are provided with the given means of transport in the given relation, $K_{öszz}$ – Number of people included in the survey in the given settlement, $KAérték_x$ – Given means of transport's KA value in the analysed settlement in reference points (x), $TAérték_x$ – Given means of transport's TA value in the analysed settlement in reference points (x), n – Number of analysed means of transport.

Following the encoding, the processing of each questionnaire, data systematisation and structuring were carried out using the MS Access 2016 database manager software. MS Excel 2016 was used for some data selection and encoding results, calculation of descriptive statistical parameters and determination of fMFÁ values. The statistical operations were run using the IBM SPSS Statistics 22.0 program. The digital maps attribute tables were uploaded and data groups were organised using Libre Office 3.6, and QGIS 2.12.2 (Quantum GIS) was used for the imagery and visualisation.

Results

Development of mobility level boundary conditions in the most disadvantaged group of job seekers

Travel time, commuting distance and commuting expenses in the disadvantaged group of job seekers (exogenous approach)

In case of the parameters of model no. 1, it follows from the analysed group's structural characteristics (particularly, low qualification) that the expected value of the available wage proposal – presuming that the workplace exists and is accessible – is the amount of the national minimum wage. The values calculated for the travel expenses for the analysed area in HUF/km/month were 442.47 for motor vehicles, 348.8 for train journeys and 274.6 for bus travel, considering that employee's minimum employment is 21.5 days per month. Another inclusive cost factor may be the value of loss of earnings due to time spent on travelling. This includes the following examples:

- Potential for loss of overtime or the decrease in or excess of burden
- Reduction in time spent on alternative income-generating activities (such as backyard farming and additional works)
- Loss of efficiency resulting from giving up of break periods

Based on the experiences of the survey, the summarised value of the above is recorded by the analysis in two lots (0 HUF/month and 3,150 HUF/month). It speaks for the nil value that the possibility of overtime within the frame of public employment is limited; there is hardly any chance for alternative income-generating activities (21% of the analysed group had this), and its expected value is low. Taking into account the value of lost income amounting to 3150 HUF is justified by those cases (13% of the surveyed group stated so) in which the above circumstances restrict the undertaking of mobility; therefore, the factor in the accurate model cannot be ignored.

The fourth model parameter, the locally available earnings within the scope of the analysed group, is well approximated; taking into account the weakness of the local labour market (demonstrated by the tendency of the relative spatial index that is typical to the region and higher than the national average), its rate maximises at about the wage of public employment.

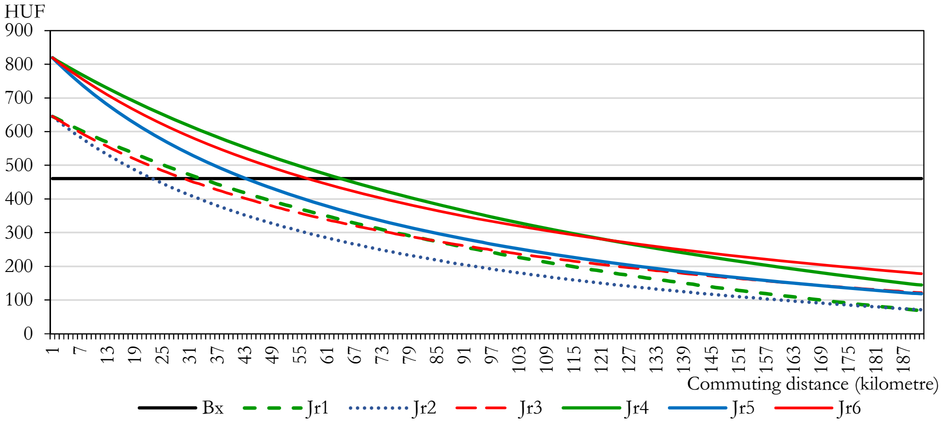
Based on the above discussed, it can be assumed that only the travel expense changes along with the increase in commuting distance. Although the expected value of wage increases in principle with the growing commuting distance in the case of non-disadvantaged job seekers or those with unequal opportunities, the correlation is not valid in the case of the analysed group and relations because of two aspects. The usage of invariant values, therefore, causes no issues. On one hand, for the persons concerned, especially in the case of the accumulation of unequal opportunities, the expected value of earnings in the distant workplaces is not potentially higher than the minimum wage. On the other hand, because the model works with 1 to 1 relations, the longer distance does not mean a stronger employment centre or more extensive labour market; it only refers to the transport situation's less favourable endowments.

The model's J=0 optimised value supposes that for rationally active, disadvantaged job seekers living in the multiple less favoured areas (HH-areas), the viable commuting distance (there and back again collectively) is between 64.8 and 261.9 kilometres.

Model no. 2, compared to the previously discussed, approaches the question in a completely different way. Among its variables, t_u can be estimated by the value of one km worth of travel time calculated along with the analysed area's enumerated relations; this is 1.16 minutes in the case of motor vehicles, 1.86 minutes for bus travel and 2.41 minutes for train travel. Because of commuting, the income value lost by the time for travel – according to the questionnaire survey – includes the possibility of overtime loss, the limitation of alternative income-generating activities (household management or additional works) or cost efficiency loss coming from the full or partial dispatch of the rest period. At this point, the relative hourly wage as a function of the viable commuting distance develops according to the method shown in Figure 1.

Figure 1

Development of the relative hourly wage as a function of the commuting distance and its relation to the public service hourly rate



J_{r1} – Commuting by motor vehicle with a zero value income loss due to journey time; J_{r2} – Commuting by train with a zero value income loss due to journey time; J_{r3} – Commuting by bus with a zero value income loss due to journey time; J_{r4} – Commuting by motor vehicle with a value of 3,150 HUF income loss due to journey time; J_{r5} – Commuting by train with a value of 3,150 HUF income loss due to journey time; J_{r6} – Commuting by bus with a value of 3,150 HUF income loss due to journey time.

According to the two end values (J_{r1} and J_{r4}), the resulted, rationally viable travel distances for an entire daily journey changes significantly in this case. The minimum value is fixed at 21.8 km and the maximum at 63 km; therefore, in one direction, the viable travel distance hardly exceeds 10 km and 31.5 km. Moreover, the preference of the means of transport changes as well, because according to model no. 1, the best option is bus and the worst is motor vehicle; whereas in model no. 2, railways is the shortest and motor vehicle is the longest viable travel distance. Beyond this phenomenon stands model no. 1, which did not take into account the travel journey's time saving advantages due to the type of transport's own speed, whereas model no. 2 insists on the importance of this specifically.

Both of the above approaches describe the behaviour of a rational, optimising person whose characteristics are reflected on the disadvantaged groups of people and actors of the space segment. To identify which of the above approaches interlocks more precisely with the decision-making process of the individual, the result evaluations must be compared with the experienced values.

Travel time, commuting distance and cost of commuting in the analysed group (endogenous approach)

In model no. 3, the probable value (Be_y) of the expected (gross) earning rounded to the nearest whole is gross 134,500 HUF; therefore, it is 23,500 HUF larger than the one outlined in the exogenous model. The group of the disadvantaged job seekers in this dimension can be broken into four significantly different types. Individuals with closely rational behaviour represent only 13.3%. Those who are considered as having minimum wage are guaranteed the minimum earnings acceptable for commuting in the hope of better employment. Therefore, Be_y values are 120,750 HUF. The largest proportion, approximately 30%, is represented by those who set their wage demands above the public servants' wages; they, however, even a small wage increase is sufficient for them to put up with the inconvenience of commuting. Their Be_y values are 98,356 HUF. High wage demand is represented by 20.7% of the group. Their reasoning includes typically subjective factors that can be divided into three categories. The factors are related to family, the inconvenience of commuting or giving up of additional salary and their convenient situation. Their Be_y values are 149,354 HUF. Extremely high wage demand appears among 25.3% of surveyed; in their case, the reasons are mostly subjective; their expectations are not based on their qualification but on domestic reasons (they are supposed to earn those wages to live well) or self-evaluation (then I would feel that they respect the work that I do). Their Be_y values are 190,526 HUF.

Even more extreme is the development of the endured travel expenses (ke_u). Between the smallest and the largest, the difference is a two-fold magnitude. The specimen's expected value is 9,031 HUF, which is far behind the analysed relations' average costs (approximately 21,000 HUF). This does not directly mean that there is a strong limiting effect of the enduring expenses on commuting. The low expenditure commitments only express that the distant relations are highly dispreferred in the group.

Because both the endured distance and expense are flexible downward (the person more likely to travel and spend less on it), the discovery of the real limits requires knowledge of the distribution of the endured commuting distances. Thus, the group can again be broken into three segments. Only local employment and a very small commuting area (less than 10 km) is represented by 30% of the group. They are, according to their self-declaration, physically limited in commuting (for example, due to health problems or age) or their present expectations are met by the wages offered in the public employment sphere, which could only be imbalanced by irrationally high, non-accountable extra wages. The age above 50 is defined as a disadvantage; 8.6% of the surveyed stated it as the extreme limit of mobility, which even exceeded the influencing power of marital status and health problems. Also belongs here a proportion of disadvantaged job seekers who are willing to commute but consider it unfeasible due to poor transport conditions. The group with the largest number shows a striking similarity as regards the preference of journey distance with the results of model no. 2 (time prorated salary calculator). The endured distance – in one direction – is between 21 km and 30 km, and the underlying effects of the state of transportation play a decisive role. Nearly 73% of the group pointed towards some of the elements of the Jr_x variable as a mobility-limiting factor. The upper end limit – in 13% of surveyed – falls between 46 km and 50 km, which is shorter than the maximum of both exogenous models. The reasons can be clearly identified and are different compared to those measured in the two other groups. In the previous exogenous models, with a limit of the projected backlog, problems related to lower income expectations and availability of means of transport (which will be addressed in the KMI evaluation) play key roles. The importance of this latter element is shown in the disadvantaged areas where the average work-related commuting distance is 46 km; in this case, the research's basis of forming employment centres appears to be a relevant direction (backed also by personal motivations). Thus, by loosening their ties, commuting for work and integrating into the primary labour market – assuming the existing labour demand of the host centres – people from these areas can be helped most strongly.

The above effects and the values of the endogenous model variables are summarised in Table 1, which also includes comparison with the exogenous approach.

Table 1

Summary of values discovered during the empirical analysis and results calculated by the exogenous model

(HUF)

	Model [2]				Model [1]				Difference [2]-[1]		
	J_f	Be_y	ke_u	B_x	J	Be	k_u	k_i	ΔBe	$\Delta ke_{(u,i)}$	$\Delta\ Be_y, B_x$
Minimum	11,540	98,356	7,661	79,155	0	111,000	31,845	0	–12 644	–24 184	19,201
Average	45,825	134,500	9,520	79,155	0	127,000	44,695	3,150	7 500	–38 325	55,345
Maximum	98,007	190,526	13,364	79,155	0	144,000	61,695	3,150	46 526	–51 481	111,371

The lesson from the above is that, in the case of the respondents, the value of the remaining income is significantly higher than the optimum value calculated for the rational disadvantaged persons. Beyond this stand, on the one hand, higher wage demand and, on the other hand, lower endured travel expenses. The reason for this phenomenon is that the original model aimed to find end values; therefore, in the case of the calculated parameters, the benefit of the demanded income exactly equals the level of the current earning. Of the excess income, 100% is spent towards traveling, and the decision maker, in turn, maximises the distance. In contrast, the degree of sacrifice involving travel goes beyond the actual costs; thus, the commuter would like to earn extra income by the action of commuting between home and the nearby employment centre.

The individuals also have several effects on the value of the expected wage, which, either directly or with significant distortion, can be measured. This includes costs associated with abandoning other income-generating activities. Moreover, it involves, besides legally undertaken unskilled works, the real value of black labour, backyard income and even benefits received in the context of public employment; for the surveyed group, this amount in the entire specimen is the difference between the Be_y and B_x values, which is between 19,201 HUF and 111,371 HUF per month. The value of the remaining excess income shaped by the other component, the endured travel expense, is significantly below the data calculated for a person with unequal opportunities and distance maximising behaviour. According to this, for making decisions regarding expenses, the consideration of the time-relativised hourly wages is likely to be more significant (thus, model no. 2. describes the real situation). Individuals, as regards travel expenses, take into account the employment travel allowance, and in the absence of that, they opt for local employment. Among the trinity of travel time, distance and expense, the inflexibility associated with changes in the cost was stated by the majority of surveyed.

Overall, it has been established that the disadvantaged job seekers are significantly more inflexible than their in-model alter egos, who are aiming for rational decision making. In reality, this is justified by the empirical parameterisation and control of the mobility measuring models. Moreover, they call to attention the hindering effects of the analysed persons' substantial increase in mobility, which are as follows:

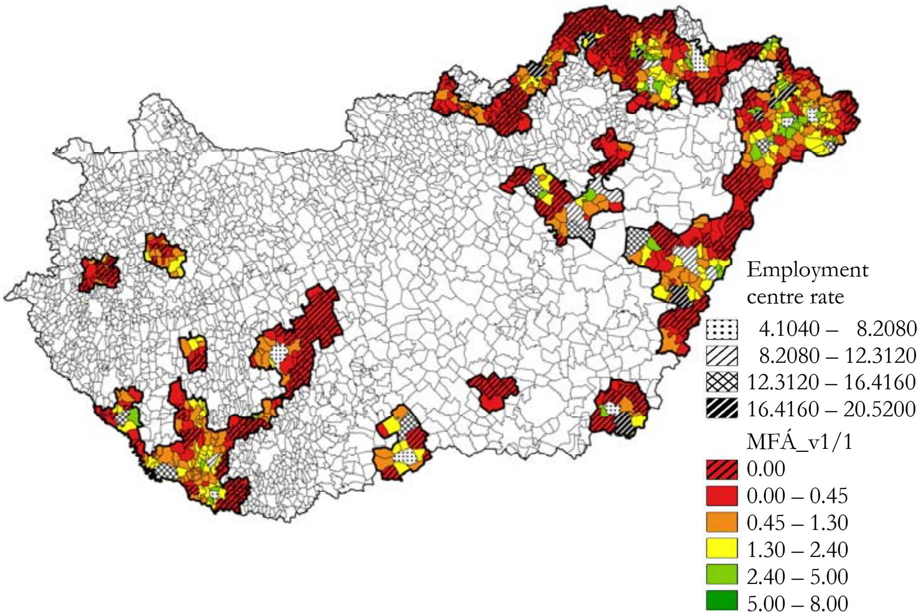
- The persons' demand for high income exceeds their qualification level.
- The limit regarding time and distance are according to the travel-related sacrifices (although, in this view, the respondents perfectly confirmed their decisions in connection to the nearest values of the exogenous model no. 2).
- The endured expenses are the biggest barriers of mobility. Members of the group for x HUF additional earning were willing to undertake more journeys in space and time to a distant workplace, whereas the budgets hardly changed.

Mobility level of the settlements, the end value model

If daily commuting was not supported by any financial allowances, the majority of the settlements in the disadvantaged areas would fall below the lowest level defined by the group (Figure 2).

Figure 2

The mobility level of the HH-area's settlements in relation to the disadvantaged groups according to three types of means of transport without any travel allowance



In about one-third of the settlements analysed, in relation to both cost and time, commuting from a certain place to the employment centre exceeds the value that applies to the most tolerant segment of the group (P_{90}=20,000 HUF, 50 minutes). In these villages and towns, even in the case of full availability of means of transport, mobility is not likely to begin automatically. The disadvantaged persons – based on the sample – are not able to endure commuting due to their current financial situations. This is in line with the model-based calculations of the values of expected income and endured expense ratio; thus, the basic conditions of commuting involve income higher than the current or a significant drop in expenses.

Nationally, within the surveyed area, five quasi-coherent, zero-mobility zones can be identified. Regarding the travel expenses, the situation in the Edelényi, Szikszói, and Encsi districts is almost entirely extremely disadvantaged. The Northern areas of the Putnoki and Gönci districts, where – in the absence of railways and locations' layouts – bus services are unfavourable and low-grade road surfaces cause extreme peak travel times (especially in Gönci district where one-km travel time is 126% of the national average). Additionally, in cases of borderline settlements, the significant distance to the employment centres (for example, Miskolc) provides an adverse picture. The second area is the Pétervásárai district, which is significantly different compared with the previous areas because the road quality corresponds to the national average. In this area, due to the settlement layouts' special characteristics, the extremely long distances detract from the value of the index, which uplifts the expenses and travel time. It is very similar to the situation of the third area, which begins at the Sárbogárdi district and draws an arc as far as the eastern border of the Sellyei district. The difference is because railways – which are a means of transport similar to motor vehicles and buses – are present in the area but are not sufficient to reduce commuting expenses and journey time due to the absence of a nearby employment centre. In places where the employment centre could be accessed by a short distance travel (for example, in Tamási district), due to inconsistence in transport times, a bus journey to the centre can only be completed after changing buses and enduring excessively long waiting times (in some cases, over an hour). In this case, however, the situation can be enhanced by creating direct bus routes. The nature of the road network, according to the previous types, can be traced in a completely different way through the fourth zone: the Vas county sub-periphery. Here, the number of dead-end villages are small, but both the employment centres can hardly be accessed from most of the scattered, small-sized villages (the bus services in several cases operate with changes). Towards the north, the River Rába limits the commuting traffic. The fifth zone is in the Debrecen's catchment area, which forms a compact whole among the borderline settlements. In this case, there is only one employment centre, accessing which is complicated because of the sparse road network. The sixth zone is scattered, more mosaic shaped; in the view of the wrong MFÁ values, the sparse road network, other centralised characteristics and the back and forth attraction (not the nearest centre's preferred attitude) play key roles.

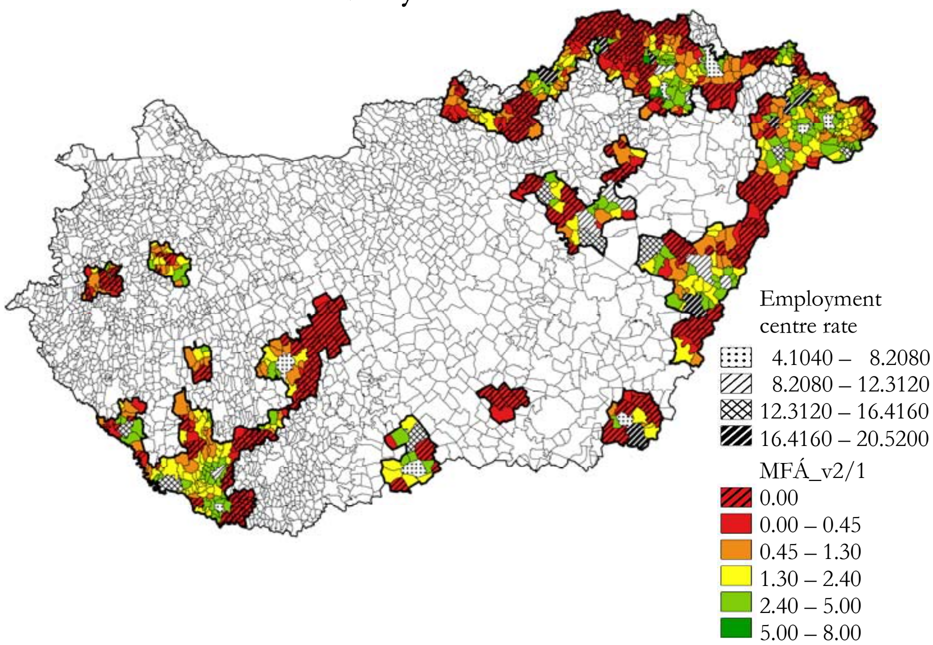
Coherent areas with a favourable mobility position can hardly be found within the surveyed areas. One area that stands out is the Szabolcs-Szatmár-Bereg county where the interaction of the centre and its surroundings is more pronounced (many dominant micro-centres are able to append their surrounding places) and powerful. Centres that are accessible by direct transport services provide a more favourable position to work-related commuting, which is also reflected in the MFÁ. Another important aspect is that here, especially in the Mátészalkai and Fehérgyarmati districts, the availability of railways make the previously shown cost saving possible; thus, it is a realistic replacement of buses and motor vehicles.

The optimised MFÁ model, discovery of the factors of the ideal commuting strategy

The picture significantly changes if it is assumed that a person only chooses the means of transport that is optimal for them to access their workplace (Figure 3).

Figure 3

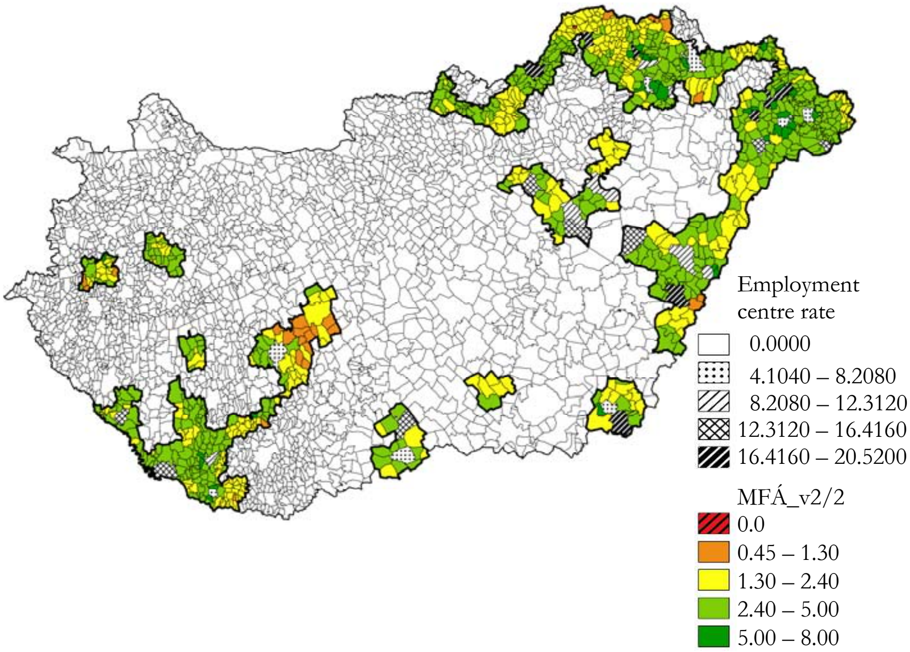
The optimised MFÁ model in relation to the disadvantaged groups according to the three types of means of transport without any travel allowance



The most striking effect is a considerable degree of mobility improvement in the areas outside of the unchanging mobility zone; in line with this the permanence of the space segment. As the asset optimisation becomes a possibility, the group of settlements with low mobility level (0.01–1.3 MFÁ) narrows or decreases by half or one-fifth; the settlements that show higher mobility potential (2.4–5 values) expand by the multiple of 3.6. The improvement, however, is isolated; it is only a solution for those settlements where the possibility of commuting was recorded as genuinely high. On the whole, a person can only ease the circumstances if they differ from being extreme, because the existing isolation, expenses and travel times can create such situations that attempts to counteract them can only increase the group's expenses. Therefore, the average of the achievable earnings should increase drastically, at least by 19,650 HUF, or there should be a drop in the travel costs. The latter is generated by realisation of the 86% employer travel allowance (Figure 4).

Figure 4

The optimised MFÁ model in relation to the disadvantaged groups according to the three types of means of transport with an 86%-rate travel allowance



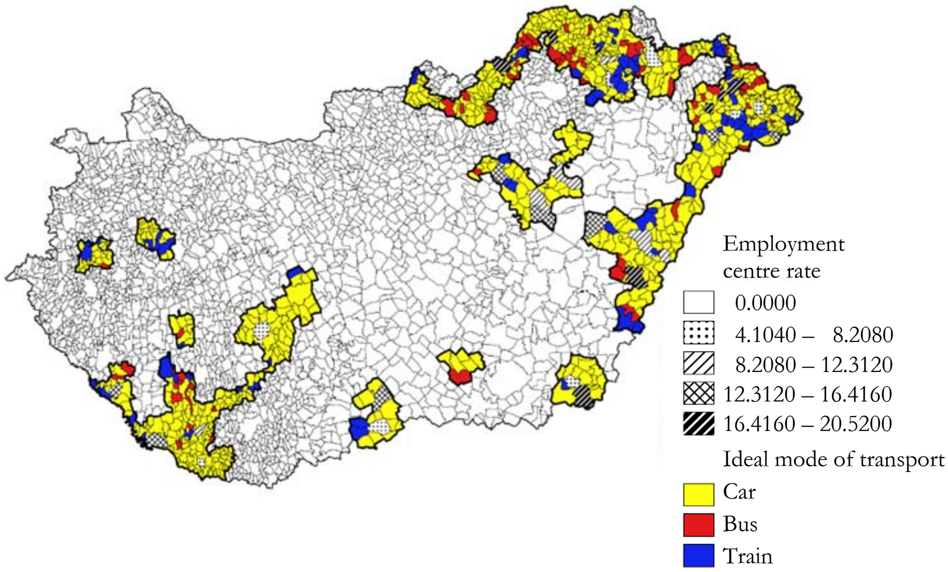
Granting full access to the travel allowance can improve the situation significantly: the original, more advantaged mobility zones can strengthen and zones with higher values may expand. The isolation is mostly limited to the border areas of the Sárbogárdi and Tamási districts, as well as to the initially very unfavourable northeastern borderland, which, in this current model, has significantly better accessibility. The tensions, therefore, seem to dissolve, but the image is somewhat overshadowed by the following objectives:

- The reimbursement of travelling expenses is realised only for people who are able to overcome other factors that are making employment difficult and can compensate additional costs by their productivity.
- The upper limit of the increasingly common category of 2.4–5 shows only moderate mobility.
- The mean increase of mobility level, compared to the model on the end limit values that carries the most powerful restrictions, is only two units, which is an outstanding and positive value; however, due to its low basis, it is not sufficient to increase commuting in the case of most settlements.
- The availability of means of transport is not comprehensive, as it depends on group specifics.

The last point raises the problem of the accessibility of means of transport. To assess the overall effects, it is necessary to have the knowledge of the type of transport chosen as an optimal strategy (Figure 5).

Figure 5

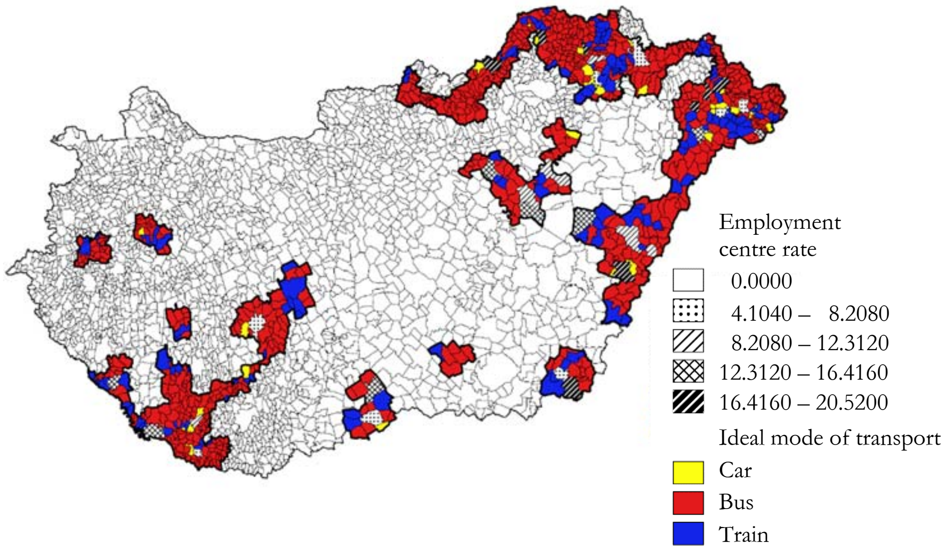
The ideal type of transport commuting in case of an optimised MFÁ model in relation to the disadvantaged groups according to the three types of means of transport without travel allowance



Without travel allowance, the dominance of motor vehicles is strongly emphasised (79%). Among the most decisive reasons are the possibility of time saving (36.3 minutes on a daily basis, expressed in money value as regards the disadvantaged job seekers and in relation to the HH-area means 21,025 HUF monthly saving), the previously quantified cost advantage in larger distances and several other convenience aspects. It is important to point out that, in the matter of motor vehicles, the model neither counts the maintenance expenses nor considers whether one single car is used by several others to commute. Bus transportation came in second, and the line was closed by railway, which far surpassed the former in its level of accessibility (37% of the railway links topped on the efficiency rank, whilst the same value in the case of the bus was 11.7%). Considering the previous travel allowance, the spatial image changes fundamentally (Figure 6).

Figure 6

The ideal type of transport commuting in case of an optimised MFÁ model in relation to the disadvantaged groups according to the three types of means of transport with an 86%-rate travel allowance



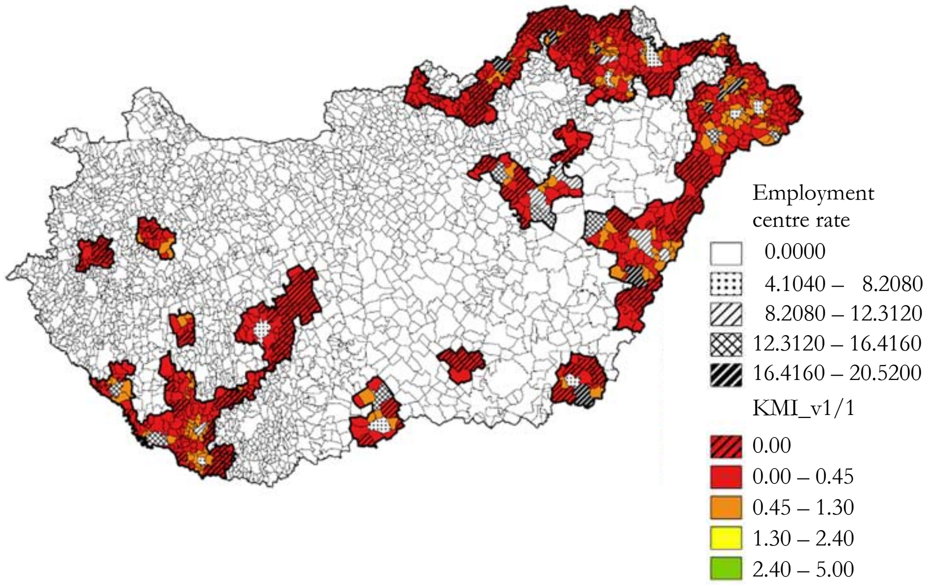
Motor vehicles lose ground, and their share drops to 17%, primarily in favour of buses whose share increases up to 68%. It is, therefore, appropriate to prioritise the means of transport in a support system framework. Another specificity is that of the available railway lines, approximately 59% are primary, which increases the realistic importance of train transport even though, because of its low accessibility, railways do not provide a significant solution to most settlements within the HH-area. The isolation of the areas with low mobility – at personal scale – can be eased to the greatest extent through the choice of bus. The role of train transport is most significant in the boundary zone between the favourable and unfavourable areas. However, there are two exceptions to the rule. In the Sárbogárdi district, when travel allowance is in use, train transport is more efficient in most parts of the settlements; this is an argument in favour of the operation of the Sárbogárd–Székesfehérvár railway line, which has been closed and reopened several times. In Szabolcs-Szatmár-Bereg county, the railway contributes the most into the higher fMFÁ values of the previously described scopes: favourable mobility microcentre-related commuting zones.

The settlements' adjusted degree of mobility

In the case of the questionees, the access probability regarding each of the alternatives comes to 12% for motor vehicles (cars), 62% for bus services and 19% for trains where accessible. According to the KMFÁ model variant adjusted with the accessibility data without travel allowance, the group's degree of mobility is spatially average (Figure 7).

Figure 7

Adjusted degree of mobility in the case of the settlements in the HH-area in relation to the disadvantaged groups according to three types of means of transport without travel allowance



A downturn is uniform; however, it does not uniformly affect the settlement structure. The main losers are the villages and towns rated 2.4–5 according to their degree of mobility, besides which a significantly smaller downturn affects the circle of settlements with high mobility rated 5–8. Decisively, groups below the very low 0.45 MFÁ value gain strength (it nearly doubles the number of settlements in this category). As previously discussed, the above effects are caused by the pursuit of an optimal asset selection strategy without any mobility allowance; thus, the choice of motor vehicle contributes to the widening of the horizon of commuting. According to the survey's experiences, however, the car is the least inaccessible for the group's members, especially the most disadvantaged job seekers. In the case of motor vehicles, the expenditures refer to a narrow cross-section. In sum, according to those who were included in the model sample (their details are given in the chapter describing spatial structure), buying a motor vehicle (for example, a car) would require additional sacrifices that the returns of commuting could offset over many years. The competitive advantage as regards motor vehicles is the highest in locations where the employment centre is located relatively close; however, due to the organisation of public transport services, the access is limited or, because of the significant distance, it is rationally inaccessible. In the first case, the return of investment's most significant barrier is the additional income's low-grade availability, typically in nearby, small-scale and weaker employment centres. In the latter case, the high expenses are relatively counterbalanced for the vehicle user by the extra compensation on time per kilometre. This may be a solution if several employees join forces and rely on commuting using one vehicle only. This alternative, however, has not gained mass popularity because of the low number of motor vehicles in the circle of job seekers and difficulty in synchronising the commuting, which can only be effective with smallest losses if the commuters work at same workplace during the same shift.

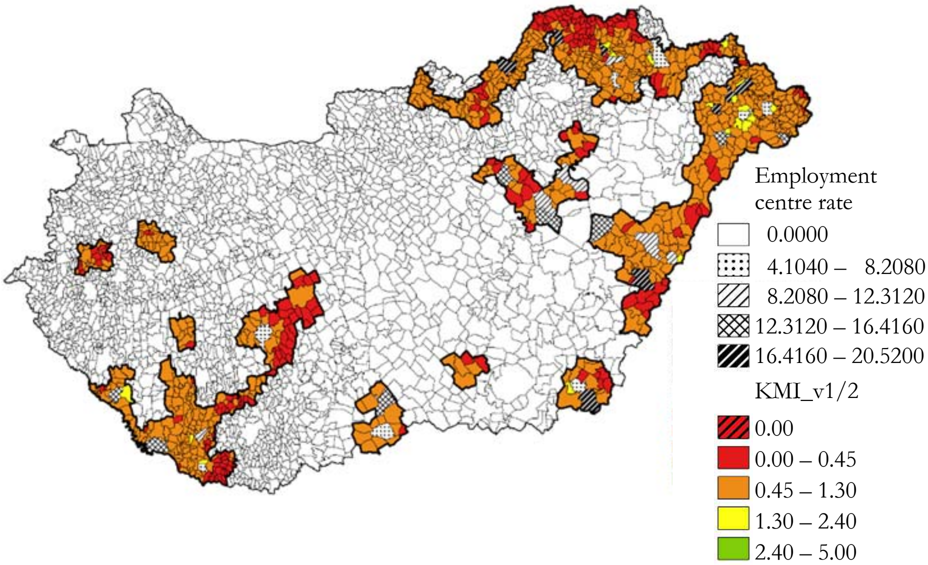
The most significant losses (about 3–5 units drop in degree of mobility) can be seen in the Kunhegyesi, Gönczi, and Devecseri districts. On the southern edge of the Gönci district, it is common that partly due to the transfer relations and partly due to the long journey distances, there are no alternative methods available besides motor vehicles. In the Devecseri and Kunhegyesi districts, the absence of railways decreases the mobility degree further by reducing the choice of transport to bus for commuters who own no motor vehicles. Because of the transport organisation, the above-mentioned districts' settlements have multiple disadvantages, and the worst conditions are due to the complete absence of direct connections.

KMI calculated with allowance

The introduction of travel allowance significantly changes the structure of the optimal commuting strategy. It increases the degree of mobility, and shifts its preference of ideal mode of transport from motor vehicle to bus. The degree of accessibility of the latter asset for the group is moreover higher, and its background effects strongly differ from the first mode, which makes a differentiated approach towards the isolation and improvement of the labour market position of the disadvantaged people possible. As an effect of the travel allowance scheme's introduction, the asset availability adjusted spatial mobility changes at a number of points, but in value and not in pattern (Figure 8).

Figure 8

Adjusted degree of mobility in the case of the settlements in the HH-area in relation to the disadvantaged groups according to three types of means of transport with 86%-rate travel allowance



The availability with adjusted-allowance calculated degree of mobility is substantially less effective in lowering the isolation than it was in the case of the model based on full availability. The primary reason for this is that even though in the case of receiving travel allowance and from the point of view of mobility, the bus is the most relevant asset, its availability to the people included in the sample hardly exceeded 68%. The availability of buses and their restrictive factors are in the first place as regards the employment-related inconsistency, which is about the same proportion as that of costs. Among the first factor's components in certain relations, bus transport does not allow for timely commuting to start a scheduled 8 o'clock shift or requires a disproportionately high sacrifice (which is hardly comparable to the additional benefits). Another aspect of this asset is the problem of higher time-value compared to a motor vehicle, which can typically be expressed only indirectly but has definitely been experienced. Regarding the scheduling of a journey, however, the principal problems are not related to travel times. This is because the travel-allowance generated improvement proves the significant role of the cost limit 'compared' to travel time. The real problem actually comes from the waiting, which in the case of a transfer can irrationally increase the time spent on travelling. This could be solved partly by increasing the number of operating services. The small number of services adjusted to the working hours can be only a partial solution; because of the diversity of workplaces, there are several different shift start timings. The problem becomes more significant due to the three-shift work pattern-related incoherence. This practically means that the commuter – if there is no worker transport service operated by the employer – falls out of the three-shift work schedule. This is a common practice in industries whose sector is the target group's largest potential employer. Because of the increase in unequal opportunities, the accessibility of motor vehicles drops and commuters partly migrate to the bus. Lastly, one of the effects of the availability of buses on the disadvantaged groups is the possibility of additional income. If there are alternative income sources available, those will diminish the marginal utility of commuting by bus. The effect of travel allowance in this case has no pronounced spatial projection, and sporadic, occasional improvements and extreme values are common.

Conclusions

The objective of this analysis is to reveal factors that play key roles in the mobility of the disadvantaged and multiple disadvantaged job seekers, as well as evaluate the questions regarding the target group's spatial-specific degree of mobility using the fMFÁ and KMFÁ models. The analysis pointed out that the revealed factors can be broken into two distinct groups: endogenous and exogenous factors, of which exogenous factors are significant among the analysed persons. First, the limit values and parameters during the indexing process of the degree of mobility were determined using two models based on rational decision making aimed at maximising the commuting distance; the first model formulated the conclusion based on the connection between the adjusted values of local and commuting-related available income. The obtained limit values for the commuting distance evolved between 64.8 km and 261.9 km. The second model approached the question using the locally accessible and journey time-related available hourly earnings; according to this, the viable travel distance was significantly smaller and did not exceed 10 km and 31.5 km. In order to reveal the contradiction between the methods and hidden background effects, empirical testing was carried out on both models. The analysis showed that the latter model was closer to real decision making and that, in case of all the questionees, the expected value of the remaining income significantly exceeded the optimum value calculated for a rational disadvantaged person. Beyond this, there is demanded earning on one hand and lower viable travel expense on the other.

The objective of the second part of the analysis was to know the limit values in order to survey the degree of mobility as regards the specific spatial segments of settlements (taking into account the objective factors, accessibility of the means of transport, role of travel allowance schemes and person-specific subjective components). It should be noted that if daily commuting is not supported by any allowance scheme, a significant proportion of the settlements in defined disadvantaged areas would fall below the lowest mobility threshold as defined by the analysed group. Nationally, within the surveyed area, five, quasi-coherent, zero mobility zones can be identified. Moreover, regarding travel expenses, the situation of the Edelényi, Szikszói and Encsi districts are almost entirely extremely disadvantaged. The Northern areas of the Putnoki and Gönci districts, the Pétervásárai district, the area that begins at the Sárbogárdi district and draws an arc as far as the eastern border of the Sellyei district, the sub-periphery of Vas county and the Debrecen's catchment area that forms a compact whole among the borderline settlements are similarly disadvantaged. With full access to travel allowance, the situation can improve significantly. The original, more advantaged mobility zones will strengthen, but the group's effects will further restrict the degree of mobility. The analysis of the ideal means of transport showed that without travel allowance, the choice of motor vehicles is more common; however, if there is an 87% drop in commuting expenses, the share of this asset will diminish and fall to 17%, primarily in favour of buses whose share will increase to 68%. Another specificity is that the available railway connections (about 59%) are primary, which increases the train transport's real importance, even though, due to its low accessibility, the railway does not provide a significant travel solution for most settlements within the HH-area. Considering the availability of each mode of transport, the calculated KMFÁ values pointed out that the disadvantaged groups with limited mobility possibilities reduce the degree of mobility significantly; therefore, creating a foundation for work-related commuting in the disadvantaged area is significantly more difficult.

It is apparent from the investigation that among the target groups, the degree of mobility will only increase substantially, especially if some of its components (for example, available wages, travel expenses and time and time table synchrony) as well as several other factors show simultaneous improvement. In the absence of this, some of the effects will cancel each other, and the temporary continuation of the barriers will significantly limit the viability of commuting for a major proportion of the group. The expansion of opportunities for mobility seems appropriate, on one hand, to improve competitiveness of the job seekers and, on the other hand, to strengthen labour demand in the employment centres. If there are no or only limited possibilities for improvement, then the increase in local employment may bypass the labour market gap between the sub-periphery and developed areas and may lead to favourable spatial equalisation.

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The importance of spatial adjustment processes in the labour force: the case of Albania

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Using census data on work commuting in Albania – collected for the first time in 2011 – this study examines the spatial adjustment processes between demand and supply of labour across the country. The first part focuses on the spatial adjustment of labour forces that occur within and between Albanian's prefectures. Several statistical indicators, derived using origin-destination matrices, measure the differential levels of attraction and expulsion of each prefecture. Results show a high level of heterogeneity and emphasise the crucial role of spatial contiguity among prefectures on this spatial dynamic. The second part examines the role of the municipality of Tirana. This is first investigated within a three-territorial-units system (the municipality of Tirana, rest of the prefecture and rest of Albania) and then within the prefecture as a closed system. Interestingly, 71.5% of all the commuting flows directed to the Municipality originate from municipalities located very close to Tirana (less than 10 km). We conclude that the spatial structure of the prefecture, reasonably extendable to the whole country, can be defined as monocentric. Further studies should focus on the implied costs of this system to the society and environment of Albania.

Keywords:
work commuting,
census data,
territorial imbalances,
spatial adjustments,
Albania

Introduction

The last decade has witnessed a growing interest in modelling and understanding commuting behaviour, (Eliasson et al. 2003, Schwanen et al. 2004, Frost 2006, Krakutovski–Armoogum 2007, Champion 2009) and the derived urban spatial structure (e.g. monocentric vs. polycentric city models; Bertaud 2003, Knox–McCarthy 2005, Romein 2005, Ding 2007). Particular interest has been devoted to the relationship between rural and urban areas (Champion 2009). Upon analysing census-based data for residents travelling to work, both Champion (2009) and Hincks (2012), suggested that a simple urban–rural dichotomy is not enough to describe the phenomenon of regional commuting to work and spatial labour adjustments.

We focus on the role of territorial units at different levels of aggregation[1] and how the process of spatial adjustment between the supply and demand of labour force is realised by employing data from the 2011 Albanian census, which collected information on work commuting for the first time in Albanian history. We are particularly interested in investigating the role of the municipality of Tirana to describe how commuting takes place in Albania and understand whether the spatial structure of Albania is polycentric or monocentric. As argued in several empirical studies (e.g. Camagni et al. 2002) and defined by the European Commission (EU Commission 1999), a monocentric system is a system that does not allow efficient, balanced and sustainable patterns of spatial development. In particular, the growth of the daily population of the centre (e.g. Tirana) could have negative repercussions in terms of spatial saturation, traffic and air pollution with a decrease in the quality of life of the population that permanently resides in this municipality. The role of the municipality of Tirana is crucial in terms of both attraction and repulsion of work-commuting flows. Finally, the focus on commuting within Albania borders is novel as most of the literature discussing Albanian labour force problems and productivity tackles the issue of focusing on migration rather than commuting (Instat 2014, Lerch 2014).

The methodology used to answer our research question belongs to the macro approaches: a class of approaches focused on territorial units in which spatial interactions are considered as the response to territorial discrepancies between needs (labour force demand) and opportunities (labour force supply) under a cost function (Bottai–Barsotti 2006). In this framework, the labour-force commuting network becomes an effective indicator of the relative economic potential of each territorial unit and its position in relation to the two components of labour market (demand and supply). The distribution of economic activities on a given territory takes place in

[1] The study has been conducted at three different territorial levels of analysis. In the first level, there were 12 territorial units (prefectures); in the second, there were three territorial units (municipality of Tirana, the rest of the Tiranë prefecture, and the rest of Albania); and in the third, there were 29 territorial units (the municipalities of the prefecture of Tiranë). For more details about the territorial level of analysis, see next session.

accordance to the functioning of the economic system. Therefore, the economic space can be defined as a distribution system of production and consumption, and mobility can be interpreted as a response to this economic space as a process in which the worker is both a productive factor and a consumer (Bottai–Barsotti 2006).

Given its mobility, each worker can offer his or her working capacity at different points in space. Such mobility can be achieved either by commuting between the residence and work (on a daily, weekly or monthly basis), by moving the residence or, in some cases, moving both the residence and workplace (Termote 1975, Clark et al. 2003). Commuting from home to the workplace can be considered an adjustment of the sphere of production, as it is a relocation of an individual – a production factor – due to the different territorial distribution of other production factors (Gottdiener 1987). Obviously, changes in the place of usual residence are not merely an adjustment to the domain of production activities, as they also occur for extra-economic reasons (e.g. marriage or improvements in social and housing conditions), as pointed out by several empirical studies (Dieleman 2001, Kim et al. 2005, Feijten et al. 2008). However, changes of residence modify, occasionally even to a great extent, the territorial distribution of labour supply. These changes are prone to become a source of uncertainty and instability (Courgeau–Lelièvre 2006). This study's contribution to the national and international literature is that it is one of the first studies on work commuting in Albania, a country in transition, in which the territorial reorganisation and processes of urbanisation are particularly significant.

In the reminder of the paper, the next section describes the data used and the territorial level of analysis. The following section is devoted to the explication of the analytical framework of reference and the model adopted. The results are presented and discussed in the last two sections. The final section also draws conclusions, discusses the limitations of the study and highlights avenues for future research.

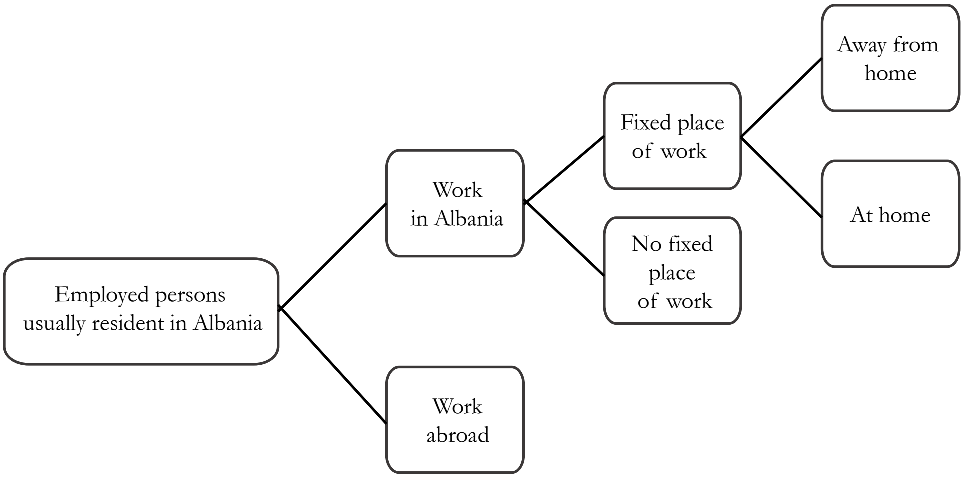
Data used and the territorial level of analysis

Data

The study is based on the outcomes of the 2011 Population and Housing Census data of Albania, which, for the first time, devoted some questions to the issue of commuting from home to work. Namely, the census collects the following information on commuting for all currently (at the time of the census) employed persons: type of place of work, geographic location of the place of work, mode of transport to work and frequency of travelling from home to work. Information on the workplace location is collected mainly to link it to the place of usual residence in order to establish accurate commuter flows from the place of usual residence to the place of work. In fact, breaking down the currently employed population usually residing in Albania by type of workplace enables us to distinguish employed persons working in Albania from those working abroad and classify the former by distinguishing those working at home from those working at a fixed place outside their home and those with no fixed place of work (Figure 1).[2]

Figure 1

Logical scheme of the aggregate of employed persons usually resident in Albania in function of the variable 'place of work'



Source: Author's own elaborations.

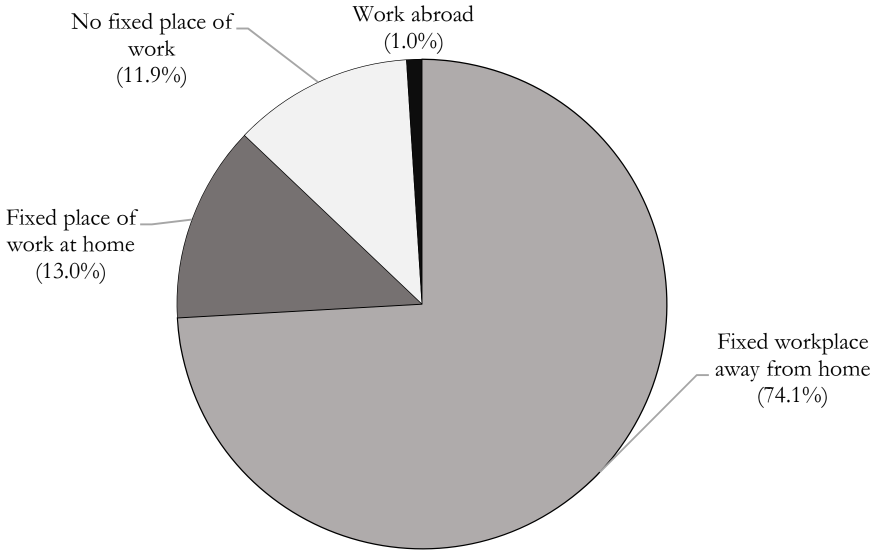
In detail, the category 'Fixed place of work, away from home' includes all employed persons usually resident in Albania that work in a place not coincident with their home. This category comprises persons who do not have a fixed place of work but report to a fixed address at the beginning of their work period (e.g. bus driver), as well as operators of street market stalls that are not removed at the end of the workday. The category 'Fixed place of work, at home', includes all employed persons usually resident in Albania that work at home. 'Home-based workers' refers to persons such as farmers who work and live on their farms and self-employed persons operating shops inside their own home. Finally, the category 'No fixed place of work', includes all employed persons usually resident in Albania whose work involves travelling to different areas and who do not report daily to a fixed address (e.g. travelling salesmen and long-distance lorry drivers), as well as ambulant vendors and operators of street/market stalls that are removed at the end of the workday and construction workers working at different sites during the reference period (Instat 2014a).

[2] The wording of the question on the place of work was 'Where is your place of work? 1) In Albania 2) Abroad'. Those answering 'In Albania' had to choose among the following three options: 1. 'Fixed workplace, away from home', 2. 'Work mainly at home', and 3. 'No fixed place of work'. In case of a fixed workplace away from home, the name of the town/village and code of the prefecture had to be specified. In case the place of work is abroad, the country had to be specified (Instat 2014a).

In the last Albanian census, the total number of employed persons was almost 680,000, excluding 2.8% of the records that could not be classified by place of work due to inconsistent answers. The percentage distribution of employed persons usually resident in Albania by type of workplace is reported in Figure 2.

Figure 2

Percentage distribution of employed persons usually resident in Albania by type of workplace



Source: Author's own elaboration of the 2011 Albanian Census data.

Generally, work commuters are all employed persons who have fixed workplace outside of home, although the destination of the journey from home to work may vary from being within the same town/village of the usual residence to a different country. In this broad sense, three out of four employed persons in Albania may be defined as work commuters. This category includes both workers having fixed a workplace outside home in Albania and those working abroad (Figure 1). Indeed, a small percentage of commuters are individuals who travel on a regular basis across the border to a neighbouring country (1.0% of the overall employed population). If three-quarters of the employed persons may be defined as work commuters (in the above-mentioned broad sense), the remaining quarter is composed almost equally of home-based workers (13.0% of the overall employed population) and workers with no fixed workplace (11.9% of the overall population; Instat 2014a).

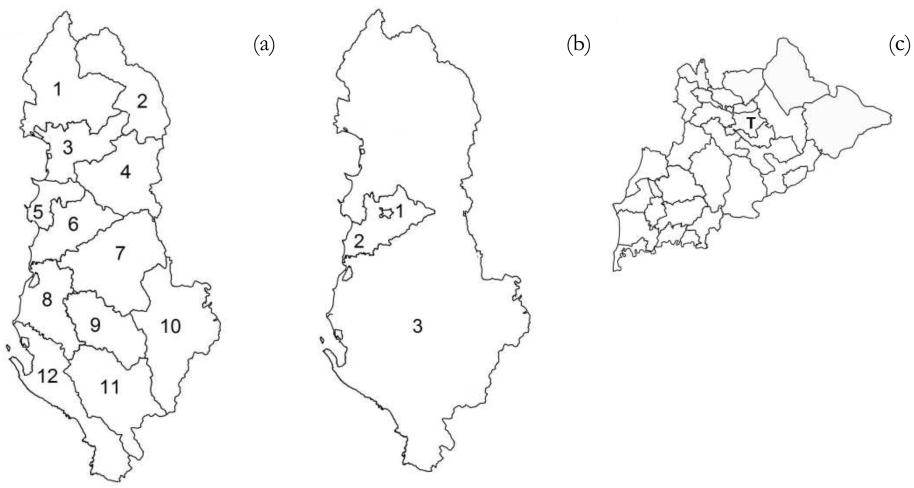
As better defined in the next section, our analysis is focused, at different territorial levels of analysis, on persons who have a fixed place of work away from home (the so-called inner work commuters).

Territorial level of analysis

The issue of selecting the territorial level for studying commuting patterns is crucial, as the results will be directly related to the territorial cut adopted in the analysis. Indeed, the bigger the geographical scale at which we observe work commuting flows, the smaller their volume. For this reason, we start from the highest territorial disaggregation (prefectures) and then gradually decrease the geographical scale and focus on Tirana.

Figure 3

The territorial levels of analysis. Albanian's prefecture (a); municipality of Tirana, rest of the prefecture of Tiranë and rest of Albania (b); and the municipality of Tirana and other municipalities of the same prefecture (c)



Legend (a)
1 Shkodër 2 Kukës 3 Lezhë
4 Dibër 5 Durrës 6 Tiranë
7 Elbasan 8 Fier 9 Berat
10 Korçë 11 Gijrokastër
12 Vlorë

Legend (b)
1 Municipality of Tirana
2 Rest of prefecture of Tiranë
3 Rest of Albania

Legend (c)
T Municipality of Tirana

Source: Author's own elaborations.

In detail, in the first part of the study, we analyse the processes of spatial adjustment of the labour force supply/demand with reference to the highest territorial level of the administrative subdivision – the 12 prefectures (Qarke) that constitutes Albania (Figure 3a). In the second section of the study, we focus our analysis on the role of the municipality of Tirana in the process of spatial adjustment observed in the first part of the study. To do so, we reconstruct the spatial interrelations system that reciprocally links three territorial units: the municipality of Tirana, the rest of the prefecture of Tiranë and the rest of Albania (Figure 3b). In the final part of the study, to better understand the role played by Tirana in its surrounding areas, we consider the spatial interactions within the prefecture of Tiranë amongst the various municipalities that belong to the same prefectures. With this territorial cut, we can observe the role played by the municipality of Tirana inside its prefecture as well as the role of others municipalities belonging to the same prefecture (Figure 3c).

Analytical framework of reference and mathematical notations

The different spatial-interaction approaches can be split into two large classes at the macro or micro levels. At the macro level, attention is focused on territorial units (e.g. region and municipalities), while at the micro level, the units of observation are the individuals. The macro approaches comprise gravitational models, while micro approaches are based on behavioural models (Bottai–Barsotti 2006). In the macroanalyses, spatial interactions among territorial units of a given economic system are envisioned as the response to locational disequilibria between needs (demand) and opportunities (supply) under a cost function (distance), whereas in the microanalyses, it is the individual's probability of movement that determines the volume of flows (Bottai–Barsotti 2006). As underlined in Bottai and Barsotti (2006), the choice of approach is often conditioned on the availability of data. The greatest diffusion of macro approaches is probably due to the amount of information supplied by official statistics, notably the censuses. In contrast, micro approaches most often need *ad hoc* sample surveys.

The approach applied in this contribution is a macro one. The proposed model of analysis is based on the use of origin-destination matrices, implementing several types of statistical indicators that allow us to measure different dimensions for each territorial unit under observation (i.e. local labour market): degree of self-containment, attraction and repulsions capacity, degree of openness and closure in relation to spatial interactions and contribution (in terms of labour supply/demand) to other local labour markets[3].

To describe our theoretical model, it is necessary to formally define the aggregates of reference and then explain the logic behind the use of origin-destination matrices. Let W^T be the total employed persons usually resident in Albania (in 2011). Taking into account the variable 'place of work', we can define W^T as the sum of four aggregates:

$$W^T = W^{IC} + W^H + W^A + W^{NF} \quad (1)$$

[3] This type of approach has been used in several empirical studies on work commuting and regional economic analysis, see Termote (1975), Barsotti (1986) among others. In particular, the statistical indicators applied here are partially based upon the work of Barsotti (1986).

where W^{IC} represents workers with a fixed place of work away from home (in Albania), the so called inner work commuters, W^{H} represents workers with a fixed place of work at home (in Albania), W^{A} represents workers residing in Albania but working abroad (the so-called abroad work commuters) and W^{NF} is the total number of workers in Albania with no fixed place of work. Let M_t^{IC} be an origin-destination square matrix of order *n* (number of spatial units in a given spatial system) of the inner work commuters *(W^{IC})* at time *t*. In M_t^{IC}, each element (w_{ij}^{IC}) represents the inner work commuters who resides in spatial unit *i* at time *t* and commute to spatial unit *j*.

$$M_t^{IC} = \begin{bmatrix} w_{11}^{IC} & w_{12}^{IC} & \dots & W_{i.}^{IC} \\ w_{21}^{IC} & w_{22}^{IC} & \dots & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ W_{.j}^{IC} & \dots & \dots & W^{IC} \end{bmatrix} \tag{2}$$

Note M_t^{IC} that is a square matrix because *i=j* and it varies from 1 to *n*. We can, therefore, define W^{IC} in terms of the mathematical elements that constitute M_t^{IC}. Thus, this can be presented formally as follows:

$$W^{IC} = \sum_{i=1}^{n} W_{i.}^{IC} = \sum_{j=1}^{n} W_{.j}^{IC} = \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}^{IC} \tag{3}$$

where $W_{i.}^{IC} = \sum_{j=1}^{n} w_{ij}^{IC}$ represents the total number of inner work commuters residing in *i* and working in Albania (i.e. the supply of labour of economic system *i*); $W_{.j}^{IC} = \sum_{i=1}^{n} w_{ij}^{IC}$ represents the total number of inner work commuters working in *j* and residing in Albania (i.e. the demand of labour of economic system *j*); w_{ij}^{IC} represents the inner work commuters who reside in territorial unit *i* and work in territorial unit *j* (i.e. the quota of supply of labour of economic system *i* absorbed by the demand of economic system *j*); w_{ji}^{IC} represents the inner work commuters who reside in territorial unit *j* and work in territorial unit *i* (i.e. the quota of supply of labour of economic system *j* absorbed by the demand of economic system *i*); w_{ii}^{IC} represents the inner work commuters who reside in territorial unit *i* and work in the same unit (i.e. the diagonal of M_t^{IC}); and *i* and *j* are, respectively, the spatial units of residence (place of residence) and spatial units of work (place of work) at time *t*.

Note that, in our case, the number of spatial units is equal to 12 in the first part of the analysis (12 Albanian's prefectures), 3 in the second part (municipality of Tirana, rest of prefecture of Tiranë and rest of Albania) and 29 in the final part (29 municipalities that form the prefecture of Tiranë).

Moreover, it should be noted that, since the phenomenon of spatial adjustment between supply and demand of labour is analysed through the distribution of inner work commuters (W^{IC}), as enumerated by the 2011 Census by place of residence (*i*) and place of work (*j*), the aggregate 'supply of labour' referred to a territorial unit includes only the inner work commuters living in *i* who work in *i* or in a *j* area located outside. Therefore, the following area excluded or underestimated: both implicit components (informal employment or underemployment), the unemployed (individuals without work and seeking employment), individuals who work at home (W^{H}), individuals who work abroad (W^{A}) and, finally, individuals who do not have a fixed place of work (W^{NF}). Thus, due to the nature of the data, labour supply is not defined as the currently active population (generally synonymous with the labour force) but only as the employed and, more precisely, as the explicit (declared) component of the employed that belong to aggregate W^{IC}.

On the other hand, the aggregate 'labour demand', which comprises all the units that belong to W^{IC} working in *j*, regardless of their place of usual residence (as typically some are usually resident in *j* and others in *i*), ignores or underestimated the part of the demand that is not satisfied due to inadequacy of labour supply as well as the part satisfied by informal employment. Furthermore, 'labour demand' excludes those from *j* who work at home in *j* (W^{H}) and, by definition, W^{A} and W^{NF}.

Results

Processes of spatial adjustment at the prefecture level

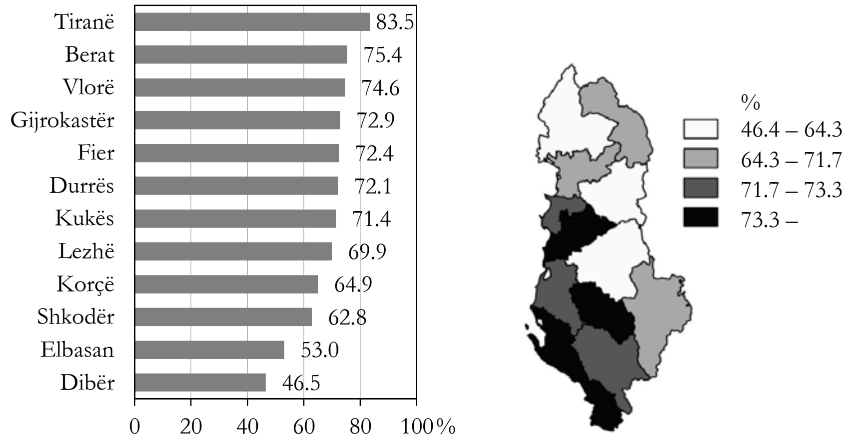
Before focusing on the results obtained from the indicators, it is important to better understand the spatial structure of the Albanian economy and job market. Albania is an economy in transition, characterised by significant regional disparities in terms of demographic and socio-economic characteristics. The Albanian territory is largely composed of mountains and hills, determining a very low proportion of urban population, with the exception of the expanding urban areas of Tiranë and Durrës. These two prefectures are linked by commuters travelling for work from one to the other, almost creating a single urban area (Benassi et al. 2015). Indeed, these are the only two prefectures with the population density exceeding 200 people per km^2, which is very high compared to the average of 100 people per km^2 (Instat 2015). On the other hand, the lowest population density is found in the most peripheral areas of the country: typically in the north east, particularly in the prefecture of Kukës, and in the southwest, where the prefecture of Gijrokastër has the lowest demographic density of the country, with as little as 25 people per km^2. The Albanian economy is still based mainly on intense agricultural production – sheep and goat farming – and exploitation of mineral resources. The industry, although affected by a technological gap and limited territorial expansion, has obtained good results in recent years, in line with what is expected of a developing country in transition. Furthermore, in recent years, several Italian enterprises have relocated some of their services (mainly remote customer services such as call centres) to Albania. Finally, the economy is starting to record growing tourism, mainly to the coastal regions and the seaside. Within this general framework, there are some specific territorial differences to be noticed. According to data in the Albanian Regional Statistics Yearbook (Instat 2015), in 2011, about 35% of the total employment in the public administration sector occurred in the prefecture of Tiranë, emphasising the importance of this prefecture in the Albanian socio-economic structure. This figure becomes even more important when compared to the second prefecture, Elbasan, which has barely 8.5% of the total employment in the administration. Looking at the structure of employment, it is interesting to notice that in 2011, approximately half (48.5%) of those employed in the non-agricultural sector were located in the prefecture of Tiranë, followed by Durrës (12.3%) and Vlorë (7.0%). These figures are very low for other highly agricultural territories such as Kukës (0.8%), Dibër (1.4%) and Gijrokastër (2.5%). On the other hand, as reported in Instat (2015), the share of people employed in the private agricultural sector is comparatively high in the territories of Fier (15.2%), Elbasan (14.9%) and Korçë (11.0%).

Finally, looking at active companies and their growth rates, it is possible to notice the difference in economic dynamism across the country. According to Instat (2015), in 2011, the highest proportion of active companies was in Tiranë (43.4%), followed by that in Durrës (11.6%) and Fier (8.6%). In the same year, territories with the highest rate of new enterprises were Vlorë (14.3%), Shkodër (12.8%) and Tiranë (12.7%). Finally, significant regional variations are detected as a function of the distribution of active enterprises by sector of economic activity. Starting from the primary sector, the highest proportion of active companies is in the prefecture of Vlorë (22.8%), followed by that of Durrës (14.6%) and Shkodër (13.5%). In the secondary sector, the highest proportion of active enterprises is registered in the prefecture of Tiranë (34.9%), followed by that of Durrës (12.9%) and Vlorë (9.7%). Finally, in the tertiary sector, the highest proportion of active enterprises is recorded in the prefectures of Tiranë and Durrës (39.9% and 11.6%, respectively) and Fier (9.0%).

The different spatial structure of Albanian local labour markets (in terms of supply and demand) is highlighted in Figure 4. Here, we notice for each prefecture *i*, the percentage proportion of inner work commuters of the total of those employed by prefecture of residence. As we can see, the prefectures that present comparatively higher values of this indicator are located in the more urbanised areas of the country on the Central-West and Southern-West parts, namely Berat, Tiranë and Vlorë. On the other hand, the prefectures located in the Northern and Eastern part of the country – namely Shkodër, Dibër and Elbasan – register lower percentages of inner work commuters of the total of those employed.

Figure 4

Proportion of inner work commuters every 100 employed persons, Albanian prefectures



Source: Author's own elaboration on the 2011 Albanian Census data.

We now analyse the inner work commuters (W^{IC}) and the sub aggregates ($W_{i.}^{IC}$ and $W_{.j}^{IC}$) in which they can be decomposed. To do this, we used several simple statistical indicators that we explain in detail in the remaining of this section and the next.

At the prefecture level, the labour force supply (demand) not coincident accounts to 19,762 units. This is the number of employed who work in a different prefecture from the one where they usually reside, and it accounts for 4.1% of the inner work commuters (W^{IC}). This means that, at this territorial level of analysis, the process of spatial adjustment of supply-demand between the Albanian prefectures concerns 41 working units for every 1,000 inner work commuters.

Further exploring the process at the prefecture level, for each of the 12 territorial units, we computed an indicator related to the distribution of the work supply (employed) of the Albanian prefectures according to the origin of the demand. This statistical indicator, which shows the proportion of labour supply absorbed by domestic demand, allow us to detect, for each prefecture, the level of self-containment[4] of the spatial interactions due to work reasons. The indicator ($LSADD_i^{IC}$) is calculated as follows:

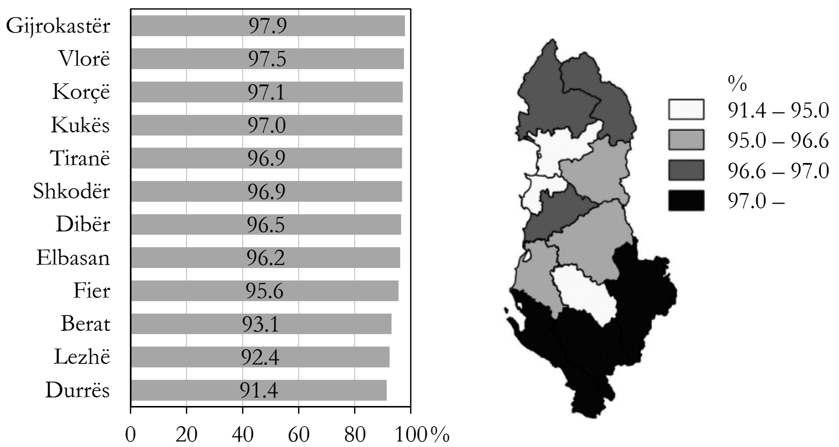
$$LSADD_i^{IC} = w_{ii}^{IC} / W_{i.}^{IC} \qquad (4)$$

[4] With the term 'self-containment', we refer to the capacity of a given local labour system to contain the majority of spatial interaction due to work reasons inside its geographical boundaries.

Looking at the distribution of the indicator in Figure 5, it is noticeable how the value is comparatively lower in the prefectures of Durrës (91.4%), Lezhë (92.4%) and Berat (93.1%). This means that, in these prefectures, the degree of evasion from the supply side, namely the part of labour supply satisfied by extra-prefecture demand, is comparatively high. It is therefore possible to conclude that the labour market in these prefectures is essentially opened. In the remaining nine prefectures, where the value registered by the indicator exceeds 95%, the opposite is true: the labour market is essentially closed because the part of the job offer absorbed by domestic demand is high.

Figure 5

Distribution of the proportion of labour supply absorbed by domestic demand ($LSADD_i^{IC}$). Albanian prefectures



Source: Author's own elaboration on the 2011 Albanian Census data.

The next step to accurately evaluate the degree of opening/closure of the labour market should also consider, simultaneously, the share of demand 'outstanding' from local supply, which is the proportion of demand satisfied by external or extra-areal supply. However, when referring to prefectures, such a measure can only be calculated with regard to the supply-demand relation that develops with other Albanian prefectures (as we consider the overall labour market, namely at the national level, closed). According to Barsotti (1986), one way to measure the degree of opening/closure of each Albanian prefecture, taking into account both part of the supply processed and share of demand outstanding, is to calculate the weighted arithmetic averages of the share of supply absorbed by extra-prefecture demand and that of the demand satisfied by the extra-prefecture supply, taking into account as weights the prefecture consistency of supply ($W_{i.}^{IC}$) and demand ($W_{.j}^{IC}$), respectively.

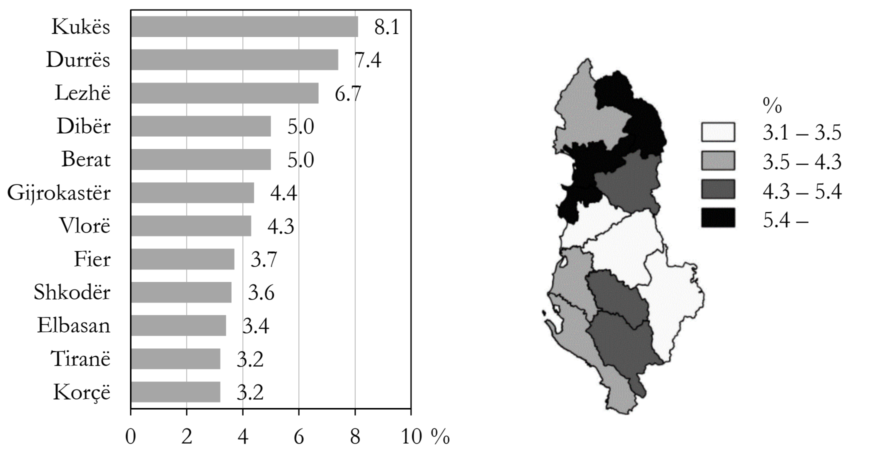
More formally, for each prefecture, the degree of opening/closing (D_i^{IC}) in relation to inner work commuting flows is computed as follows:

$$D_i^{IC} = W_{.j}^{IC} + W_{i.}^{IC} - 2w_{ii}^{IC} / W_{.j}^{IC} + W_{i.}^{IC} \qquad (5)$$

The distribution of this indicator is shown in Figure 6. The prefectures of Kukës (8.1%), Durrës (7.4%) and Lezhë (6.7%) record a less high rate of 'closure' (in these prefectures, the index value of opening/closure is higher: >5.0%). On the contrary, the remaining prefectures – in particular Shkodër, 3.6%, Elbasan, 3.4%, Tiranë, 3.2% and Korçë, 3.2% – record, despite a different gradation, more high rates of 'closure' as the value of the index is comparatively low.

Figure 6

Distribution of the degree of opening/closing (D_i^{IC}) in relation to inner work commuting flows, Albanian prefectures



Source: Author's own elaboration on the 2011 Albanian Census data.

In the next series of results, we further examine the relationship between supply and demand at the level of prefectures to verify whether they are characterised, with reference to W^{IC}, by a surplus of demand over supply ($W_{.j}^{IC} > W_{i.}^{IC}$) or vice-versa ($W_{.j}^{IC} < W_{i.}^{IC}$). To achieve this, following the approach of Barsotti (1986), we have computed five measures for each prefecture. The first indicator represents the extra-areal component of the demand (EAD_i^{IC}) and is computed as follows:

$$EAD_i^{IC} = W_{.j}^{IC} - w_{ii}^{IC} \qquad (6)$$

The second indicator represents the extra-areal component of the supply (EAS_i^{IC}) and is computed as follows:

$$EAS_i^{IC} = W_{i.}^{IC} - w_{ii}^{IC} \qquad (7)$$

The third indicator represents the surplus of demand over supply (SDS_i^{IC}) and is computed as follows:

$$SDS_i^{IC} = (W_{.j}^{IC} - w_{ii}^{IC}) - (W_{i.}^{IC} - w_{ii}^{IC}) \quad (8)$$

However, as evaluating the phenomenon in only absolute terms can be limiting, we have calculated two additional relative indexes. The first, $READ_i^{IC}$, is obtained by dividing the excess of demand over supply of each prefecture by the demand of the same prefecture as follows:

$$READ_i^{IC} = (W_{.j}^{IC} - W_{i.}^{IC}) / W_{.j}^{IC} \quad (9)$$

The second ($READ_i^{IC*}$) is obtained by comparing, in case of positive excess, the surplus of demand over supply of each prefecture to the extra-areal component of the demand and, in case of negative excess, to the extra-areal component of the supply. The formula is as follows:

$$READ_i^{IC*} = \begin{Bmatrix} (W_{.j}^{IC} - W_{i.}^{IC}) / (W_{.j}^{IC} - w_{ii}^{IC}) \ \mathit{if} \ (W_{.j}^{IC} - W_{i.}^{IC} > 0) \\ (W_{.j}^{IC} - W_{i.}^{IC}) / (W_{i.}^{IC} - w_{ii}^{IC}) \ \mathit{if} \ (W_{.j}^{IC} - W_{i.}^{IC} < 0) \end{Bmatrix} \quad (10)$$

Results are presented in Table 1 and show an excess of labour force demand for seven out of 12 prefectures. It is possible to observe values of some relevance for the prefecture of Vlorë (+1,209), followed by that of Kukës (+807), Gijrokastër (+654) and Tiranë (+288). Among the areas in which there is an excess of demand over supply, Kukës stands out for a comparatively high value: more than 8% of its demand would remain unsatisfied even in the event that the whole supply of the area (the total employed residents in the prefecture of Kukës) worked within the same area. The opposite surplus is geographically less widespread and affect the remaining five areas, amongst which stand out the prefectures of Berat (–1,292), Durrës (–1,073) and Fier (–854). The ratio between the excess of demand over supply and demand is also comparatively high in the prefectures of Gijrokastër (4.0%), Vlorë (3.3%) and Dibër (1.7%). Moreover, an excess of supply is observed for the prefecture of Berat, as 4% of its supply would remain unabsorbed if the demand of the area were to be fully satisfied by indigenous workers (employed residents in the same area).

Table 1

Extra-areal component of the demand (EAD_i^{IC}), extra-areal component of the supply (EAS_i^{IC}) and excess of demand over supply (SDS_i^{IC}). Indices (%) of relative surplus: ($READ_i^{IC}$) and ($READ_i^{IC*}$)

Prefectures	(EAD_i^{IC})	(EAS_i^{IC})	(SDS_i^{IC})	($READ_i^{IC}$)	($READ_i^{IC*}$)
Berat	876	2,168	–1,292	–3.9	59.6
Dibër	796	419	377	1.7	47.4
Durrës	2,646	3,719	–1,073	–2.2	28.9
Elbasan	1,187	1,453	-266	–0.5	8.3
Fier	1,764	2,618	–854	–1.2	32.6
Gijrokastër	948	294	654	4.0	69.0
Korçë	1,227	1,015	212	0.5	17.3
Kukës	1,026	219	807	8.4	78.7
Lezhë	738	996	–258	–1.6	25.9
Shkodër	938	742	196	0.6	20.9
Tiranë	5,610	5,322	288	0.2	5.1
Vlorë	2,006	797	1,209	3.3	60.3

Source: Author's own elaboration on the 2011 Albanian Census data.

The role of the municipality of Tirana in the processes of spatial adjustment

In this section, we evaluate the role of the municipality of Tirana in the process of the spatial adjustment observed above. To do so, we reconstruct the spatial interrelations system that reciprocally links three territorial units: the municipality of Tirana, rest of the prefecture of Tiranë and rest of Albania (Figure 3). In the 2011 Census, the municipality of Tirana recorded the usually resident population of 418,495, which is equal to almost 56% of the total usually resident population in the prefecture of Tiranë (749,365 units). This fact is linked to the urbanisation phenomenon – a process that concerns almost all the countries of the world but assumes particular importance in the less developed and transition countries such as Albania (Henderson 2002). In this study we do not want to analyse this type of phenomenon; however, there is strong evidence for a relationship between urban growth, migratory movement (spatial redistribution of population) and commuting (Pumain 2006).

Table 2 presents results from the analysis, in reference to the aggregate (W^{IC}), of the supply distribution by the origin of work demand. It is possible to appreciate that the municipality of Tirana presents a high capacity of self-containment of its workforce that commutes. Of the inner work commuters residing in the municipality of Tirana, 96.5% work in the same municipality. The situation changes if we refer to the inner work commuters that reside in the rest of the prefecture of Tiranë; in this case, almost 60% work in the municipality of Tirana, 37% in the rest of the prefecture of Tiranë and 5% in the rest of Albania. Referring to those who reside in the rest of Albania, we notice that 1.2% work in the municipality of Tirana, almost 1% in the rest of the prefecture of Tiranë and 98.1% in the rest of Albania. Considering the total number of employed (inner work commuters) of Albania, we can see that almost 32% work in the municipality of Tirana, 4.4% in the rest of the prefecture of Tiranë and almost 64% in the rest of Albania.

Table 2

Work supply ($W_{i.}^{IC}$) broken down by the origin of demand. Municipality of Tirana, rest of the prefecture of Tiranë and rest of Albania (percentage values)

Origin (place of residence, *i*)	Destination (place of work, *j*)			
	Municipality of Tirana	Rest of the prefecture of Tiranë	Rest of Albania	Albania
Municipality of Tirana	96.5	0.9	2.6	100
Rest of the prefecture of Tiranë	58.0	37.0	5.0	100
Rest of Albania	1.2	0.7	98.1	100
Albania	31.7	4.4	63.9	100

Source: Author's own elaboration on the 2011 Albanian Census data.

Table 3 presents, with reference to the aggregate W^{IC}, the distribution of the demand by the origin of the supply. The share of the inner work commuters that work and reside in the municipality of Tirana is 79.2%; it is 18.5% for those that work in the municipality of Tirana but reside in the rest of the prefecture of Tiranë, while it is 2.3% for those who reside in the rest of Albania. In the rest of the prefecture of Tiranë, the proportions are, respectively, 5.1%, 85.2% and 9.7%. Finally, referring to the total inner work commuters that reside in Albania, we can see that 26.0% work in the municipality of Tirana, 10.1% in the rest of the prefecture of Tiranë and 63.9% in the rest of Albania. From these analyses, it is clear that the role of attraction played by the municipality of Tirana in the Albanian labour market is of primary importance. It is also clear that such a role implies great costs in terms of spatial saturation, mobility, environment and pollution. We will come back to this point in the final part of the paper.

Table 3

Work demand ($W_{.j}^{IC}$) broken down by the origin of demand. Municipality of Tirana, rest of the prefecture of Tiranë and rest of Albania (percentage values)

Origin (place of residence, *i*)	Destination (place of work, *j*)			
	Municipality of Tirana	Rest of the prefecture of Tiranë	Rest of Albania	Albania
Municipality of Tirana	79.2	5.1	1.1	26.0
Rest of the prefecture of Tiranë	18.5	85.2	0.8	10.1
Rest of Albania	2.3	9.7	98.1	63.9
Albania	100	100	100	100

Source: Author's own elaboration on the 2011 Albanian Census data.

To better understand the role played by Tirana, we consider the spatial interactions within the prefecture of Tiranë amongst the various municipalities that belong to the same prefecture. In other words, we want to observe the role played by the municipality of Tirana inside its prefecture as well as the role of other municipalities belonging to the same prefecture. We, therefore, consider the prefecture of Tiranë as a closed system. Starting from the origin (place of residence, *i*) destination (place of work, *j*) square matrix (M_t^{IC}) computed in reference to W^{IC}, we have calculated three ratios. The first one is the inflow ratio (r_j^I) that represents, for a generic location (*j*), the proportion of inflow on the total flow volume of the same generic location (in this case, the municipality of the prefecture of Tiranë). The inflow ratio has been computed as follows:

$$r_j^I = (W_{.j}^{IC} - w_{ii}^{IC})/(W_{.j}^{IC} - w_{ii}^{IC}) + (W_{i.}^{IC} - w_{ii}^{IC}) \quad (11)$$

The second ratio is the outflow ratio r_i^O that represents, for a generic location (*i*), the proportion of daily outflow on the total daily flow volume of the same generic location (in this case, the municipality of the prefecture of Tiranë). The outflow ratio has been computed as follows:

$$r_i^O = (W_{i.}^{IC} - w_{ii}^{IC})/(W_{.j}^{IC} - w_{ii}^{IC}) + (W_{i.}^{IC} - w_{ii}^{IC}) \quad (12)$$

The third ratio is the net flow ratio (r_i^N) that represents, for a generic location (*i*), the net proportion of the inflow and outflow compared to the total flow volume of the same generic location (in this case, the municipality of the prefecture of Tirana). The net flow ratio has been computed as follows:

$$r_i^N = (W_{.j}^{IC} - w_{ii}^{IC}) - (W_{i.}^{IC} - w_{ii}^{IC})/(W_{.j}^{IC} - w_{ii}^{IC}) + (W_{i.}^{IC} - w_{ii}^{IC}) \quad (13)$$

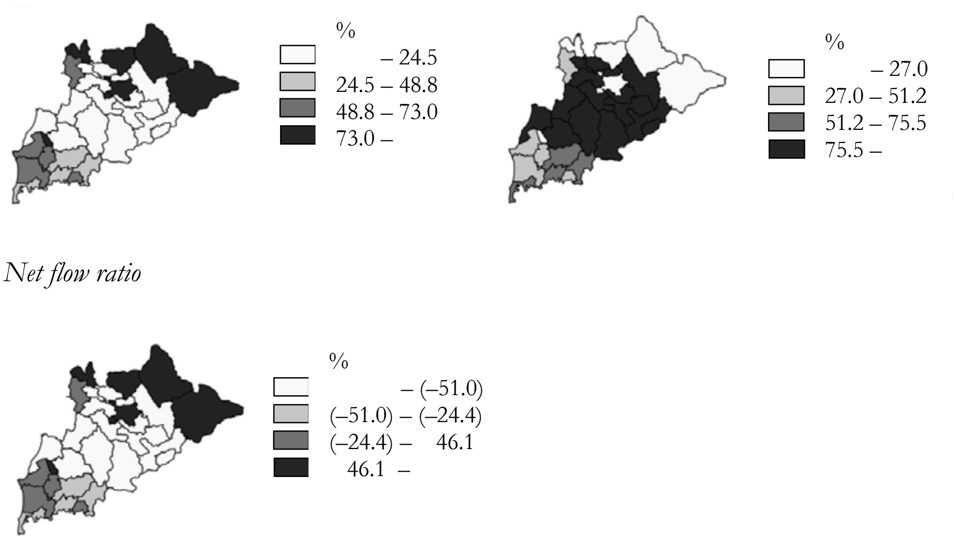
These three measures are presented in Figure 7 and show that the municipality of Tirana attracts inner work commuters mainly from its surrounding areas, especially from municipalities that are spatially contiguous. This dynamic is coherent with the theoretical frameworks in which a core-periphery model is elaborated: people migrate from the core municipality to the surrounding areas and then start to commute to the core municipality and, at the same time, other people migrate from other municipalities, located quite far from the core municipality, to municipalities located in the surrounding area of the core municipality and then start to commute to the core municipality (Termote 1975, Bottai–Barsotti 2007).

Obviously these dynamics, which are 'classic', especially in countries such as Albania where the distance from the municipality of residence (*i*) and municipality of work (*j*) plays a crucial role because the system of transportation is not well developed, imply a lot of risks and costs that are typically connected to a monocentric system.

Figure 7

Municipalities of the prefecture of Tiranë.
Inflow ratio, outflow ratio and net flow ratio.

Inflow ratio *Outflow ratio*



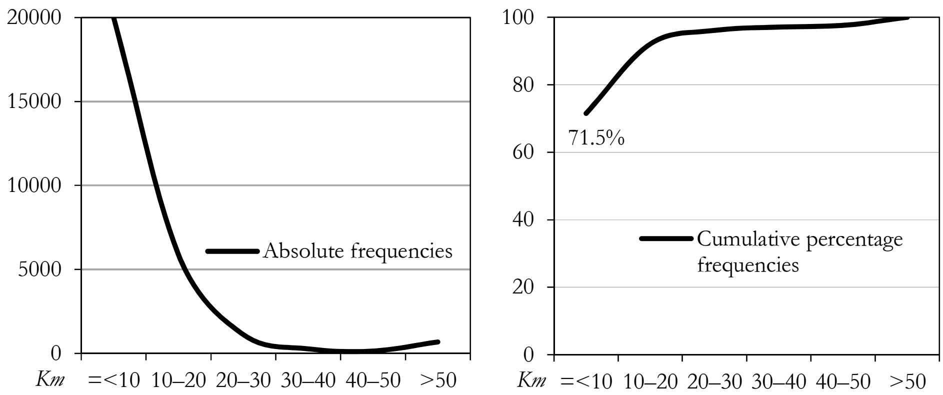
Source: Author's own elaboration on the 2011 Albanian Census data.

Figure 8, in which commuting flows from all the Albanian municipalities are taken into account, reinforces the power of attraction played by the municipality of Tirana. This power of attraction significantly decreases as the distance increases.

In fact, 71.5% of all the commuting flows directed to the municipality of Tirana originated from municipalities that are located very near to Tirana (=<10 km). The weighted distance mean is in fact equal to 11.3 km, whereas the modal distance is 8.3 km.

Figure 8

Distance and commuting inflow. Municipality of Tirana



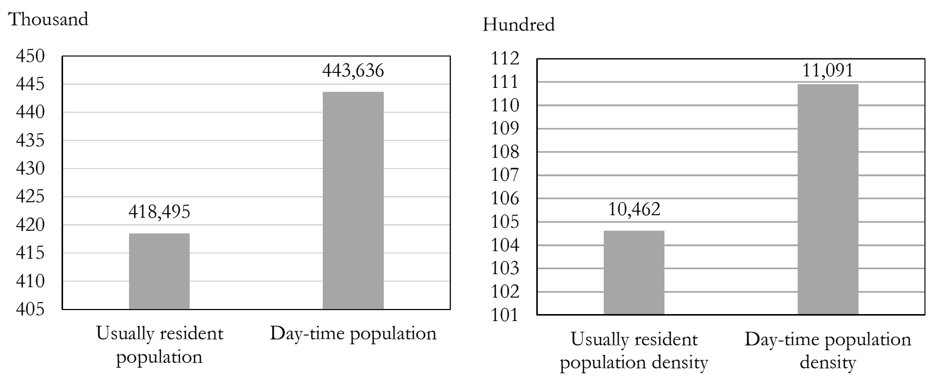
Source: Author's own elaboration on the 2011 Albanian Census data.

The effects of these dynamics are very important in order to better understand the costs of an urban system that qualifies itself as monocentric. The difference between inflow and outflow $(W_{.j}^{IC} - w_{ii}^{IC}) - (W_{i.}^{IC} - w_{ii}^{IC})$, for the municipality of Tirana is positive and equal to +27,076. Even when considering only the daily commuting flows, the difference remains positive (+25,141).

This means that every day the population of Tirana grows from 418,495 units to 443,636 units (+6.0%). Obviously, the population density also increases: the resident population density of the municipality of Tirana, usually equal to 10,462.37 persons per km^2, becomes 11,090.9 persons per km^2 during working day-time (Figure 9).

Figure 9

Municipality of Tirana. Usually resident population and daytime population and usually resident population density and daytime population density



Source: Author's own elaboration on the 2011 Albanian Census data.

Considering the daytime population, the municipality of Tirana represents more than 20% of the total Albanian usually resident population. These data allow us to define the spatial structure of Albania as monocentric; a spatial structure that implies costs for the society and environment (Berry–Kim 1993). European policies have recognised that polycentric configurations in regions and countries can be intended as a means to achieve multiple goals, namely more efficient, balanced and sustainable patterns of spatial development (EU Commission 1999). This is why polycentric development and polycentric spatial structures in regions and countries have become an important analytical concept, as well as a popular normative goal of spatial planning (Camagni 1993, Bailey–Turok 2001, Kloosterman–Musterd 2001, Cattan 2007). The importance of polycentric development has also been stressed in academic debates. Several authors have studied the emergence of polycentric spatial structures and their implications on economies and physical systems (Priemus 1994, Lambooy 1998, Davoudi 2003 Parr 2004, Meijers 2008). Polycentrism is also included in the 'policy aims' identified by the European commission (EU Commission 1999) as a means to be used towards sustainable development of the European Union territory.

Discussion and conclusions

This study is one of the first study on work commuting in Albania and shows how each territorial unit – at different territorial levels of analysis – contributes to the process of spatial adjustment of labour force supply/demand in Albania. Within this framework, the role played by the municipality of Tirana is crucial in terms of both attraction and repulsion of work commuting flows. The daily population of the municipality of Tirana grows significantly due to a positive net between daily inflow and outflow, which defines the spatial structure of Albania as monocentric. This allows us to elaborate on some considerations about the costs naturally implied by a monocentric system. A monocentric system, as argued in several empirical studies and defined by the European Commission, is a system that does not allow efficient, balanced and sustainable patterns of spatial development. In particular, the growth of the daily population of Tirana could have negative repercussion in terms of spatial saturation, traffic and air pollution and a decrease in the quality of life of the population that resides in this municipality. In order to become an effective member of the European Union, territorial planners and policy makers should concentrate on this point, facilitating the development of a polycentric system that could contribute to diminish these negative externalities that traditionally characterise transition countries.

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Fuzzy models in regional statistics

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Many regional data are not provided as precise numbers, but they are frequently non-precise (fuzzy). In order to provide realistic statistical information, the imprecision must be described quantitatively. This is possible using special fuzzy subsets of the set of real numbers $\mathbb{R}$, called fuzzy numbers, together with their characterising functions. In this study, the uncertainty of measured data is highlighted through an example of environmental data from a regional study. The generalised statistical methods, through the characterising function and the δ-cut, that are suitable for the situations of fuzzy uni- and multivariate data are described. In addition, useful generalised descriptive statistics and predictive models frequently applicable for analysis of fuzzy data in regional studies as well as the concept of fuzzy data in databases are presented.

Keywords:
fuzzy data in regional studies,
characterising function,
statistics with fuzzy data,
fuzzy data in databases

Introduction

The measurement of continuous variables is often clouded with uncertainty, and many data are not exact numbers but more or less fuzzy. This type of uncertainty is different from errors. However, the count data are, if considered in a larger scope, often associated with various types of uncertainty. The inaccuracy of data is not usually assumed in standard statistics. However, these problems should be approached with caution. Inaccurate data are quite general in many environmental analyses, and occur often in regional studies. In these cases, the inaccurate data are often presented with considerable uncertainties. Nevertheless, such data are essential for decisions, despite their uncertainties. Lee (1995) proposed some useful concepts of fuzzy spatial statistics. The work by Burrough (2001) emphasises that the fuzzy set theory is a useful tool for spatial analysis. There have also been efforts to apply fuzzy models in the field, for example, for the assessment of urban air quality (Guleda–Ibrahim–Halil–2004) and the estimation of underground economy (Ene–Hurduc 2010).

The description of fuzzy data and their statistical analysis also form an active field of research. The most suitable mathematical model to describe the fuzziness is fuzzy numbers and their characterising functions (Viertl 2015). In this contribution, the generalised statistical methods to handle fuzzy data, usually found in regional studies, are described. In the next section definition and examples of fuzzy data are provided. Characterisation of fuzzy data through special membership functions of fuzzy numbers, i.e. so-called characterising functions, is described in the third section. Some useful descriptive statistics for fuzzy data are explained in the fourth section. In the fifth section models for prediction based on fuzzy information are described. In the sixth section, the use of fuzzy data in databases is introduced. The contribution is concluded with final remarks in the final section.

Fuzzy Data in Regional Studies

In regional studies, measurements, often statistical, are necessary for further analyses. The concept of measurement has been developed in conjunction with the concepts of numbers and units of measurement. In statistics, data as a result of measurements are typically categorised at different levels, i.e. nominal, ordinal, interval and ratio data. Knowing the level of the measurement helps in applying appropriate methods and/or models in interpreting and analysing data of different levels accordingly.

Examples of one-dimensional fuzzy data are height of a tree, water levels in lakes or rivers and concentrations of toxic substances in the air. On the other hand, many measurements under consideration are generally in the form of multivariate data (Wichern–Johnson 2007); that is, the corresponding idealised results are real vectors $\mathbf{x} = (x_1, \dots, x_k) \in \mathbb{R}^k$. For example, data on several variables are used altogether in identifying factors that are responsible for a nation's growth index. These data are frequently represented in the form of time series, which requires specific methods for further data analyses, such as those introduced in the fifth section.

Real observations x of continuous stochastic quantities X are not precise numbers or vectors, whereas the measurement results are more or less non-precise, or fuzzy. The fuzziness of individual measurement results is described by the so-called fuzzy numbers, while the variability is described by stochastic models. As a result, the analysis of repeated measurements is possible by using suitably generalised statistical methods (Viertl 2015).

As an illustration, the measurement results of substances in the air are generally reported by different regions as part of the environmental data in regional studies. The Austrian Ambient Air Quality Protection Act has established air quality limit values for sulphur dioxide (SO_2), nitrogen dioxide (NO_2), nitric oxide (NO), lead, benzene, carbon monoxide (CO) and particulate matter (PM), as well as target values for ozone (Austria's Federal Environment Agency 2002). Limit values for NO_2 are often exceeded in agglomerations, predominantly at traffic-related areas. Table 1 shows the measurement of NO_2 emission in the air at different measuring stations in South Tyrol, Italy (Landesinstitut für Statistik Bozen, Südtirol 2015). Table 2 lists the levels of severity in 'linguistic' terms as an interpretation of the numerical measurement (adapted from (Amt der Tiroler Landesregierung 2016)).

Table 1

The amount* of NO2 emission in the air at different measuring stations

Stations	2009	2010	2011	2012	2013	2014
Bozen 6	...	...	...	28	32	30
Bozen 4	46	44	46	43	43	41
Bozen 5	41	40	42	39	40	37
Leifers	27	28	28	27	27	25
Meran	34	34	34	31	33	31
Latsch	18	18	19	17	18	17
Bruneck	21	22	21	20	20	19
Sterzing	32	34	34	30	31	30
Brixen	29	29	30	27	27	30
Feldthurns (A22)	67	67	65	60	60	58
Auer (A22)	49	45	47	45	45	42
Kurtinig a.d.W.	...	33	40	32	32	30
Ritten	4	3	5	3	3	3

* Annual average in $\mu g/m^3$ of the daily averages from the concentration data collected for over a year.
Source: Landesinstitut für Statistik (ASTAT), Bozen, Südtirol (2015).

Table 2

Evaluation of the level of NO2 emission in the air

Level	NO_2[a)]
Very small polluted	< 50
Small polluted	≥ 50
Polluted	≥ 80

a) Measured in $\mu g/m^3$
Source: Abteilung Raumordnung-Statistik, Amt der Tiroler Landesregierung (2002).

Measurement of a continuous variable, the amount of NO_2 in this case, is often a source of uncertainty. On the other hand, allocation of the quantitative measures into different classes is frequently necessary. The allocation itself, as well as the interpretation between classes, is defined by qualitative data (linguistic terms), and the corresponding quantitative measurement values, as in Table 2, are subjective and uncertain (fuzzy). Problems often arise when the quantitative measures lie somewhere close to and/or on the border lines between neighbouring classes, for example, the amount of NO_2 measured in Auer (A22) from Table 1. Categorising such border-line amounts as very small or small polluted can be subjective and uncertain. Subjectively categorising such measures may subsequently trigger unnecessary corrective actions, which, in turn, cost time and money. Thus, to further analyse such data appropriately, a generalised model to quantify such uncertainty is necessary.

The best (to-date) mathematical description (see also (Klir–Yuan 1995)) of such data (observations) is by means of fuzzy numbers $x_1^*, \dots, x_n^*$ with corresponding characterising functions $\xi_1(\cdot), \dots, \xi_n(\cdot)$, described in the next section or by a fuzzy vector $\mathbf{x}^*$ with corresponding vector-characterising function $\zeta(\cdot, \dots, \cdot)$ for multivariate fuzzy data.

Characterisation of fuzzy data

In order to describe observations or measurements of continuous quantities, the definition of general fuzzy numbers is useful.

Definition 1: A general fuzzy number x^* is defined by its characterising function $\xi(\cdot)$, which is a real function of one real variable and has the following properties:

(1) $\xi: \mathbb{R} \to [0,1]$

(2) The support of $\xi(\cdot)$, denoted by $supp[\xi(\cdot)]$ and defined by
$supp[\xi(\cdot)] := \{x \in \mathbb{R}: \xi(x) > 0\}$,
is a bounded subset of $\mathbb{R}$.

(3) For all $\delta \in (0,1]$, the δ-cut $C_\delta[\xi(\cdot)]$, defined by
$C_\delta[\xi(\cdot)] := \{x \in \mathbb{R}: \xi(x) \geq \delta\} = \bigcup_{j=1}^{k_\delta} [a_{\delta,j}, b_{\delta,j}]$,
is non-empty and finite union of compact intervals.

Along with general fuzzy numbers, a related critical question is how to obtain the characterising function of a measurement result. First, a function has to be defined and then the special membership functions of fuzzy numbers, which are characterising functions, describing measurement results, can be obtained (Kovářová–Viertl 2015).

Observations or measurements of continuous quantities obtained from the measuring equipment are norms in regional studies. In case of analogue measuring equipment, the measurement result can be read from a pointer position on a scale and further recorded by a photograph. Such photographs display the position of the reading pointer in the form of colour intensity $g(\cdot)$ along a measurable scale. The characterising function $\xi(\cdot)$ can then be obtained in the following way:

Taking the value c of the basic colour intensity, a function $h(\cdot)$ is defined as

$$h(x) := g(x) - c \qquad \forall x \in \mathbb{R}.$$

Based on the function $h(\cdot)$, the characterising function $\xi(\cdot)$ of the fuzzy number describing the measurement is obtained in the following way:

$$\xi(x) := \frac{|h'(x)|}{max\{|h'(x)|: x \in \mathbb{R}\}} \qquad \forall x \in \mathbb{R},$$

where $h'(\cdot)$ is the derivative of function $h(\cdot)$.

For measurements of vector quantities, the concept of fuzzy vectors is essential.

Definition 2: Using the notation $\mathbf{x} = (x_1, \dots, x_k)$, a k-dimensional fuzzy vector $\mathbf{x}^*$ is determined by its so-called vector-characterising function $\zeta(\cdot, \dots, \cdot)$, which is a real function of k real variables $x_1, \dots, x_k$ and has the following properties:

(1) $\zeta: \mathbb{R}^k \to [0,1]$

(2) The support of $\zeta(\cdot, \dots, \cdot)$ is a bounded set.

(3) For all $\delta \in (0,1]$, the δ-cut $C_\delta[\mathbf{x}^*]$, defined by

$$C_\delta[\mathbf{x}^*] := \{ \mathbf{x} \in \mathbb{R}^k : \zeta(\mathbf{x}) \geq \delta \},$$

is non-empty, bounded, and finite union of simply connected and closed sets.

As an example for the special case, where $k = 2$, the vector-characterising function of a measurement, or a representation of a light point on a screen, can be obtained in the following way:

Let $h(x_1, x_2)$ be the light-intensity at coordinates (x_1, x_2). The values of the vector-characterising function $\zeta(\cdot,\cdot)$ are given by

$$\zeta(x_1, x_2) := \frac{h'(x_1, x_2)}{max\{h'(x_1, x_2): (x_1, x_2) \in \mathbb{R}^2\}} \quad \forall (x_1, x_2) \in \mathbb{R}^2.$$

For higher dimensions ($k > 2$), measurements of components x_i^* are usually given by their corresponding characterising functions $\xi_i(\cdot)$. These characterising functions can be combined into a vector-characterising function $\zeta(\cdot, \dots, \cdot)$ by using a triangular norm. Especially for coordinate measurements, the product-t-norm is useful. In this case, the values of the vector-characterising function are given by

$$\zeta(x_1, \dots, x_k) = \prod_{i=1}^{k} \xi_i(x_i) \qquad \forall (x_1, \dots, x_k) \in \mathbb{R}^k.$$

Further details on characterising functions can also be found in Kovářová and Viertl (2015) and Viertl (2011).

Descriptive statistics for fuzzy data

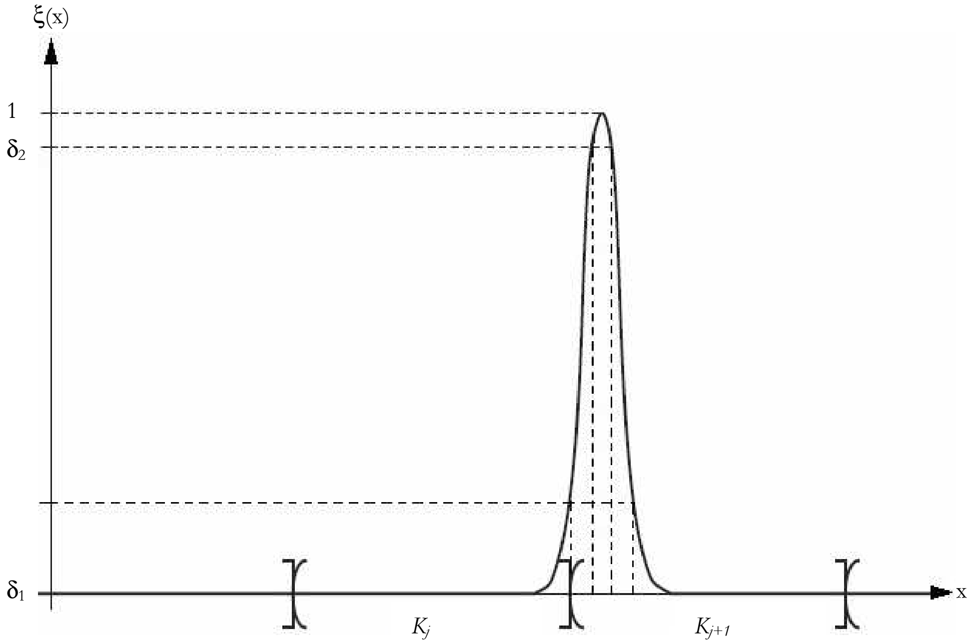
Data analysis in regional studies ranges from analysis encompassing very simple summary statistics to extremely complex multivariate analyses. This section introduces some descriptive statistics for fuzzy data with a focus on relatively simple methods. Most collected data can be used in different ways to explain the areas – variables and their behaviours –that are the main focus of the studies. The starting point for the data analysis is basic descriptive statistics, such as tables of frequencies of the main variables of interest, histograms, empirical distribution functions and correlation coefficients. This section presents these generalised descriptive statistics for fuzzy data.

Fuzzy Histograms

Given a fuzzy sample $x_1^*, \dots, x_n^*$ and a partition $K_1, \cdots, K_m$ (i.e. m classes) of the real numbers $\mathbb{R}$, the concept of relative frequencies and histograms can be extended naturally from the idealised case of real-valued samples. In this case, the most crucial aspect is that an element x_i^* may not lie within a single class but partially within different classes as depicted in Figure 1.

Figure 1

Fuzzy observation and classes of a histogram



Therefore, the relative frequency of class K_j becomes a fuzzy number $h_n^*(K_j)$. For $C_\delta\left(h_n^*(K_j)\right) = \left[\underline{h}_{n,\delta}(K_j), \overline{h}_{n,\delta}(K_j)\right]$, every $\delta \in (0,1]$ and every set $K_j \subseteq \mathbb{R}$ defines the lower relative frequency on a δ-cut, $\underline{h}_{n,\delta}(K_j)$, $j=1(1)m$ and the upper relative frequency of the δ-cut, $\overline{h}_{n,\delta}(K_j)$, respectively, as follows:

$$\underline{h}_{n,\delta}(K_j) := \frac{\#\{x_i^* : C_\delta(x_i^*) \subseteq K_j\}}{n}$$

$$\overline{h}_{n,\delta}(K_j) := \frac{\#\{x_i^* : C_\delta(x_i^*) \cap K_j \neq \emptyset\}}{n},$$

where # indicates cardinality, and for a fuzzy sample $x_1^*, \dots, x_n^*$, the δ-cuts are defined by $C_\delta(x_i^*) = \left[\underline{x}_{\delta,i}, \overline{x}_{\delta,i}\right]$ $\forall \delta \in (0,1]$.

For example, given the characterising functions of a fuzzy sample of size 10 as in Figure 2, the characterising function $\eta(\cdot)$ of the fuzzy relative frequency of the class **[1, 2]** is shown in Figure 3.

Figure 2

Fuzzy sample of size 10

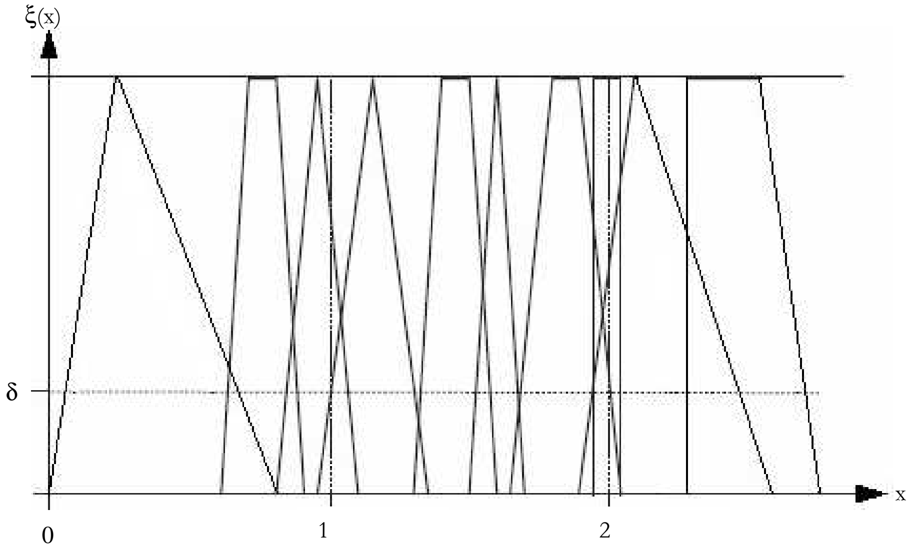
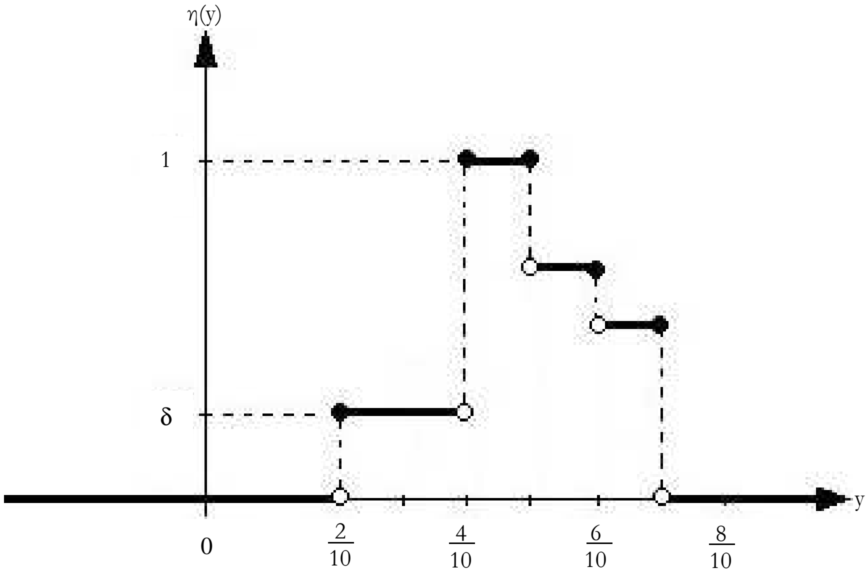


Figure 3

Characterising function of $h^*_{10}([1,2])$



In this case, at a specified δ-level, the lower ($y_1 = \underline{h}_{n,\delta}(K_j)$) and upper relative frequencies ($y_2 = \overline{h}_{n,\delta}(K_j)$) of the class [1,2], determined by $C_\delta\left(h^*_{10}([1,2])\right)$, are

$\frac{2}{10}$ and $\frac{7}{10}$ respectively. Fuzzy histograms provide more information for further statistical analysis through fuzzy probability densities.

Fuzzy empirical distribution functions

For a fuzzy sample, the empirical distribution function $\hat{F}_n^*(\cdot)$ is a fuzzy valued function defined on ℝ. For fixed $x \in \mathbb{R}$ and every $\delta \in (0, 1]$, $\hat{F}_{\delta,L}(\cdot)$ and $\hat{F}_{\delta,U}(\cdot)$, the lower and upper δ-level functions of $\hat{F}_n^*(\cdot)$, respectively, are defined by

$$\hat{F}_{\delta,L}(K_j) := \frac{\#\{x_i^* : C_\delta(x_i^*) \subseteq (-\infty, x]\}}{n} \text{ and}$$

$$\hat{F}_{\delta,U}(K_j) := \frac{\#\{C_\delta(x_i^*) \cap (-\infty, x] \neq \emptyset\}}{n}.$$

For a fuzzy sample $x_1^*, \ldots, x_n^*$ whose δ-cuts are given by

$$C_\delta(x_i^*) = [\underline{x}_{\delta,i}, \overline{x}_{\delta,i}] \quad \forall \delta \in (0,1],$$

the corresponding δ-level functions of the fuzzy valued empirical distribution function are given by

$$\hat{F}_{\delta,L}(x) = \frac{1}{n}\sum_{i=1}^{n} I_{(-\infty,x]}(\overline{x}_{\delta,i}) \text{ and } \hat{F}_{\delta,U}(x) = \frac{1}{n}\sum_{i=1}^{n} I_{(-\infty,x]}(\underline{x}_{\delta,i}) \ \forall x \in \mathbb{R},$$

where $I_A(\cdot)$ represents an indicator function with respect to set A.

Fuzzy correlation coefficient

For multivariate continuous data, or one observation with k variables (dimensions), idealised measurement results in a k-dimensional real vector $(x_1, \ldots, x_k)$. For the special case $k = 2$, combining samples result in a fuzzy vector, denoted as $(x_1, x_2)^*$ with the vector-characterising function $\zeta(x_1, x_2) = \xi_1(x_1)\cdot\xi_2(x_2) \ \forall (x_1, x_2) \in \mathbb{R}^2$.

In case of n observations, i.e. $\mathbf{x}_i^* = (x_{1\cdot i}, x_{2\cdot i})^* \mathrel{\hat{=}} \zeta_i(\cdot,\cdot)$, $i = 1(1)n$, the combined fuzzy sample $\mathbf{X}^*$ is obtained by

$$\mathbf{X}^* = (x_1, x_2, \ldots, x_{1\cdot n}, x_{2\cdot n})^* \mathrel{\hat{=}} \zeta(x_1, x_2, \ldots, x_{1\cdot n}, x_{2\cdot n}), \text{ where } \zeta: \mathbb{R}^{2\cdot n} \to [0,1].$$

In this case, the vector-characterising function $\zeta(\cdot, \ldots, \cdot)$ of the combined fuzzy sample is obtained in the following way:

$$\zeta(x_1, x_2, \ldots, x_{1\cdot n}, x_{2\cdot n}) := \min_{i=1(1)n}\{\zeta_i(x_{1\cdot i}, x_{2\cdot i})\}$$

$$= \min\{\zeta_1(x_1, x_2), \ldots, \zeta_n(x_{1\cdot n}, x_{2\cdot n})\} \ \forall (x_1, x_2, \ldots, x_{1\cdot n}, x_{2\cdot n}) \in \mathbb{R}^{2\cdot n}$$

In other words, through the combination of n fuzzy observations $\mathbf{x}_i^*$, $i=1(1)\,n$ of a k-dimensional fuzzy quantity with vector-characterising functions $\zeta_i(\cdot)$ by the minimum-t-norm, n fuzzy k-dimensional vectors are combined into a $(k\cdot n)$-dimensional fuzzy vector with vector-characterising function $\zeta(\cdot, \ldots, \cdot)$. The δ-cuts of the combined fuzzy sample $\mathbf{X}^*$ are the Cartesian products of the δ-cuts of the fuzzy vectors $\mathbf{x}_i^*$, $i=1(1)n$, which is seen from

$$\text{by } \mathsf{X}_{i=1}^{n} C_\delta[\xi_i(\cdot)] \Leftrightarrow \xi_i(x_i) \geq \delta \ \forall i=1(1)n \Leftrightarrow \min_{i=1(1)n}\{\xi_i(\cdot)\} \geq \delta.$$

Applying the extension principle to the following function $f_{\hat{\rho}}(\mathbf{X})$, the fuzzy sample correlation coefficient $(\hat{\rho})$ is obtained as follows:

$$f_{\hat{\rho}}(\mathbf{X}) = \frac{\sum_{i=1}^{n}(x_{1i}-\bar{x}_1)(x_{2i}-\bar{x}_2)}{\sqrt{\sum_{i=1}^{n}(x_{1i}-\bar{x}_1)^2}\sqrt{\sum_{i=1}^{n}(x_{2i}-\bar{x}_2)^2}},$$

where the characterising function of the generalised fuzzy empirical correlation coefficient r^* is given by

$$\zeta_{r^*}(r) := \begin{cases} sup\{\zeta(x_1, x_2, \ldots, x_{1 \cdot n}, x_{2 \cdot n}): \text{for } f_{\hat{\rho}}(\mathbf{X}) = r\} \\ 0 \quad \text{otherwise} \end{cases} \quad \forall r \in [-1,1].$$

Applying the δ-cuts $C_\delta[\mathbf{X}^*]$, the lower and upper boundaries of the estimated sample correlation coefficients are obtained through simple linear programs (Shiang-Tai–Chiang 2002). A correlation coefficient provides a quantitative measure of some type of statistical relationships among the observed data values.

Models for predictions based on fuzzy information

Different methods are useful in developing models for prediction purposes, which are often of interest in regional studies, such as using historical data for projection of the next year's gross domestic product (GDP) per capita of a certain area. In general, there are two types of predictive models: parametric and non-parametric. Parametric models require some specific statistical assumptions with regard to one or more of the population parameters that characterise the underlying distribution(s), while non-parametric models are less strict with respect to the required assumptions than their parametric counterparts. The models developed for standard data have been generalised to handle fuzzy data.

Fuzzy regression

Fuzzy parametric models based on results from experiments and analysis can be constructed; for example, $\hat{Y}^* = f(x_1^*, \ldots, x_k^*)$, where x_i^* are fuzzy independent variables and $\hat{Y}^*$ is a fuzzy dependent variable. In applications, there are several possibilities for taking the fuzziness into account when considering the regression models (Viertl 2011):

a) The parameters β_k and independent variables x_i are assumed to be standard real values, but the dependent variable y_i^* is fuzzy.
b) The parameters β_k^* and dependent variables y_i^* are assumed to be fuzzy, but the independent variables x_i are standard real values.
c) The dependent variables y_i as well as values of the independent variables x_i are standard real numbers, but the parameters β_k^* are fuzzy numbers.
d) The values of the independent variables x_i are fuzzy numbers x_i^*, but all other quantities are standard real numbers.

e) The independent variables and dependent variables are fuzzy, x_i^* and y_i^* respectively, but the parameters β_k are standard real values and the data set is $(x_{i1}^*, \dots, x_{ik}^*; y_i^*)$.
f) All considered quantities are fuzzy.

Frequently, quantitative regional data are collected for an analysis to model the relationship between independent and dependent variables$(x_{i1}, \dots, x_{ik}; y_i)$ for further understanding and, subsequently, for necessary prediction. Based on specific circumstances, these variables are often of uncertain (fuzzy) nature, for example, a regression model for GDP (dependent variable) with consumption, investment, and government expenditure as three independent variables. Accordingly, the fuzziness of these variables can be quantified through the methods presented in section 3. In this case, directly applied to possibility (e) for example, the independent variables and the dependent variable are fuzzy, while parameters β_k are standard real values and the data set is collected in the form of $(x_{i1}^*, \dots, x_{ik}^*; y_i^*)$. The fuzziness of these variables, without having to intuitively introduce another fuzzy coefficient into the model, can be combined before applying the extension principle. However, according to possibility (b), as originally proposed by Tanaka et al. (1982) and the most frequently used method, fuzzy regression models assume a fuzzy dependent variable and a fuzzy coefficient, but crisp independent variables to minimise the fuzziness of the model (Shapiro 2006).

In case of a k-dimensional sample of observations $\mathbf{x}_i^*$, i=1(1) n, the generalised minimum rule is applied to obtain the vector-characterising function $\zeta(x_1, \dots, x_{kn})$ for the combined fuzzy vector $\mathbf{X}^*$, which is the combined fuzzy sample.

Considering a fuzzy sample $\mathbf{x}_1^*, \dots, \mathbf{x}_n^*$ with the corresponding vector-characterising functions $\zeta_i(\cdot, \dots, \cdot)$, where $\mathbf{x} = (x_1, \dots, x_k) \in \mathbb{R}^k$ and sample space $\mathbb{R}^{k\cdot n}$, that is $\mathbf{x}_i^* \in \boldsymbol{\mathcal{F}}(\mathbb{R}^n)$, i=1(1) n and the combined fuzzy sample $\mathbf{X}^* \in \boldsymbol{\mathcal{F}}(\mathbb{R}^{k\cdot n})$, through the combination of n fuzzy observations $\mathbf{x}_i^*$, i=1(1) n of a k-dimensional fuzzy quantity by the minimum-t-norm, n fuzzy k-dimensional vectors are combined into an $(k\cdot n)$-dimensional fuzzy vector with vector-characterising function $\zeta(\cdot, \dots, \cdot)$, for which the following property holds:

$$C_\delta[\,\zeta(\cdot, \dots, \cdot)] = \mathrm{X}_{i=1}^{n} C_\delta\left[\zeta_i(\cdot)\right] \qquad \forall\, \delta \in (0,1],$$

where $\zeta(x_1, \dots, x_{k\cdot n})=\min\{\zeta_1(x_1, \dots, x_k), \zeta_2(x_{k+1}, \dots, x_{2k}), \dots,$
$\zeta_n(x_{(n-1)k+1}, \dots, x_{kn})\} \quad \forall (x_1, \dots, x_{k\cdot n}) \in \mathbb{R}^{kn}$

Let η_i, for i = 1(1)n, denote the characterising function of y_i^* and the combined fuzziness is contained in the fuzzy element $\mathbf{t}^*$of $\mathbb{R}^{(k+1)n}$, whose vector-characterising function $\tau(\cdot, \dots, \cdot)$ is defined by

$$\tau(\mathbf{x}_1, \dots, \mathbf{x}_n, y_1, \dots, y_n) \coloneqq \min\{\zeta_1(\mathbf{x}_1), \dots, \zeta_n(\mathbf{x}_n), \eta_1(y_1), \dots, \eta_n(y_n)\}$$

$$\forall \begin{cases} x_i \in \mathbb{R}^k \\ y_i \in \mathbb{R} \end{cases}.$$

Based on this fuzzy element $\mathbf{t}^*$ in $\mathbb{R}^{(k+1)n}$, the estimators $\hat{\beta}_k$ for the regression parameters can be generalised. The characterising function $\phi_j(\cdot)$ of the fuzzy estimator $\hat{\beta}_j^* \in \mathbb{R}$ is given by

$$\phi_j(z) := \begin{cases} sup\{\tau(\mathbf{t}) : \hat{\beta}_k(\mathbf{t}) = z\} & \text{if } \exists \mathbf{t} \in \mathbb{R}^{(k+1)n} : \hat{\beta}_k(\mathbf{t}) = z \\ 0 & \text{if } \nexists \mathbf{t} \in \mathbb{R}^{(k+1)n} : \hat{\beta}_k(\mathbf{t}) = z \end{cases} \quad \forall z \in \mathbb{R}.$$

A generalised least-squares method may be used in approximating the crisp regression coefficients $\hat{\beta}_k$. The estimated fuzzy regression model can be built as

$$\hat{Y}_i^* = \hat{\beta}_0 \oplus \hat{\beta}_1 \odot x_{i1}^* \oplus \hat{\beta}_2 \odot x_{i2}^* \oplus \ldots \oplus \hat{\beta}_k \odot x_{ik}^*,\ i = 1(1)n,$$

where $\hat{Y}_i^*$ and x_{ik}^* represent the estimated fuzzy dependent variable and the k^th fuzzy independent variable of the *i*-th observation, respectively. The predictions of dependent values from a specified model are results from applying the generalised algebraic operations (multiplications and additions) for fuzzy quantities.

Fuzzy time series

The main objective of time series analysis is to build mathematical models based on known trends and seasonal influences from historical data for future prediction. A fuzzy time series x_t^*, where $t \in T = \{1,2,3,\ldots, N\}$, is an ordered sequence of fuzzy numbers. In other words, a one-dimensional fuzzy time series is a mapping $T \rightarrow \mathcal{F}(\mathbb{R})$, which results in a fuzzy number x_t^* at any time point t. Different descriptive methods of fuzzy time series analysis, such as moving averages (a filtering method), have been well developed.

Moving averages apply the concepts of local approximation through a local arithmetic mean to eliminate the random oscillations of observed fuzzy time series data x_t^*. Through the extension principle, the fuzzy numbers $x_{t-q}^*, \ldots, x_{t+q}^*$ can be combined into a fuzzy vector $\mathbf{x}^* \in \mathcal{F}(\mathbb{R}^{2q+1})$, which is determined by its vector-characterising function $\zeta_{\mathbf{x}^*}(\cdot,\ldots,\cdot)$. As a result, the smoothed time series y_t^* is obtained, where $t = q+1(1)N-q$ and q denotes the length of moving averages. The characterising function of y_t^* and the δ-cut $C_\delta[y_t^*]$ of the smoothing through a local arithmetic mean are derived as in (Viertl 2011) by

$$\zeta_{y_t^*}(y) = sup\left\{\zeta_{\mathbf{x}^*}(x_{-q}, \ldots, x_q) : (x_{-q}, \ldots, x_q) \in \mathbb{R}^{2q+1} : \frac{1}{2q+1}\sum_{i=-q}^{q} x_i = y\right\},$$

and

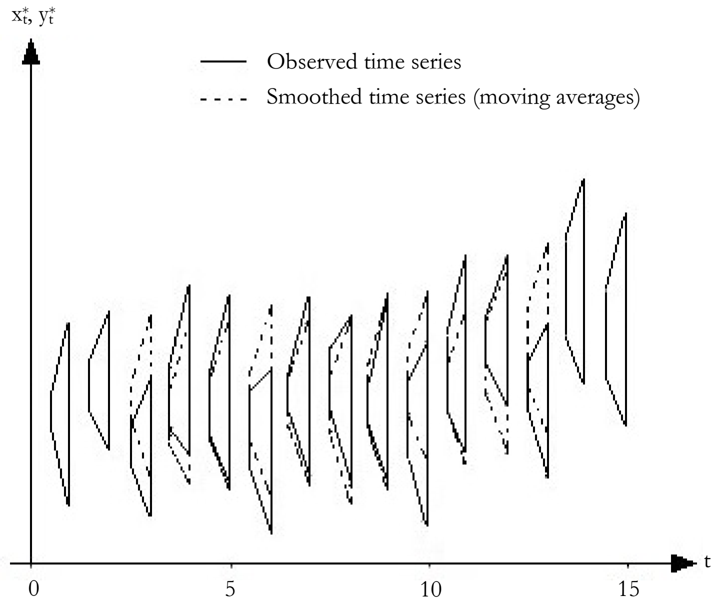
$$C_\delta(y_t^*) = \left[\min_{(x_{-q},\ldots,x_q)\in C_\delta(\mathbf{x}^*)} \frac{1}{2q+1}\sum_{i=-q}^{q} x_i,\ \max_{(x_{-q},\ldots,x_q)\in C_\delta(\mathbf{x}^*)} \frac{1}{2q+1}\sum_{i=-q}^{q} x_i\right],$$

respectively.

As an example, let $T = \{1,2,3,\ldots,15\}$ and a fuzzy time series x_t^* with trapezoidal characterising functions, that $(x_t^*)_{t=1(1)15} = \left(t^*(m_t, s_t, l_t, r_t)\right)_{t=1(1)15}$. As results of applying moving averages of length 2, the characterising functions of the values of the smoothed time series $(y_t^*)_{t=3(1)13}$ are shown (trapezoids with dashed line) in Figure 4.

Figure 4

Fuzzy time series with moving averages



The filtered time series is smoother if more observations are considered for the filtration, i.e. larger q, with exceptions on the boundaries where the filtered values cannot be obtained. On the other hand, the smoothed time series (y_t^*) is shorter than the original time series (x_t^*).

Fuzzy predictive densities

In Bayesian inference, probabilities of events $A \in \mathcal{A}$ based on a fuzzy probability density $f^*(\cdot)$ are relevant. The standard predictive density for stochastic model $X \sim f(\cdot \mid \theta)$; $\theta \in \Theta$, based on data D, is defined as marginal density of the stochastic quantity X of $(X, \tilde{\theta})$, that is the following:

$$p(x|D) := \int_{\Theta} f(x|\theta)\pi(\theta|D)\, d\theta \quad \forall x \in M_x,$$

where M_x is the observation space of X and $\pi(\cdot\,|D)$ is the a-posteriori density of the parameter. Fuzzy probability densities are a more general form of expressing a-priori information concerning the parameters θ in stochastic models $f(\cdot \mid \theta)$, $\theta \in \Theta$. The generalisation of the predictive density for fuzzy a-posteriori densities $\pi^*(\cdot \mid D^*)$ based on fuzzy data D^* is possible in the following way (Viertl–Sunanta 2013):

Let D_δ be the set of all standard probability densities $h(\cdot)$ on Θ with $\underline{\pi}_\delta(\theta \mid D^*) \leq h(\theta) \leq \overline{\pi}_\delta(\theta \mid D^*)$ $\theta \in \Theta$; $\underline{\pi}_\delta(\theta)$ and $\overline{\pi}_\delta(\theta)$ are lower and upper bounds of the densities at each δ-level.

In case of fuzzy a-posteriori density $\pi^*(\cdot \mid D^*)$, the integration has to be generalised accordingly. This generalised integration yields fuzzy intervals as a result. Based on D_δ, the generating family of intervals $[a_\delta, b_\delta]$, $\delta \in (0,1]$ is defined by

$a_\delta := \inf \{\int_\Theta f(x|\theta)h(\theta)d\theta : h \in D_\delta\}$

$b_\delta := \sup \{\int_\Theta f(x|\theta)h(\theta)d\theta : h \in D_\delta\}$.

Definition 3: The fuzzy predictive density $p^*(\cdot \mid D^*)$ is defined by its values $y^* = p^*(x \mid D^*)$ $\forall x \in M_x$, whose characterising function $\psi_x(\cdot)$ is given, through the construction lemma (see also Viertl 2011), by

$\psi_x(y) = \sup\{\delta . \mathbb{1}_{[a_\delta, b_\delta]}(y): \delta \in [0,1]\}$ $\forall y \in \mathbb{R}$, where $[a_0, b_0] := \mathbb{R}$.

In other words, the fuzzy value of the generalised predictive density is defined via the family of nested compact intervals $[a_\delta, b_\delta]$. The fuzzy predictive distribution is used in making probabilistic statements of the unobserved x without explicit conditioning on parameters θ, but with conditioning on previously collected fuzzy data D^*.

Fuzzy data in databases

As part of building a complete system, data and information are obtained, analysed, and stored in databases. The important information generally comes from different sources and often cannot be replicated, such as estimation from human experts who describe their knowledge about the areas of interest in natural languages, sensory measurements and mathematical models derived according to physical laws with respect to the systems of interest. Many practical applications require data management components that provide support for managing uncertain data. There are different types of uncertain data: imprecise, vague, ambiguous, inconsistent and incomplete data (Popat–Sharda–Taniar 2004). Fuzzy theory allows us to develop models for imprecise or vague data, in other words, to integrate the vague knowledge into databases. To store this type of information, fuzzy databases are necessary for storing fuzzy data.

There are several efforts for extending relational database systems in order to represent imprecise data and queries. For example, the work by Serrano et al. (2001) shows that fuzzy models can work with the imprecision and uncertainty associated with agriculture information in relational databases. The fuzzy relation and fuzzy set theory provide a requisite mathematical framework for dealing with such fuzzy data (Guglani–Katti–Saxena 2013). Fuzzy relational database theory extends the relational model to allow for the representation of imprecise data and, thus, provides a more accurate representation of the intended information. In other words, applied databases must be able to store fuzzy numbers and fuzzy vectors in order to provide realistic information concerning real data. Fuzzy numbers and fuzzy vectors can be represented in databases by storing δ-cuts. In addition, fuzzy multivariate data can be represented in databases by storing a suitable family of δ-cuts of the corresponding vector-characterising function. Learning how to store fuzzy data in traditional relational databases is critical to satisfying the normal forms and keeping the integrity of a database through the fuzzy meta-model of a relational database. A fuzzy meta-model keeps all relevant fuzzy data and manages links to the relations of real entities (see also Hudec 2016 for details).

Final remarks

In regional studies, measurements are crucial in data collection for further statistical analyses. These measurements of continuous variables are uncertain, or more or less fuzzy. The fuzziness of individual measurement results can be described by so-called fuzzy numbers, whereas the variability and errors are described by stochastic models. As a result, the analysis of repeated measurements is possible using respective generalised statistical methods. In this contribution, some generalised statistical methods to handle the so-called fuzzy data are described. Descriptive statistics provide simple summaries of the collected samples and measures (data). They form the basis of virtually every quantitative analysis of the data. Through concepts of fuzzy numbers and characterising functions, fuzzy data are summarised and represented in forms of fuzzy histograms, which provide more information when memberships of the individual data to different classes are not crisp. Some other statistics, such as fuzzy empirical distribution functions and correlation coefficients, are also useful for preliminary data analysis. For better understanding and future projection of the behaviours of the variables under analysis, models for prediction based on fuzzy information, such as fuzzy regression, fuzzy time series and fuzzy predictive density, have been generalised and introduced.

Fuzziness is everywhere in the physical world. In order to describe different regional facets of reality, the methods have to undertake this type of uncertainty. This is possible, and related methods are available through mathematical models. Accordingly, application of such methods results in more realistic models for data analysis and, subsequently, better understanding of the collected data.

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Analysis of the lowest airfares considering the different business models of airlines, the case of Budapest

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This study reports the findings of a research that compared the lowest airfares of full-service network carriers and low-cost airlines and mapped the cost distance between Budapest and European cities. The study investigated return air tickets for three time periods in 48 European cities for travellers who originated from Budapest. The study was based on quantitative research methods using automated internet data collection and a unique GIS-based mapping method to compare airfares and visualise the cost distance between European cities and Budapest. Our findings showed that low-cost airlines outperform full-service network carriers by offering lower-fare air tickets, while the cost distance maps showed that cities accessible by low-cost airlines are 'closer' to Budapest in general.

Keywords:
airfare,
low-cost airline,
cost distance,
air transport,
GIS

Introduction

From the second half of the 20th century, the air transport market has undergone significant changes due to the development of new transportation and infocommunication technologies, deregulation of the markets and proliferation of low-cost carriers (LCCs) following the liberalisation of air transport (Garrigos–Simon et al. 2010). The common feature of these processes is that they facilitate spatial flows and speed up travel, while enabling more people to travel cheaper and helping overcome the constraints of time and space. The geographical manifestation of these processes can be seen in the changes by which the importance of distance is decreasing[1]. However, these processes do not concern all the places on Earth and not all places and people are affected equally (Dicken 2011, Knowles 2006, Massey 1994, Warf 2006), although many cities are better connected than before (Dobruszkes 2014).

In recent years, Hungary is becoming more and more connected to the global economy and flows, mainly through Budapest, which serves as a gateway to the global flows. Therefore, it is particularly important to know to what extent the Hungarian capital is integrated into the air transport networks and flows. The research rests on the above-discussed theoretical foundations and focuses primarily on Budapest and the role of air transportation in shaping the Hungarian air transportation market/space. In the last two decades, market liberalisation, bankruptcy of the Malév Hungarian Airlines (Malév) in 2012 and proliferation of LCCs significantly changed the aviation segment of Budapest, modifying the regions' accessibility and spatial relations values considerably. Geographical analyses of low-cost air travel have so far focused primarily on network structure analyses (Dobruszkes 2006, 2009, 2013, Dudás 2010, Graham 2009, Suau-Sanchez–Burghouwt 2011), transferability of low-cost model to long-haul market (Francis et al. 2007, Morell 2008), effects of liberalisation (Doganis 2002, 2005, Dudás 2010, Pompl 2007), definition of catchment areas of airports (Pantazis–Liefner 2006), expansion of tourism under the influence of LCCs (Graham–Dennis 2010, Rey et al. 2011) and pricing behaviour and strategies of LCCs (Malighetti et al. 2009, Pels–Rietveld 2004). Nevertheless, a number of studies have dealt with the Malév bankruptcy and its after-effects, primarily focusing on the air transportation market (CAPA 2012b, Török-Heinitz 2013), tourism (Bohl 2013) and consumer welfare effects (Bilotkach et al. 2014). In contrast, little attention was paid to the space-forming role of LCCs; despite having the characteristics of low-cost business models (e.g. cheap ticket prices and point-to-point routes), LCCs have a significant impact on cities' cost and time spaces as the increasing number of LCCs might alter the cost accessibility of certain cities.

The aim of the research is to compare the lowest airfares of full-service network carriers (FSNCs) and LCCs. We also seek to understand how the increasing number and market share of LCCs – after the bankruptcy of Malév in February 2012 – shaped ticket prices and, in relation, the cost spaces of Budapest and its air traffic connections. The mapping of these changes requires the use of alternative distance concepts, because as technology advances, the distance between two points is no longer primarily determined by physical distance but by the time and cost needed to cover these distances (Dusek–Szalkai 2007). Thus, the quantification and measurement of the cities' spatial relations require the use of time distance and cost distance values, which, in our case, are derived from air traffic data.

[1] The absolute distance between two points has not changed but relative distances have decreased (Warf 2006).

Based on the issues outlined in the previous paragraphs, the research seeks to answer the following question: How do ticket prices of FSNCs and LCCs shape cost accessibility (cost distance from Budapest) of European cities in our study period? In connection with the above, a further issue will be also analysed: Compared to Budapest, how do the European cities move in space due to changes in airfares if we consider cost distance values instead of geographical distance to analyse the spatial connections of Budapest?

In the first half of the study, we present the applied methods used in the research and briefly summarise what we consider as an LCC in the study. In the second part of the research, we map and analyse the cost distance values of European destinations from Budapest using thematic maps.

Methodology

In the research, we combine the quantitative methods of human geography, transport geography, economic geography and GIS. In the absence of appropriate databases, our research is based mainly on internet data collection, which is a frequently used technique in similar researches (Bilotkach 2010, Dudás et al. 2016, Law et al. 2010, 2011, Lijesen et al. 2002, Zook–Brunn 2006). In this chapter, we describe our methodology and define what we consider to be an LCC.

Defining low-cost airlines

In the last two decades, the emergence and rapid spread of LCCs have revolutionised air transport. The low-cost business model was introduced by Southwest Airlines in the early 1970s (Malighetti et al. 2009). From the 1990s onwards, due to the ongoing liberalisation of aviation markets, more and more airlines adopted the Southwest model, and LCCs have become important global players in aviation. Nowadays, LCCs account for 22 per cent of the worldwide passenger traffic and offer 26 per cent of all airline seats (Budd et al. 2014). The low-cost airline concept is often used as a homogeneous category, but there is neither an up-to-date list of these LCCs nor a universally accepted definition of what is classified as an LCC (Budd et al. 2014, Pels 2008). As a result, academic literature defines LCCs in different ways. In some classifications, airlines are considered as LCC if their ticket prices do not exceed a certain percentage of the prices of FSNCs on the same routes (Dobruszkes 2006, 2009, 2013, Dudás 2010). Others base their classification on the extent to which the airlines adopted the basic elements[2] of the low-cost model (Budd et al. 2014, Button–Ison 2008, Klophaus et al. 2012).

[2] These elements include the following: point-to-point traffic, single aircraft type (usually Boeing 737 or the Airbus A320 family), use of secondary or uncongested airports, direct sales of airline tickets through the airline's website, single cabin class, no in-flight services or frequent-flyer programs, and intensive use of the aircraft with 20–30 min turnaround times.

The aim of our study was not to create a new LCC definition; therefore, to determine LCCs, we used the classification created by Klophaus et al. (2012). In that study, the authors used 13 indicators (e.g. fleet homogeneity index, secondary airport index, single cabin class, no frequent-flyer program, point-to-point services only, etc.) to classify the airlines into four categories: 1. pure LCC, 2. hybrid carrier with predominantly LCC characteristics, 3. hybrid carrier with predominantly FSNC characteristics, and 4. FSNC. Using this list, we considered the airlines from the first three categories as LCCs in our study. So, at the time of our research, eight carriers were considered as LCCs (Table 1) from the 39 airlines serving Budapest.

Table 1

Low-cost airlines in the survey and their destinations from Budapest (March 2015)

LCC	Home country	Passengers (in millions) 2014	Destinations from Budapest (IATA code)
Ryanair	Ireland	81.7	Athens (ATH), Barcelona (BCN), Billund (BLL), Bristol (BRS), Brussels (CRL), Dublin (DUB), London (STN), Madrid (MAD), Manchester (MAN), Milan (BGY), Pisa (PSA), Paris (BVA), Rome (CIA), Tampere (TMP) and Venice (TSF)
easyJet	UK	64.8	Basel (BSL), Berlin (SXF), Geneva (GVA), London (LGW), London (LTN) and Paris (CDG)
Norwegian	Norway	24	Copenhagen (CPH), Helsinki (HEL), London (LGW), Oslo (OSL) and Stockholm (ARN)
Germanwings	Germany	16	Cologne (CGN), Dusseldorf (DUS), Hamburg (HAM) and Stuttgart (STR)
Wizzair	Hungary	15.8	Alicante (ALC), Barcelona (BCN), Bari (BRI), Brussels (CRL), Catania (CTA), Dortmund (DTM), Dubai (DWC)[a)], Eindhoven (EIN)[b)], Frankfurt (HHN), Göteborg (GOT), Istanbul (SAW), Kiev (IEV), Kutaisi (KTS)[a)], Larnaca (LCA), Lisbon (LIS), London (LTN), Madrid (MAD), Malaga (AGP), Malmö (MMX), Malta (MLA), Milan (MXP), Moscow (VKO), Naples (NAP), Rome (FCO), Stockholm (NYO), Tel Aviv (TLV), Thessaloniki (SKG), Târgu Mureş (TGM)[b)] and Warsaw (WAW)
Transavia	Netherlands	9.9	Paris (ORY) and Rotterdam (RTM)
Aer Lingus	Ireland	9.7	Dublin (DUB)
Jet2	UK	6.0	Edinburgh (EDI), East-Midlands (EMA), Leeds (LBA) and Manchester (MAN)

Source: Edited by the authors according to the airline's websites.

a) Non-European destination, therefore not included in the research.

b) During the research, no flights operated by traditional airlines from Budapest to these cities, therefore not included in the research.

Data collection and cartographic representation of cost distance

The next step in the research was determining the analytical units and configuring our databases. As the research is mainly based on the comparison of airfares from Budapest to European cities while considering LCC and FSNC flights, first, we made a database of the cities that are accessible from the Hungarian capital by a direct flight that was of either an LCC or FSNC or both. During the selection process, we noted that some cities have multiple airports; therefore, every airport was treated separately. This was important in order to get a more detailed picture of the spatial relations of Budapest. Moreover, this offered an opportunity to investigate the cost and time accessibility of city centres from the airports, which enabled further analysis. Thus, at the time of the research, 67 airports of 48 European cities were directly accessible from Budapest, of which 13 were accessible only with an LCC, 12 only with an FSNC and 42 airports with both (Annex 1).

After defining the analytical units, the next step was to query air traffic data between Budapest (departure airport) and European destinations (arrival airports). It is generally known that ticket prices are very volatile and can vary several times during a day. Due to the large number of our analytical units and limitations of internet sites, we were not able to perform a time-series analysis; however, to present certain temporality, we queried data for three time periods (two weeks, one month and three months in advance). Therefore, we have to emphasise that our research provides only a snapshot and presents the situation at the time of data collection. When interpreting the results, we considered these limitations and tried to avoid drawing generalised conclusions. Accordingly, we collected data from a meta-search engine called Skyscanner. It is important to note that Skyscanner is not the only online search site; there are other important online travel agencies (e.g. Orbitz, Travelocity, etc.), metasearch sites (e.g. Kayak and Momondo) and airline sites. However, during the test queries, Skyscanner displayed the most applicable information and had the most user-friendly interface for an automatic data query. Nevertheless, both ticket prices of FSNCs and LCCs can be queried from the site, which was the main deficiency of former researches (Dudás et al. 2016, Law et al. 2010, Zook–Brunn 2006).

The data collection was conducted on 16 March 2015, for fixed departure dates of two weeks, one month, and three months in advance. The fixed departure dates for the two-week period were from 30 March to 5 April 2015; for the one-month period 13–19 April 2015; and for the three-month period 8–14 June 2015. In the study, seven-day return tickets (from Monday to Sunday) were queried. In order to extract the necessary data, we developed an automated data collection system. We used the Imacros software as our data collection agent; however, we have to note that numerous similar software packages are available (Burghouwt et al. 2007). This program gathers data from the selected website (http://www.skyscanner.com) and stores the result into a database for further analysis according to pre-defined parameters (e.g. departure and arrival airport, departure and return date, direct or indirect flight, cabin class, passenger numbers, etc.). In every case, the queries were for round-trip flights with the cheapest airfares and flight times.

After the data query, we used a GIS system (ESRI ArcGIS 10) and its tools as well as the Corel Draw graphic software to visualise and handle the queried data. To determine cost distance values, we used airfares, geographical distances and price per distance parameters between Budapest and the selected destination airports. Cost distance was calculated – based on methodology developed by Dudás et al. (2016) – by dividing the ticket prices with the price per distance parameters. However, by using the price per distance parameter, we had to take into consideration that databases of former studies (Dudás et al. 2016) did not contain data about LCCs, so they represent data only for FSNCs. As LCCs primarily fly on short-haul routes, we recalculated the price per distance parameter of this category to avoid distorting results. We concluded that the cost of a 1-km flight on short-haul routes is 0.18 USD instead of 0.256 USD as in previous studies. Applying this new parameter, we calculated the cost distance values between Budapest and the destination airports and made the cartographic representation based on the visualisation technique used by Dudás et al. (2016).

Findings and analysis

In the last few years, the bankruptcy of the Hungarian national carrier resulted in significant changes in Budapest's air transportation market and gave rise to the growth of LCCs. Although LCCs were already present in Hungary, their share rose from 26 per cent to 52 per cent due to the changes (Budapest Airport 2013). According to the Hungarian Central Statistical Office data[3], Budapest Airport recovered from the failure of Malév as the airport served 9,155,961 passengers in 2014, outperforming the previous peak of 8.9 million registered in 2011. The airport statistics also show that growth still continues as passenger numbers exceeded 10 million in 2015, number of available passenger seats rose above pre-2012 levels and the average load factor of airlines rose to a record level (79 per cent), which demonstrates the increasing interest of both tourists and business travellers in Hungary and Budapest (Budapest Airport 2015).

Henceforward, we analyse the cost distance of European cities from Budapest accessible with flights from FSNCs and LCCs, and our results are displayed using thematic maps.

Annex 2 presents the average weekly lowest airfares of a given week between Budapest and destinations (55) accessible with an LCC two weeks, one month and three months in advance. Comparing the three time series, in almost all cases, the average airfare was the highest for the two-week time period. Considering the two

[3] Source: http://statinfo.ksh.hu/Statinfo/haDetails.jsp?lang=en

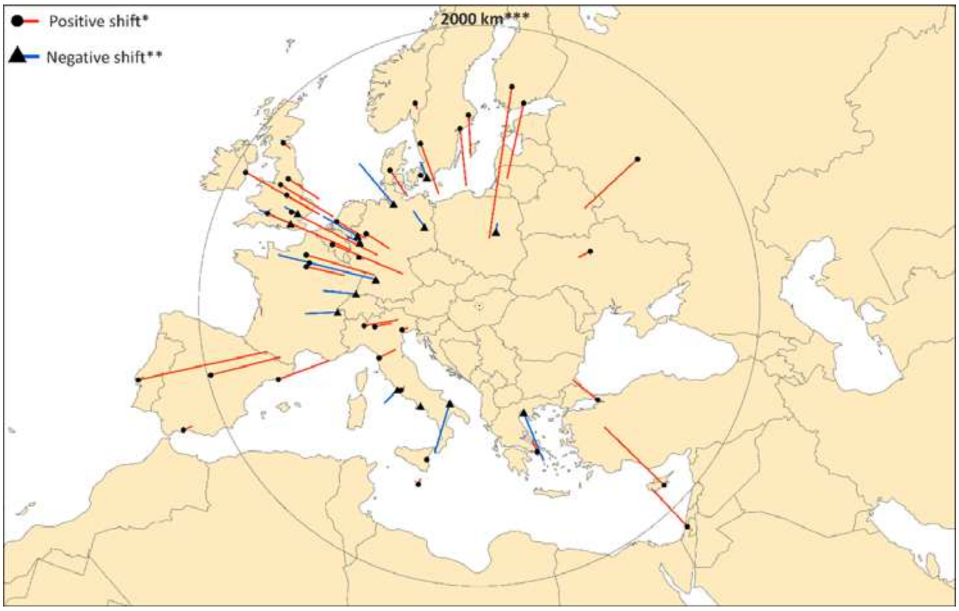
weeks and one month values, average airfares decreased by approximately 25 per cent in 43 out of 54 cases, whilst the decline was lower between the two weeks and three months values; approximately 21 per cent in 44 cases. Similar tendencies are outlined by the time series values of the FSNCs (Annex 3). In these cases, the average airfares for the two weeks were also the highest. In relation to the booking date, the two-weeks and one-month average airfares decreased approximately by 19 per cent in 38 out of 53 cases, whilst the decline was also lower between the two week and three months values, approximately 13 per cent in 42 cases. The phenomenon of rising airfares appeared in space relatively dispersed, but both were primarily affected in cases of LCCs and FSNCs' destinations in Scandinavia. Nevertheless, German destinations also showed constant price increase mainly between the two weeks and one-month values. Based on this, we can state that if we want to book a flight for an LCC or FSNC, we could get best prices one month prior to departure, but we could also buy significantly cheaper tickets three months in advance.

Comparing the average airfares of Annex 2 and 3, it clearly shows that the cheaper airfares are offered by low-cost airlines. However, significant differences are outlined between certain links. The biggest differences between the airfares of the two business models were in the case of Malmö. Tickets offered by FSNCs to the Swedish city were approx. 241 USD (117 per cent) more expensive on average; however, similar major differences were also present in the case of East Midlands (approx. 167 USD, 69 per cent) and Tampere (approx. 132 USD, 125 per cent). The tables also suggest that major differences can be detected in the airfares between Budapest and cities with secondary airports. However, the airfares of LCCs and FSNCs to major Western European capitals and economic and political centres show minor differences, probably due to increased competition and higher demand (e.g. more airlines, higher flight numbers and higher airport charges). Therefore, if someone chooses an LCC on these routes, they could save, for example, up to 63 USD on the fare to Brussels (71 per cent), 63 USD to Frankfurt (59 per cent), 68 USD to Paris (64 per cent), 86 USD to Milan (106 per cent) and 107 USD to London (93 per cent) on average.

During the research, our goal was – besides the comparison of airfares – to map how these values affect the cost accessibility of the selected cities/destinations. Accordingly, we prepared thematic maps for spatial representation on which we are visualising the relations between airport pairs using cost distance derived from ticket prices.

Figure 1

Cost distance of European cities from Budapest with LCC flights (2 week)



Source: Based on http://www.skyscanner.com and edited by the authors

* Flying to this city is cheaper than the two cities' geographical distance would imply; therefore, the relative position of the city is closer than its geographical position, and the length of the line gives the size of the positive shift.

** Flying to this city is more expensive than the two cities' geographical distance would imply; therefore, the relative position of the city is farther than its geographical position, and the length of the line gives the size of the negative shift.

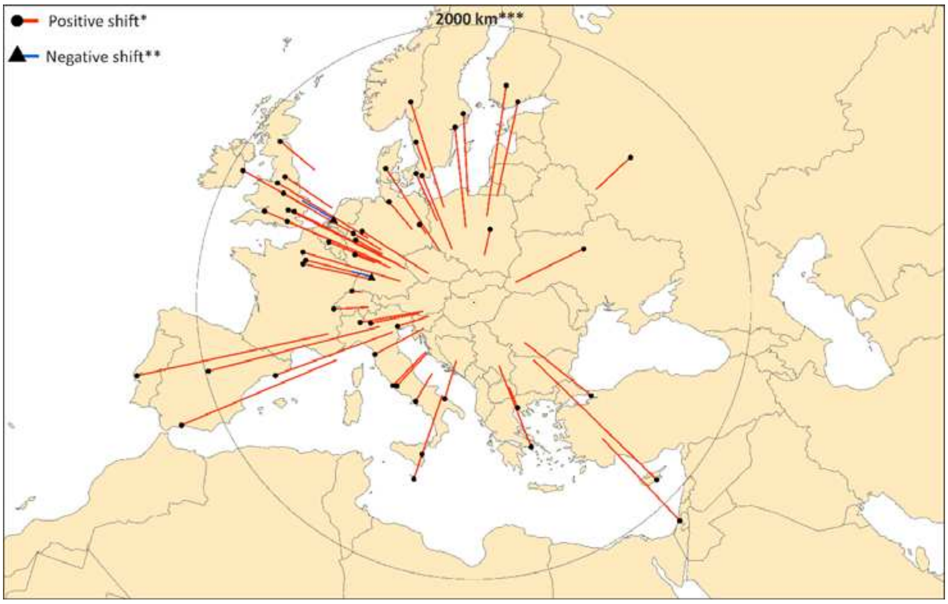
*** This circle represents the limit between the short-haul flight zone and medium-haul flight zone. In the former zone, the cost of 1 km travel is 0.18 USD, while, in the latter, it is 0.16 USD.

The cost distance maps (Figures 1–6) show a wide variety of spatial structures. Based on the two weeks values, both types outline the mixed picture. On the first map of the low-cost airlines (Figure 1), positive shifts are dominant (in 39 of 54 cases); therefore, the destinations are on average 300 km closer to the Hungarian capital than their geographical distance would imply. By contrast, on the FSNC map (Figure 4), negative tendencies are outlined for the same time period. In this case, among the 53 destinations, only 19 showed positive values, whereas in 32 cases, negative shifts (on average 360 km) can be observed. According to our calculations, destinations of Scandinavia, the Iberian Peninsula and the United Kingdom are accessible predominantly at affordable prices with an LCC, as almost all cases showed positive shifts, whereas the airfares to German destinations are more expensive than their geographical distances would imply. Of the seven German destinations, only Frankfurt and Dortmund showed a positive shift, whereas for the other five cities (Cologne, Dusseldorf, Hamburg, Stuttgart and Berlin), negative trends were dominant. This is probably because, while Frankfurt and Dortmund are served by Wizzair, the other five destinations are primarily served by Germanwings, which is the subsidiary of Lufthansa; this might have led to less price competition and manifested in higher ticket prices on these routes. Comparing the two maps (Figures 1 and 4), an 'economic threshold line' is outlined in the FSNC map. Based on this, the destinations show mainly negative shifts in relation to Budapest within a radius of approx. 1200 km. According to our calculations, airfares to destinations in Germany, Italy and the southern part of Scandinavia are more expensive than their geographical distances would suggest.

Both the one-month and three-months maps of the LCCs (Figures 2–3) show positive changes in cost distance values, due to the approx. 25 and 21 per cent reduction experienced by the ticket prices, respectively. The one-month values of 54 destinations depicted that each was located closer to Budapest (except Rotterdam and Stuttgart) than their geographical distances would imply. The average of the positive shifts was also higher (approx. 550 km) than in the case of the two-week map. The three-month values (Figure 3) represent similar trends, with the only difference that the rate (on average approx. 470 km) and number (50 from 55 cases) of the positive shifts are less than experienced in Figure 1.

Figure 2

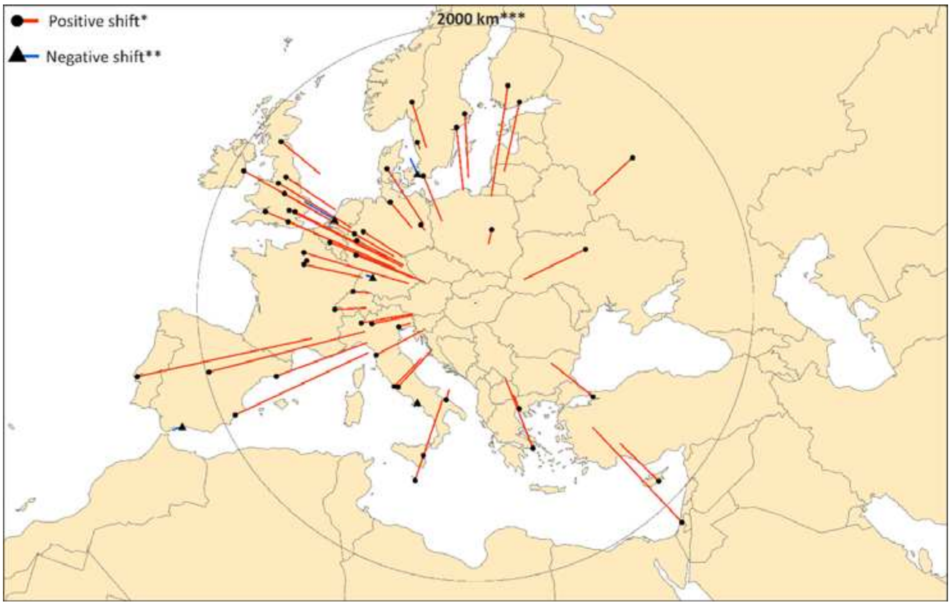
Cost distance of European cities from Budapest with LCC flights (one month)



Source: Based on http://www.skyscanner.com and edited by the authors.

Figure 3

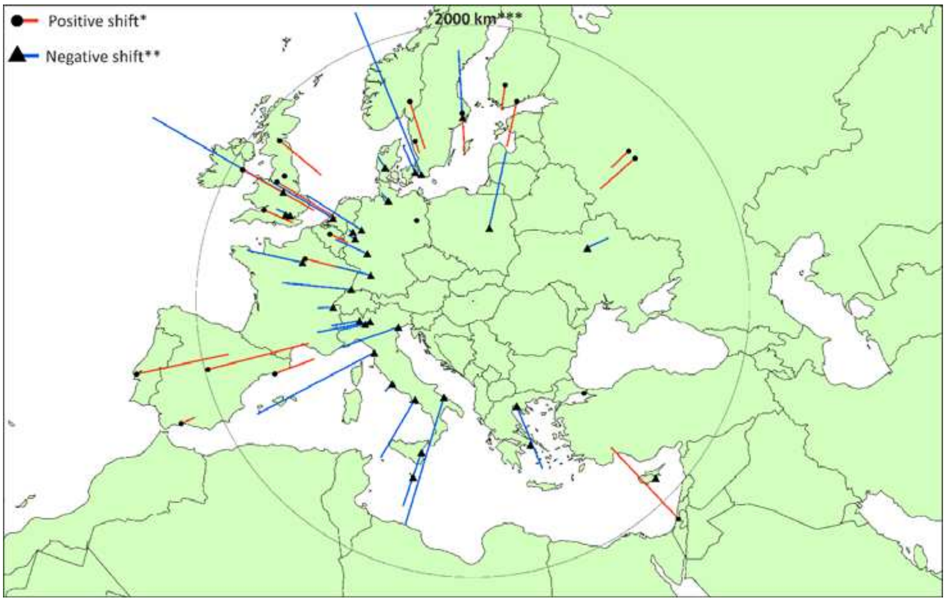
Cost distance of European cities from Budapest with LCC flights (three months)



Source: Based on http://www.skyscanner.com and edited by the authors.

Figure 4

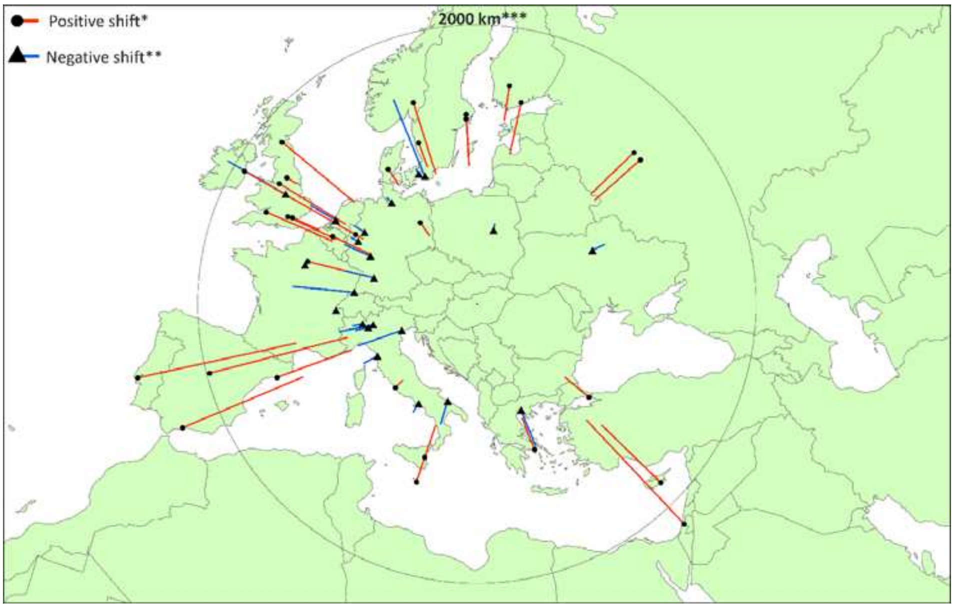
Cost distance of European cities from Budapest with FSNC flights (two weeks)



Source: Based on http://www.skyscanner.com and edited by the authors.

Figure 5

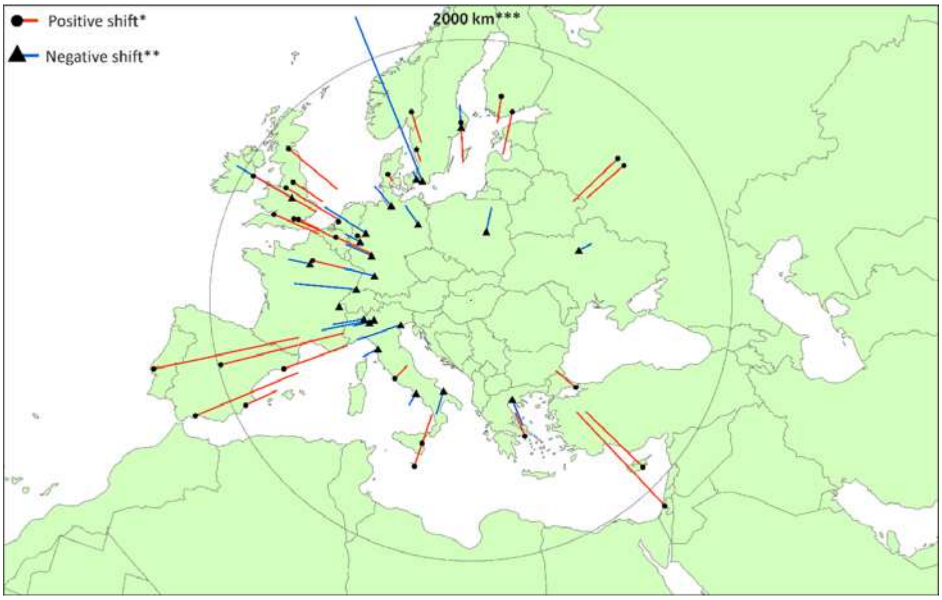
Cost distance of European cities from Budapest with FSNC flights (one month)



Source: Based on http://www.skyscanner.com and edited by the authors.

Figure 6

Cost distance of European cities from Budapest with FSNC flights (three months)



Source: Based on http://www.skyscanner.com and edited by the authors.

However, the 19 and 13 per cent decreases of airfares by the one-month and three-month values of FSNCs do not cause as significant changes as the LCCs. On the maps (Figures 5-6.), similar mixed spatial structures are outlined. In Figure 6, 22 out of 54 destinations, and in Figure 7, 21 out of 55 destinations showed negative shifts. Henceforward, on both maps, the 'economic threshold line' can be determined but at various distances. On the one-month map, the line can be drawn at a distance of approx. 1000 km around Budapest – 200 km closer than at the two-weeks map – while at the three-months map, the line can be drawn approx. 1100 km around the Hungarian capital. Similarly, on the other maps, we can also highlight the positive values of the Iberian Peninsula; the UK and Eastern Scandinavian destinations outside the 'economic threshold line' also showed significant positive changes.

Conclusions

In our study, the focus was on the difference between airfares of FSNCs and LCCs and the space-forming role of their ticket prices. The research sought to answer how, after the bankruptcy of Malév, the spread of LCCs affected airline cost spaces of Budapest and cost accessibility of European cities from Budapest Airport. To analyse and visualise these changes, we used cost distance values derived from air traffic data based on automated internet data collection.

After the bankruptcy of Malév, the passenger traffic of Budapest Airport changed significantly as the airport lost about a quarter of its flights. However, the share of LCCs rose from 26 per cent to over 50 per cent (Hungarian Central Statistical Office 2012a, 2012b). This rise, despite the decreasing passenger numbers, resulted in one million new passengers to Budapest, which can mostly be attributed to the LCCs, primarily Ryanair and Wizzair, as they added a lion's share of the capacity (CAPA 2012a, Török-Heinitz 2013). The beneficiaries of these transformations were clearly those who want to travel cheap, because our results showed that LCCs offered cheaper tickets from Budapest to European destinations than FSNCs in almost all cases.

In response to the question posed at the beginning of the study, we can state that LCCs outperform FSNCs in almost all cases in offering lower-fare air tickets. It was also outlined that considering the three time periods for the departure dates (two weeks, one month and three months), we could travel for the best price if we booked tickets one month in advance. Based on this, relative to the booking date even if it is not linear, a decreasing tendency can be observed in airfares of both LCCs and FSNCs. However, to draw deeper conclusions, further time series analyses are needed.

The cost distance analysis revealed that cities accessible with LCCs from Budapest show decisively positive shifts, so these cities were 'closer' to Budapest in relative (cost) terms than their geographical distances would imply. In contrast, the cost distance maps of the FSNCs outline a mixed picture due to higher airfares, and the negative shifts of European destinations dominate these maps.

In addition, the failure of Malév affected the Western European route network of Budapest to a lesser extent, as the number of directly accessible destinations decreased mainly in Southeast Europe (Dudás–Boros 2014). On this basis, as Budapest is still connected to the European hub airports – which showed good cost distance values during the study – the city is still an integral part of the global flow systems.

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Annex 1

Airports included in the study and their IATA codes

Airport code	Airport	Airport code	Airport
AGP	Malaga	*KBP*	*Kiev Borispol*
ALC	Alicante	LBA	Leeds
ARN	Stockholm Arlanda	LCA	Larnaca
ATH	Athens	*LCY*	*London City*
BCN	Barcelona	**LGW**	**London Gatwick**
BGY	Milan Orio al Serio	*LHR*	*London Heathrow*
BLL	Billund	*LIN*	*Milan Linate*
BMA	*Stockholm Bromma*	LIS	Lisbon
BRI	Bari	**LTN**	**London Luton**
BRS	Bristol	MAD	Madrid
BRU	*Brussels*	MAN	Manchester
BSL	Basel	MLA	Malta
BVA	**Paris Beauvais**	MMX	Malmö
CDG	Paris Charles de Gaulle	MXP	Milan Malpensa
CGN	Cologne	NAP	Naples
CIA	**Rome Ciampino**	**NYO**	**Stockholm Skavsta**
CPH	Copenhagen	ORY	Paris Orly
CRL	**Brussels Charleroi**	OSL	Oslo
CTA	Catania	PSA	Pisa
DME	*Moscow Domodedovo*	RTM	Rotterdam
DTM	Dortmund	**SAW**	**Istanbul Sabiha**
DUB	Dublin	SKG	Thessaloniki
DUS	Dusseldorf	**STN**	**London Stansted**
EDI	Edinburgh	STR	Stuttgart
EMA	East Midlands	*SVO*	*Moscow Sheremetyevo*
FCO	Rome Fiumicino	**SXF**	**Berlin Schonefeld**
FRA	*Frankfurt*	TLV	Tel-Aviv
GOT	Göteborg Landvetter	TMP	Tampere
GVA	Geneva	**TSF**	**Venice Treviso**
HAM	Hamburg	*TXL*	*Berlin Tegel*
HEL	Helsinki	*VCE*	*Venice Marco Polo*
HHN	**Frankfurt Hahn**	**VKO**	**Moscow Vnukovo**
IEV	**Kiev Zhuliany**	WAW	Warsaw
IST	*Istanbul Atatürk*		

Note: Airports in **bold** are only accessible with an LCC; airports in *italics* are only accessible with an FSNC; and other airports are accessible with both.

Source: http://www.iata.org

Annex 2

Average lowest LCC airfares from Budapest (in USD)

Airport code	Two weeks	One month	Three months	Airport code	Two weeks	One month	Three months
LGW	307,71 (242)	241,50 (176)	183,83 (212)	BGY	114,42 (80)	109,57 (72)	82,28 (65)
STN	279,71 (226)	128,28 (110)	125,85 (91)	PSA	121,00 (84)	112,66 (74)	76,00 (71)
LTN	145,57 (113)	141,85 (99)	105,42 (80)	NAP	151,66 (123)	163,66 (107)	155,66 (105)
MAN	218,83 (186)	209,50 (161)	187,50 (131)	CIA	141,71 (120)	121,42 (90)	84,42 (82)
BRS	180,00 (166)	142,33 (131)	113,00 (104)	FCO	175,00 (131)	175,00 (90)	100,14 (92)
EMA	252,00 (219)	246,00 (243)	228,00 (182)	TSF	96,00 (74)	77,33 (61)	88,00 (76)
EDI	315,00 (246)	329,00 (269)	261,00 (200)	HHN	160,50 (149)	158,50 (138)	86,00 (75)
LBA	247,00 (247)	241,50 (221)	217,50 (176)	CGN	191,85 (145)	163,14 (134)	104,71 (83)
DUB	235,85 (195)	177,00 (138)	166,71 (161)	DTM	136,42 (93)	90,71 (70)	110,71 (80)
CDG	211,71 (160)	174,14 (144)	221,85 (150)	DUS	231,00 (165)	191,85 (157)	121,14 (83)
BVA	139,50 (122)	125,50 (99)	90,25 (76)	HAM	239,14 (213)	183,00 (124)	127,42 (94)
ORY	177,00 (121)	132,00 (132)	149,66 (116)	STR	266,28 (203)	199,71 (165)	146,00 (83)
BCN	204,33 (140)	165,50 (112)	149,00 (122)	SXF	148,28 (133)	145,57 (109)	114,85 (81)
MAD	263,28 (144)	167,00 (126)	147,00 (85)	BSL	201,66 (175)	193,16 (148)	137,50 (74)
AGP	355,00 (318)	172,00 (172)	378,00 (378)	GVA	224,00 (186)	220,00 (137)	141,14 (93)
ALC			152,50 (148)	CRL	106,14 (79)	153,71 (117)	70,57 (51)
CPH	182,40 (116)	183,50 (116)	205,33 (189)	IEV	141,60 (116)	99,40 (60)	70,00 (52)

(Table continues on next page.)

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Airport code	Two weeks	One month	Three months	Airport code	Two weeks	One month	Three months
BLL	168,00 (121)	126,00 (79)	122,66 (101)	VKO	184,33 (131)	279,71 (216)	209,00 (183)
NYO	154,40 (128)	152,40 (98)	146,28 (93)	ATH	186,00 (129)	110,50 (89)	104,25 (97)
ARN	193,50 (150)	259,33 (139)	162,83 (139)	SKG	214,00 (160)	154,00 (119)	128,50 (108)
GOT	152,66 (149)	246,00 (183)	212,33 (183)	WAW	108,50 (93)	101,00 (63)	78,50 (47)
MMX	200,40 (149)	125,60 (75)	114,28 (93)	LCA	223,50 (212)	130,50 (108)	261,00 (183)
HEL	167,33 (124)	174,33 (141)	174,66 (141)	MLA	235,00 (235)	194,00 (194)	191,50 (148)
TMP	88,00 (77)	122,00 (113)	140,00 (132)	TLV	286,33 (216)	313,83 (216)	196,33 (149)
OSL	264,57 (229)	264,00 (129)	211,00 (147)	RTM	170,00 (114)	332,40 (259)	257,16 (189)
BRI	197,75 (116)	133,50 (79)	117,25 (95)	SAW	153,28 (110)	118,28 (84)	124,71 (91)
CTA	205,00 (194)	132,50 (127)	132,50 (127)	LIS	247,50 (232)	194,00 (172)	192,00 (184)
MXP	105,42 (63)	105,00 (67)	82,14 (60)				

Source: Based on http://www.skyscanner.com and edited by the authors.
Numbers in parentheses indicate the cheapest airfare of the week in USD.

Annex 3

Average lowest FSNC airfares from Budapest (in USD)

Airport code	Two weeks	One month	Three months	Airport code	Two weeks	One month	Three months
LHR	269,85 (230)	216,57 (200)	201,42 (191)	LIN	177,00 (148)	176,28 (160)	166,28 (160)
LCY	282,42 (209)	268,85 (224)	231,14 (222)	PSA	316,85 (165)	207,14 (165)	168,42 (165)
MAN	208,00 (189)	246,28 (198)	212,42 (198)	NAP	236,85 (195)	186,28 (162)	167,71 (165)
BRS	255,28 (203)	250,28 (203)	230,28 (203)	FCO	164,00 (126)	152,85 (137)	126,14 (117)
EMA	480,57 (371)	479,85 (371)	372,28 (319)	VCE	183,57 (162)	172,57 (163)	165,57 (163)
EDI	256,57 (202)	252,00 (205)	239,14 (224)	FRA	196,28 (187)	199,57 (188)	189,00 (187)
LBA	290,85 (258)	319,42 (280)	245,57 (233)	CGN	183,28 (174)	192,14 (184)	195,28 (186)
DUB	238,00 (195)	205,14 (181)	245,71 (193)	DTM	257,42 (178)	231,00 (188)	239,00 (188)
CDG	157,57 (146)	237,66 (148)	173,16 (142)	DUS	185,42 (169)	174,57 (169)	175,00 (171)
ORY	300,71 (250)	279,14 (228)	258,14 (230)	HAM	184,71 (161)	210,57 (180)	205,85 (174)
BCN	219,71 (180)	188,28 (172)	181,85 (172)	STR	184,00 (172)	186,28 (176)	181,28 (176)
MAD	220,57 (167)	185,57 (172)	180,57 (172)	TXL	125,42 (105)	131,50 (107)	159,14 (133)
AGP	348,42 (280)	264,28 (216)	229,42 (204)	BSL	249,14 (235)	241,57 (239)	244,42 (239)
ALC			294,57 (252)	GVA	202,00 (178)	202,28 (185)	183,42 (181)
CPH	220,14 (172)	201,28 (191)	194,71 (179)	BRU	179,28 (168)	170,57 (153)	149,57 (131)
BLL	225,00 (172)	201,85 (184)	196,14 (186)	KBP	194,42 (169)	184,57 (182)	184,00 (184)
BMA	327,42 (251)	315,42 (190)	270,42 (201)	SVO	250,50 (237)	226,28 (204)	196,28 (179)

(Table continues on next page.)

(Continued.)

Airport code	Two weeks	One month	Three months	Airport code	Two weeks	One month	Three months
ARN	196,42 (172)	202,16 (179)	191,50 (169)	DME	220,71 (187)	221,14 (202)	213,28 (205)
GOT	205,14 (171)	225,28 (188)	204,14 (184)	ATH	205,00 (189)	189,71 (158)	166,57 (130)
MMX	406,28 (320)	349,57 (285)	422,28 (331)	SKG	236,28 (197)	202,28 (199)	187,14 (173)
HEL	205,57 (186)	215,85 (198)	205,85 (169)	WAW	198,71 (186)	169,00 (106)	131,14 (106)
TMP	251,14 (194)	263,00 (239)	247,42 (223)	LCA	336,14 (278)	283,00 (224)	221,42 (215)
OSL	208,42 (165)	192,71 (176)	227,83 (180)	MLA	264,42 (199)	208,42 (181)	203,71 (162)
BRI	304,00 (162)	198,57 (162)	165,00 (162)	TLV	232,85 (176)	225,50 (183)	189,00 (157)
CTA	282,28 (204)	195,85 165)	166,57 (165)	RTM	303,14 (241)	294,42 (250)	212,14 (186)
MXP	187,00 (163)	185,28 (163)	193,50 (173)	IST	187,85 (172)	160,71 (148)	152,14 (148)
BGY	206,57 (169)	217,14 (181)	209,85 (181)	LIS	289,14 (244)	235,00 (212)	215,85 (189)

Source: Based on http://www.skyscanner.com and edited by the authors.
Numbers in parentheses indicate the cheapest airfare of the week in USD.

Health inequalities regarding territorial differences in Hungary by discussing life expectancy

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Since the middle of the 1990s, Hungary has seen substantial increases in life expectancy. Despite this improvement, many health outcomes remain poor, placing Hungary among the countries in the European Union with worse health status. Based on the general state of health of the population, Hungary belongs with the middle-ground countries of the world. Majority of the health indicators are worse than the average of OECD's values, and this is especially true regarding the mortality rate of the middle-aged male population.

The main objective of the study is to investigate health inequalities with regional differences in Hungary. It is still worth explaining how health inequalities and inequities have changed in terms of space and time after the Hungarian economic and political transition.

The territorial range of the study includes the national and regional levels (NUTS3) with the micro-regional level (LAU1). The statistical analysis is based on the use of life expectancy in addition to some mortality indicators. Data for 1990–2014 were examined to define health effects of the Hungarian transition as well as the consequences of the latest economic crisis.

Improvements in health along with growth of regional inequalities were found in Hungary since the second half of the 1990s. Larger relative inequalities were observed between Western and Eastern Hungary based on its higher and lower income. Gender differences are also significant in life expectancy. Poor health among the unemployed people was detected, which is a socio-economic effect of the latest economic crisis.

In Hungary, income-related health inequalities persist; however, their degree has changed in space and time over the last 25 years. For a comprehensive description of health in Hungary, assessment of the poor health of lower income social groups and the regional level of health inequalities is needed.

Keywords:
health inequalities,
health transition,
regional differences,
Hungary

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Introduction

Since the end of 1989, essential political, economic and social changes took place in Eastern–Central Europe. The transformation in these former socialist countries resulted in new initiatives, which were aimed at creating new political, economic and social links. The rapid social and cultural changes introduced by the collapse of the communist system have resulted in determinative, demographic and health challenges. Therefore, governments in post-socialist countries as well as in Hungary face many demographic, health and social challenges, which they have to overcome by reaching the level of welfare close to the average standards of the most developed European countries.

In the most developed Western European countries, the recent health-preserving and health-conscious life styles have become integrated in people's everyday values; however, in Central and Eastern European countries, the processes of post-socialist transformation have led to further deterioration of health. The bad morbidity and mortality situation in Hungary is almost unparalleled among the post-socialist countries; worse situations can only be found in the former states of the Soviet Union. The unfavourable Hungarian health condition is not unique, and health processes are very similar to European post-socialist countries.

The marked deterioration in the state of health of the Hungarian population has been going on since the middle of the 1960s. As a consequence of this process, Hungary is lagging behind countries with a more developed health culture. The general state of health of the Hungarian people is worse than justified by the level of economic development. The deterioration in the state of health, which has been going on since 1966, reached its bottom in 1985. This was not followed by a period of upswing due to the changes in the regime and the socio-economic transformation. Nevertheless, after 1989, the deterioration of the general state of health reached bottom again in 1993. '*The mortality situation in Hungary, which had been worsening for decades, developed into an epidemiological crisis by the early 1990s, and it presently hits the whole adult population*' (Józan 1994a, 1994b, 1996). The role of the transformation in the deterioration of health is easy to detect; however, differences can be experienced in its social and spatial dimensions. The social determination is essential in health inequalities.

The following important elements have to be considered into the Hungarian disadvantaged health situation (Uzzoli 2016):

- The Hungarian epidemiological crisis has long-term consequences on health inequalities. A new epidemiological stage has begun in Hungary from the middle of the 1990s with the decrease in chronic diseases of the circulatory system and increase in the average life expectancy at birth. That is a paradox situation, as although life expectancy has increased in the whole country, health inequalities have also increased territorially and socially.

- Unfavourable demographic processes, such as a natural decrease or gradual ageing, are contributing to the disadvantaged epidemiological situation.
- The most important challenge for the Hungarian health care system is that it is not functionally, structurally and financially able to reduce health inequalities that exist in the country. On one hand, the effective treatment and development of medical technology launched favourable processes in medication. On the other hand, the heritage of the state socialist system, the weak role of preventive approach in primary health care and financial conflicts of the health insurance system are the causes of serious dysfunctions in today's health care. The Hungarian health care system of the 21st century essentially combines the anomalies of the socialist system with the distortions of market mechanisms.

This review article will focus on the interpretation of the conditions of the Hungarian epidemiological crisis and the transition with its effects on health inequalities. Thus, there is no objective to present or define the determinants of the demographic crisis and anomalies of the health care system.

Material and methods

The primary aim of the paper is to describe health conditions through health inequalities/inequities in Hungary by discussing how average life expectancy at birth and its spatial pattern has changed over the last 25 years.

The study is primarily based on statistical methods and with the demonstration of the most important experiences of Hungarian publications, it shows the territorial differences of mortality and life expectancy. The main objective is to present and explain the regional inequalities of health status within Hungary and interpret the changes in life expectancy and mortality over the past 25 years. The research has tried to answer to the following comprehensive questions:

- Do the spatial inequalities of life expectancy indicators establish 'Western-Eastern gradient' in Hungarian health inequalities?
- Can the advantageous socio-economic situation verify the better life expectancy, and can it also be true conversely?
- How could the epidemiological transition influence the spatial structure of health inequalities in Hungary?

The spatial unit of the research project examines the national (country) and county levels (NUTS3) as well as the micro-regional level (LAU1). The temporal scale embraces the period after 1989/1990. The data set was acquired from the publications of the Hungarian Central Statistical Office. In addition, the analysis also contains an international comparison to define the relative position of the Hungarian health indicators among developed countries (OECD statistics).

The applied methodological tools are matched with the character and topic of the chapters: the descriptive method is taken as tool of examination in the theoretical part and analytical tools are used in the chapters showing and explaining Hungarian health inequalities. Two aspects are considered in the theoretical part, which was prepared on the basis of the literature: first, the explanation of the health inequalities problem and, second, the interpretation of the scientific literature involving the presentation of Hungarian research approaches. The empirical part of the study is based on particular statistics of mortality, such as average life expectancy at birth by age and sex. Life expectancy refers to the average number of years to be lived, calculated from birth or from a particular age; thus, it refers to the average number of years a newborn is expected to live if the current mortality rates continue to apply (Johnston et al. 2000). The index reflects the overall mortality level of a population. It summarises the mortality pattern that prevails across all age groups – children and adolescents, adults and the elderly (Wilkinson 1996). It is still worth examining how mortality rate can reflect on life expectancy. That is the main reason to analyse the run of mortality rate, because the average life expectancy at birth and its changes continuously depend on the improvement or the worsening of the mortality situation in Hungary in the second half of the 20th century.

Explanation of health inequalities and health inequities

On one hand, health is a multi-factorial phenomenon, and so it is a term that attracts various scientific approaches in its definition and interpretation (Last 2001). On the other hand, health inequalities can be defined as differences in health status or in the distribution of health determinants between different population groups and social classes. Moreover, health inequalities not only imply social or spatial inequalities but also socio-spatial inequalities as a whole (Jones–Moon 1987). It is also important to recognise that social inequalities have spatial aspects that reflect the social context of spatial inequalities.

The health status of the population living in different geographical regions, in various settlements as well as in different social groups, is determined by biological, individual, environmental, socio-economic, socio-cultural and lifestyle factors (e.g. Dahlgren–Whitehead 2006; Lalonde 1974; Marmot–Wilkinson 2006). Some of the health inequalities are independent of social and economic relations, but a larger number of them are dependent on socio-economic inequalities (e.g. Elstad 2005; Evans–Stoddart 1990). These latter factors are called health inequities in both the literature and the policy in this field. Thus, health inequities are part of health inequalities, and in order to improve the health of the population, these inequities should be decreased by means of effective policy and productive intervention.

Health determinants are factors that can directly or indirectly influence the health status, for example, lifestyle, environmental effects, genetic variations, etc.

(Mackenbach–Bakker 2002). Some health inequalities are attributable to biological variations: it may be impossible to change the health determinants, so these health inequalities are unavoidable. Other health inequalities are attributable to the external environment and socio-economic conditions mainly outside the control of the individuals concerned. The uneven distribution may be unnecessary and avoidable as well as unjust and unfair, so that the resulting health inequalities also lead to inequity in health (WHO Meeting Report 2011). Much more is now understood about the extent and socio-economic causes of health inequities; thus, action on the social determinants of health across the life-course and in wider social and economic spheres is required to achieve greater health equity and protect future generations. The social determinants of health are the circumstances of daily life – the conditions in which people are born, grow, live, work and age – and the structural drivers of these conditions (unfair distribution of power, money and resources; Marmot–Bell 2009). Inequality of life expectancy in connection to health presents in every country and mostly depends on macro-economic conditions. Behind these life expectancy inequalities related to health are economic inequalities, injustices of distribution, obstacles in the access to education and health supply, bad housing and life circumstances and a lack of opportunities for a healthy life (Benach et al. 2008).

According to a WHO definition and statement, there is ample evidence that social factors, including education, employment status, income level, gender and ethnicity, have a marked influence on how healthy a person is. In all countries – whether low-, middle- or high-income – there are wide disparities in the health status of different social groups. The lower an individual's socio-economic position, the higher their risk of poor health. Health inequities are systematic differences in the health status of different population groups. These inequities have significant social and economic costs, both to individuals and societies (http://www.who.int).

[Note: The term health inequality is used in this study as a general form to define inequities that are determined by socio-economic factors as well as biological variations.]

Interpretation of the factors of health inequalities in Hungary in light of the previously published scientific literature

The research on health inequalities has a strong tradition and considerable history in Hungary, primarily through the interpretation of socio-regional disparities of health status. Owing to the interdisciplinary character of health research, different disciplines (e.g. Medicine, Public health, Sociology of Health, Geography of Health, Science of Behaviour, etc.) examine the causes and socio-economic consequences of health inequalities using different theoretical foci and methodological emphases. In our overview, the primary aspect is the presentation of previously published scientific literature that dealt with the tendencies of epidemiological development after the regime change and which, in connection with these, focused on the identification of the characteristics of health inequalities in Hungary, particularly in view of the situation of territorial disparities.

Analyses concentrating on the quantitative approach and mortality indicators prevail in the Hungarian health inequality researches (e.g. Klinger 2003, 2006; Józan 1991, 1994, 1998). There are lot of analyses that interpret the characteristics of health inequalities primarily through the gender and territorial disparities of life expectancy or mortality rate (e.g. Egri–Tánczos 2015; Kovács 2014). There is a separate group of statistical researches that apply different socio-economic indicators as explanatory factors in the case of age- and cause-specific mortality and changes in life expectancy indicators. Most of the authors apply the following inequality dimensions in the evaluation of factors determining and influencing health inequalities: highest completed education level, economic development, income, deprivation, poverty and labour market situation (e.g. Daróczi 2004; Hablicsek–Kovács 2007; Páldy–Bobvos 2009).

One of the most important research results is that regarding health inequalities and life expectancy, '*the different macro factors do not directly affect the mortality, but they have multiple indirect impacts on life expectancy*' (Daróczi 2004 p. 57.). Essential results have been obtained about the role of education level. Scientists agree that low education level has a negative impact on the labour market situation, living conditions and life expectancy: the mortality surplus is considerable among women with the highest and men with the lowest educational level (Hablicsek–Kovács 2007 p. 34; Kovács 2011 p. 48; Kinger 2003, 2007). Bálint and Kovács examined the determinative factors of the improvement of life expectancy; they found that the increase in life expectancy can be attributed to a significant improvement in cardiovascular mortality that increased the average life expectancy at birth by 2.8 years for males and 2.9 years for females (Bálint–Kovács 2015). They also identified large inequalities in life expectancy by educational level: the average life expectancy at birth for females (males) with higher education is 5.8 years (12.5 years) higher than that of women (men) with primary education (in 2012; Bálint–Kovács 2015).

Many authors have identified unemployment as the most important factor influencing health, mainly in the periods of crisis, as unemployment was a new phenomenon after the regime change (Lackó 2015). Most of the authors interpret it as a risk factor: experiencing joblessness increases the feeling of vulnerability; however, self-esteem disturbances depend on the level of education (Kopp–Kovács 2006), and even the householder's unemployment sets back the successors' labour market opportunities (e.g. Kollányi–Imecs 2007). The significant relationship between life expectancy and unemployment is accompanied by a characteristic territorial pattern (e.g. Szilágyi–Uzzoli 2013; Uzzoli–Szilágyi 2013).

Based on international and national studies, the association between health inequalities and socio-economic inequalities is well known. This identified association highlighted the fact that the spatial pattern of different diseases and death-causes may reflect the spatial distribution of health and socio-economic inequalities. Many authors have developed a multi-factorial model to measure this statistically significant connection, and some have developed a definable approach that provides information about the spatial consequences or spatial relevances of this connection. In mid-1990s, the National Environmental Health Action Program of Hungary was one of the largest national programs that investigated different diseases, such as death causes according to the International Statistical Classification of Diseases 10th Revision (ICD-10) by their frequency and spatial distribution between 1986 and 1997 (Vincze et al. 2000). One of its most important results was to demonstrate spatial the typical death causes in Hungary along with its spatial distribution. These experiences can be used to inform national prevention strategies aimed at reducing health inequalities. Other authors developed a multi-dimensional index at the municipality level to provide information about socio-economic deprivation in Hungary and investigate the association between socio-economic status and spatial distribution of premature mortality due to different diseases (e.g. Juhász et al. 2010; Nagy et al. 2012). These risk analyses demonstrated that different population groups in different parts of the country can be identified with trends of increasing mortality caused by, for example, diseases of the circulatory system or alcoholic liver disease. For instance, areas with significantly high age-adjusted relative risks for males are found in the South Western part and at the eastern border of Hungary due to the mortality of alcoholic liver disease (Nagy et al. 2014). In addition, significantly high deprivation is identified in the North Eastern, Eastern and South Western parts of Hungary, where there is a significant association between premature cardiovascular mortality and deprivation status in both genders (Juhász et al. 2010).

At the same time, many European studies called attention to the huge differences between health indicators according to geographical areas (e.g. Dolk et al. 1995). It has become evident that mortality rates of different geographical places largely depend on the distance between urban and rural territories (e.g. Phillimore–Reading 1992). Connection between local socio-economic deprivation and health is the result of the nature of the rural area (Poortinga et al. 2008). Considering the extent of deprivation, it is possible that urban deprived areas have better illness indicator rates than deprived rural areas (Congdon 1995). In the past two decades, more and more research results have referred to the fact that differences between rural and urban health states are decreasing and that the previously evident health gap in rural areas is closing (e.g. Richardson et al. 2013).

In the past one and a half decade, the Hungarian health inequality researches have published results while taking the supply and consumption statistics into account. It is interesting that the importance of place appears in the latter statistics: they interpret the role of place of residence separately in the research on factors determining both the supply need and access to supply (e.g. Ember et al. 2013; Vitrai et al. 2008, 2010). Morbidity researches related to mental health from the 1990s (e.g. Kopp–Skrabski 1995) and public health surveys from the 2000s (e.g. OLEF 2002; ELEF 2009) have also contributed to the comprehensive understanding of domestic health inequalities.

Hungarian health indicators and life expectancy in an international comparison

This international comparison is especially based on OECD Health Statistics rather than EU or WHO statistics. On the one hand, the OECD Health Database offers a comprehensive source of comparable statistics on health and health systems across OECD countries. It is an essential tool to carry out comparative analyses and draw lessons from international comparisons of diverse health systems all over the world. On the other hand, OECD statistics can provide the opportunity to analyse the relative position of Hungary in an international context larger than EU28 but less than WHO members.

In 2013, average life expectancy at birth in Hungary was 75.7 years, 4.7 years below the OECD average of 80.2 years and the second lowest among all OECD countries (Table 1). Despite significant increases in males' life expectancy at birth, it is trailing the OECD average by 5.6 years. Overall, average life expectancy at birth is relatively low and avoidable mortality rates are high. The relatively low life expectancy is mainly because Hungary has the highest mortality rate from cancer and the second highest mortality rate from cardiovascular diseases among OECD countries. Lifestyle factors – especially the traditionally unhealthy Hungarian diet, alcohol consumption and smoking – play a very important role in shaping the overall health of the population.

Table 1

Hungary's most important health indicators from OECD Health Statistics 2015

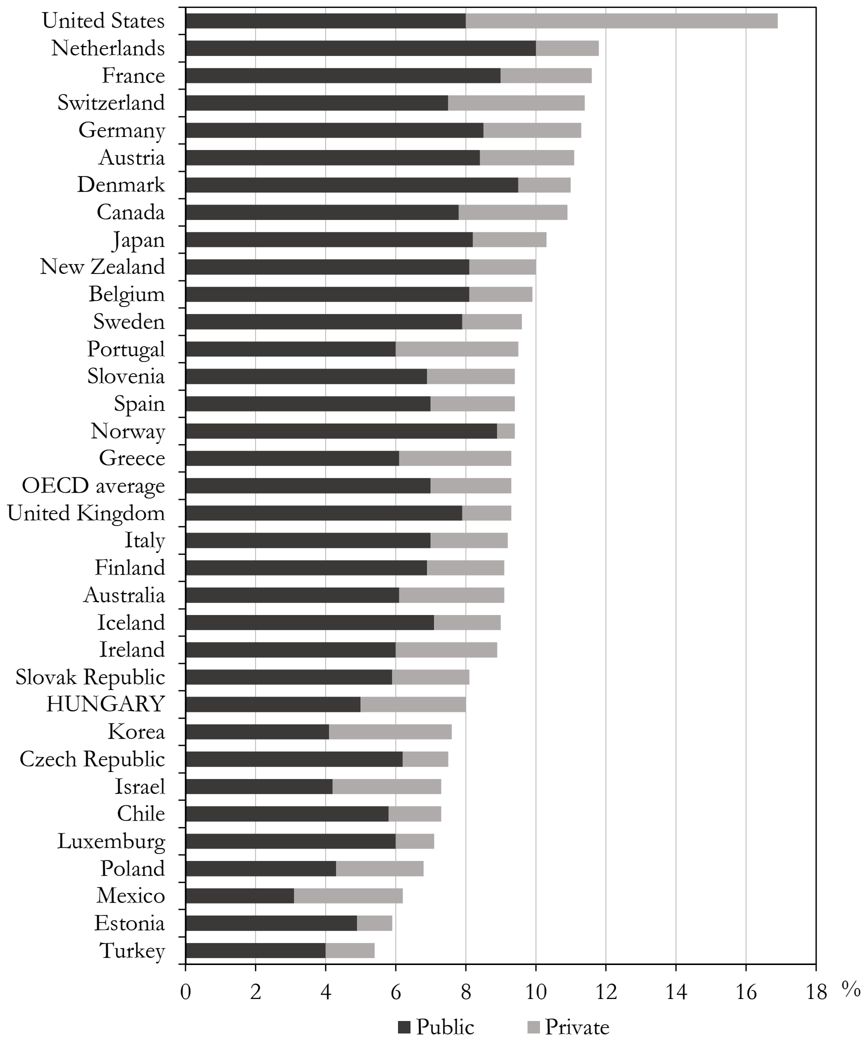
Health indicators	Hungary		OECD average		Rank among OECD countries[a)], 2013
	2000	2013	2000	2013	
Average life expectancy at birth, total (years)	71.9	75.7	77.1	80.4	33 out of 34
Average life expectancy at birth, male (years)	67.5	72.2	74.0	77.8	33 out of 34
Average life expectancy at birth, female (years)	76.2	79.1	80.2	83.0	33 out of 34
Difference between male and female life expectancy (years)	8.7	6.9	6.2	5.2	32 out of 34
Mortality from cardiovascular diseases (age-standardised rates per 100,000 people)	803.5	602.1	428.5	295.2	32 out of 34
Mortality from cancer (age-standardised rates per 100,000 people)	349.8	297.8	242.5	212.3	34 out of 34

Data source: http://www.oecd.org/els/health-systems/health-data.htm

a) Countries are ranked in descending order of values.

Figure 1

Health expenditure, public and private, as a share of GDP in OECD countries, 2012



Data source: OECD Health Statistics 2015.

The total health spending accounted for 8.0% of the gross domestic product (GDP) in Hungary in 2012, less than the average of 9.3% for OECD countries (Figure 1). In Hungary, 63% of the health spending was provided by public sources in 2012, below the average of 72% for OECD countries. Health spending growth in Hungary has been very volatile over the past decade. Years of strong spending increases were followed by periods of negative growth in the 2000s, due to either organisational reforms of the health sector or cost-containment measures introduced following the economic crisis.

After a return to growth in 2011, health spending in Hungary fell again in 2012, mainly triggered by a sharply reduction in pharmaceutical spending. This is partly due to the impact of new mandatory tendering processes for publicly financed medications, which have resulted in price reductions. The distribution of some costly pharmaceuticals has also been shifted away from pharmacies to the hospital sector, which is now included under hospital expenditure, thus over-estimating the real reduction in pharmaceutical spending (OECD Health Review 2014).

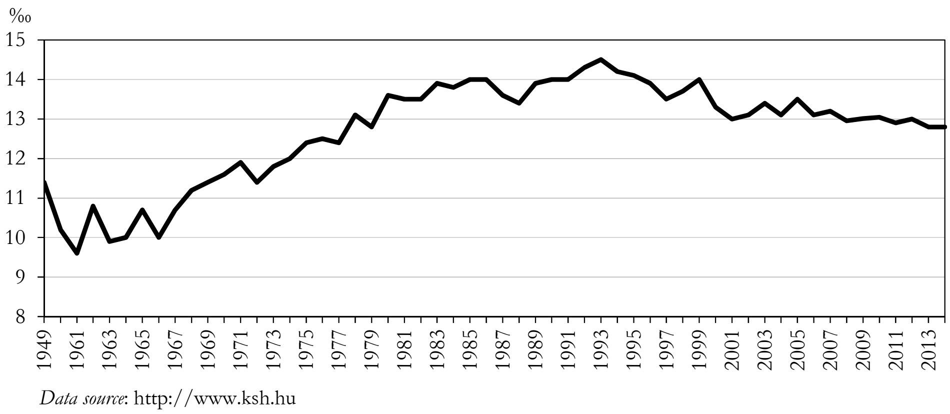
Average life expectancy at birth in Hungary is among the lowest in the OECD; however, life expectancy increased by 1.3 years between 2009 and 2013, more than in most other OECD countries during the same period. Health spending in Hungary (excluding investment expenditure in the health sector) is below the OECD average, and this has decreased by almost one percentage point since 2003 as a result of relative low health spending growth over the 10-year period (http://www.oecd.org).

Changes of the Hungarian life expectancy in time

The average life expectancy at birth and its changes in time have continuously depended on the improvement or worsening tendencies of mortality rate in Hungary in the second half of the 20th century (Figure 2). The slow, moderate improvement of mortality rate started after 1995, but the indicator reached 14% again in 1999, although since then it seems to have stagnated around 12.8–13.0%. The trend in the mortality rate in Hungary shows a similar pattern as most other Central and Eastern European countries along with some characteristic features. As in all of the European states after the Second World War, a downtown trend in mortality rate was seen, which led to an improvement period in health status through the increase in life expectancy (Michalski 2005). This favourable tendency was caused by the decrease in the number of maternal, neonatal and infant mortality rates and development of implements for infectious diseases in Europe at the beginning of the 20th century.

Figure 2

Crude mortality rate in Hungary, 1949–2014

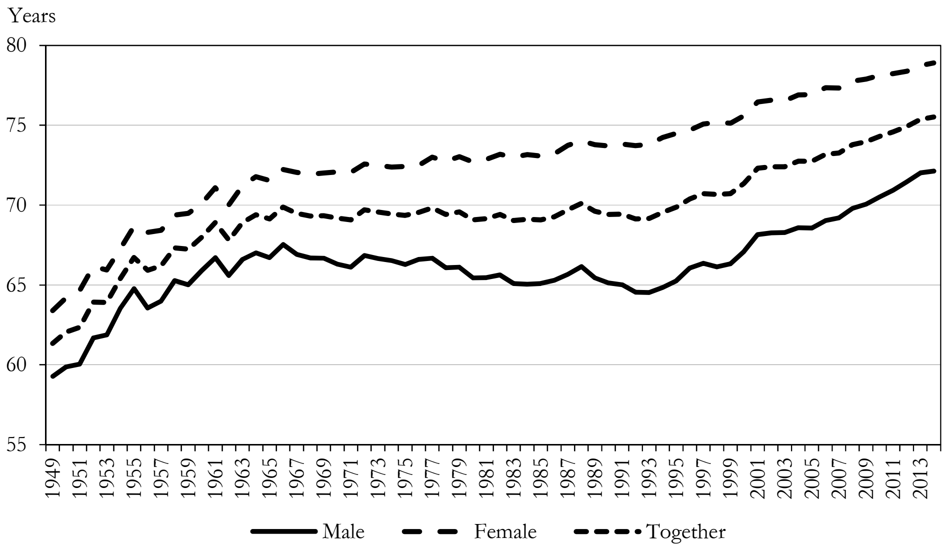


Data source: http://www.ksh.hu

The remarkable improvement in the Hungarian average life expectancy at birth with an increase of 5.4 years was mainly experienced between 1949 and 1955, and it could also increase during the 1950s and 1960s (Figure 3). However, the substantial improvement was followed by a marked deterioration of life expectancy after the end of the 1970s, because from 1966, the main health indicators changed for the worse. The deterioration of the Hungarian life expectancy reached its bottom in 1985, but this could not be followed by a period of upswing due to the change of regime and socio-economic transformation. Nevertheless, the role of the transition caused another substantial decrease in 1993. In this year, the average life expectancy at birth fell to unprecedented levels: 64.5 years for men, 73.8 years for women and 69.2 years for both sexes. The fall of life expectancy between 1989 and 1993 was caused by the sharp rise in premature mortality of the middle-aged male population. The moderation of the mortality rate after 1993 allowed life chances to increase again to over 70 years after the second half of the 1990s. The average life expectancy at birth stagnated generally for many years before rising in the late 1990s.

Figure 3

Average life expectancy at birth in Hungary, 1949–2014



Data source: http://www.ksh.hu

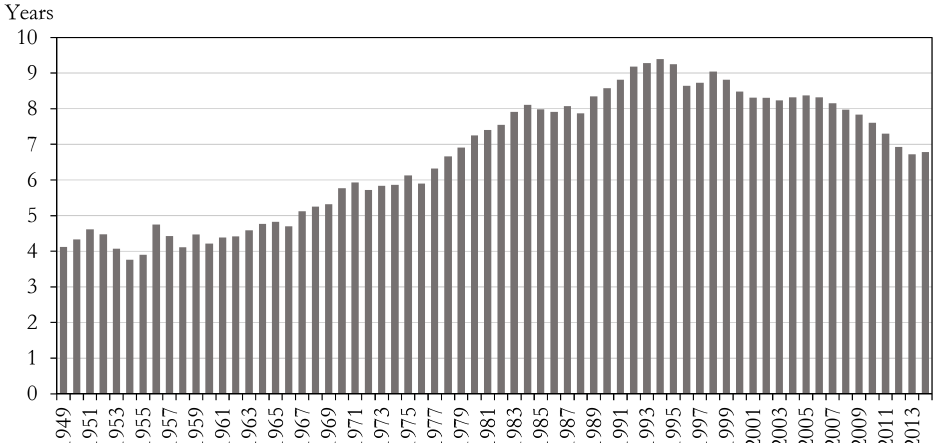
The deep social and economic crisis around the regime change had a strong impact on the health processes within a short period of time; in this way, the morbidity and mortality statistics of the whole population seriously worsened again after 1989. This was a dramatic consequence despite knowing that although our health indicators worsened from the middle of the 1960s, their stagnation already occurred in the middle of the 1980s. By comparison, in the next few years, the social and economic transition was accompanied by new, unprecedented worsening of life expectancies.

After the Hungarian transition, the slow and gradual life expectancy increase started in 1996, and it is still a growing trend. From 1996, it increased to above 70 years and from 2009, to above 74 years, which means that between 1993 and 2010, life expectancy grew 5.3 years. It must be emphasised that the average life expectancy at birth for men reached 70 years only in 2009, while women's life expectancy was already above 76 years in 2001. The difference between the life expectancy of the two sexes was the highest between 1993 and 1995 (9.3–9.4 years) after the Second World War in Hungary (Figure 4). The difference has decreased gradually from the middle of the 1990s, and in 2014, it was 6.8 years. The biomedical relation explains the disparity of life expectancy by sex, but the gap between Hungarian men and women is one of the widest in OECD. Life expectancy is influenced by the death rate (especially age-specific death rate), so it is an even compound index for life chances. According to the very disadvantageous mortality rate of the middle-aged Hungarian male population (Józan 1996), their health is mainly poor compared with the males of OECD countries. Therefore, besides the biomedical relation, the social and cultural factors can also affect the difference in life expectancy by sex (Józan 1999).

There are significant differences between the death rates of males and females, and the deterioration of age-specific mortality rate from 1966 had a significant effect on Hungarian men's life chances, especially middle-aged men. The increasing tendency in men's mortality rate in all age groups was higher than that of females (Figure 5, Figure 6); the worst deterioration could be observed among males aged 40–49 years: their mortality rate doubled between middle of the 1960s and the beginning of the 1990s (Józan 1994a, 1994b). From the middle of the 1990s, the improving tendency of the mortality rate was more remarkable among Hungarian women (Statisztikai Tükör 2008).

Figure 4

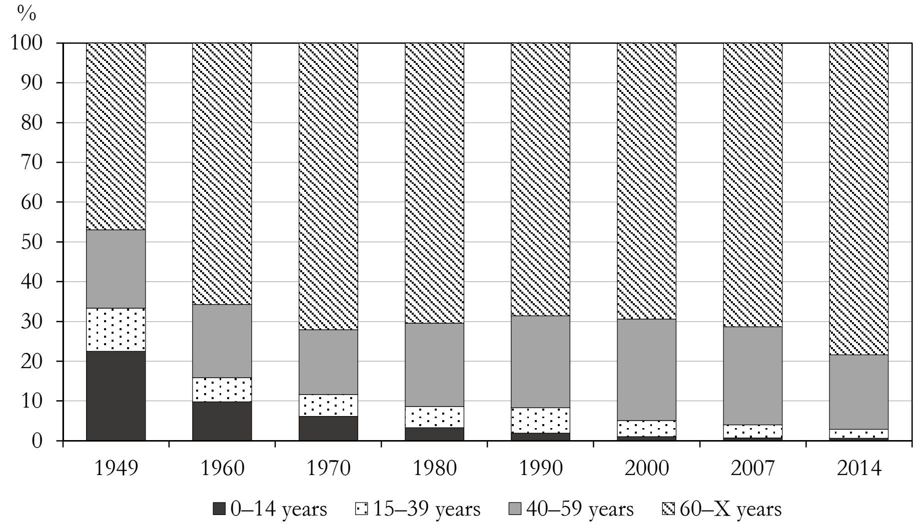
Differences between the life expectancy of males and females in Hungary, 1949–2014



Data source: http://www.ksh.hu

Figure 5

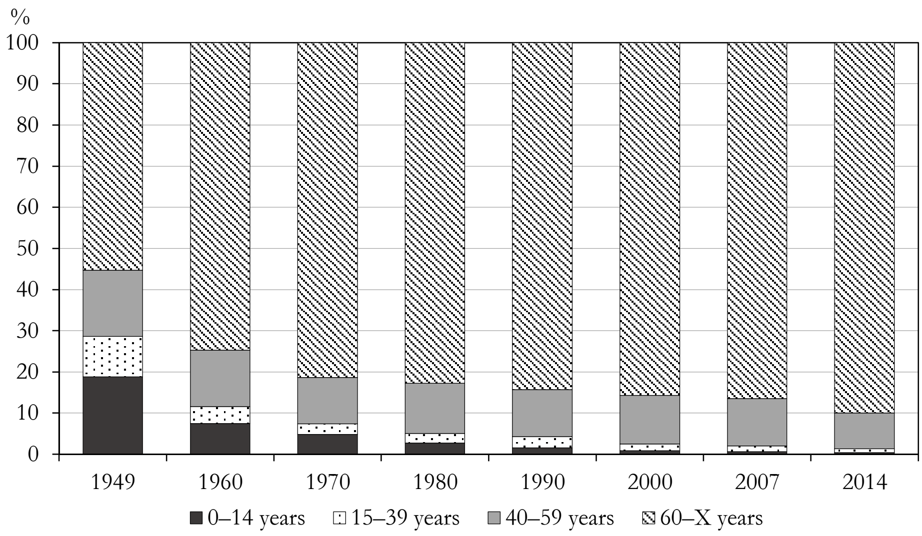
Age-specific mortality rate in Hungary, male



Data source: KSH Tájékoztatási Adatbázis, Statisztikai Tükör 2008. 2 (176) p. 2.

Figure 6

Age-specific mortality rate in Hungary, female



Data source: KSH Tájékoztatási Adatbázis, Statisztikai Tükör 2008. 2 (176) p. 2.

The epidemiological changes supervened in the mortality situations in mid-1990s. Its background was the deepening of the epidemiological crisis in early-1990s, which was the result of the decades-long worsening of health indicators. Life expectancy declined in each age group, especially for middle-aged males. From mid-1990s, the epidemiological transition resulted in the slow increase of life expectancy as well as the emergence of chronic diseases at later ages and the significant decrease of early death. At the same time, the sustained but moderate improvement in health status caused the increase in health inequalities, which was determined socially and regionally as well.

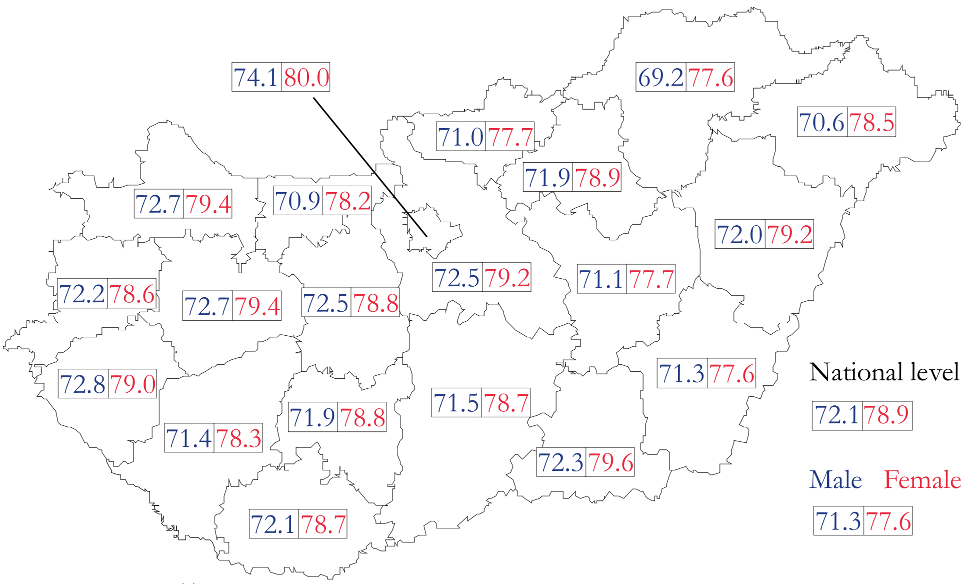
Characteristics of the spatial pattern of life expectancy

Among the life chance indicators, the average life expectancy at birth draws attention to the significant territorial inequalities at both county (NUTS3) and district (LAU1) levels. At the same time, its development over time and space after the regime change also refers to the pronounced spatial patterns of life expectancies.

According to the latest data of 2014, the life expectancy of Hungarian males is 72.1 years and that of females is 78.9 years; however, considerable divergences are shown between the different parts of the country. There is a ten-year difference between the life expectancy of women living in the capital (80.0 years) and men living in the Borsod-Abaúj-Zemplén county (69.2 years); thus, where someone is born in the country and whether one is born as a boy or a girl is not without relevance (Figure 7). Males in the capital have the highest life expectancy in Hungary nowadays. The lowest life expectancies of Hungary are found in the Borsod-Abaúj-Zemplén county: the male life expectancy is 2.9 years lower than the national level, while female life expectancy is 1.3 years lower.

Figure 7

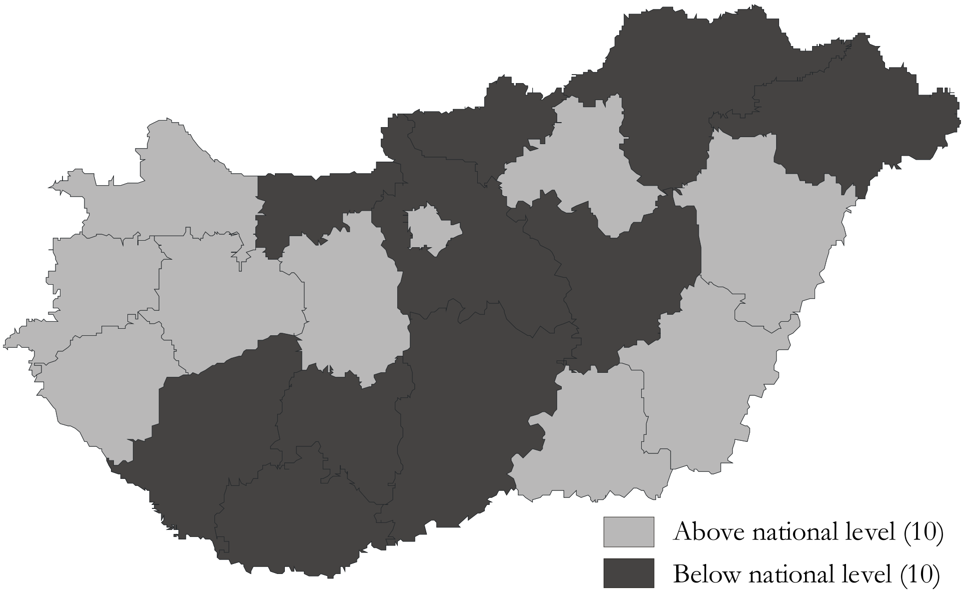
Average life expectancy at birth in the counties of Hungary, 2014



Data source: http://www.ksh.hu

Figure 8

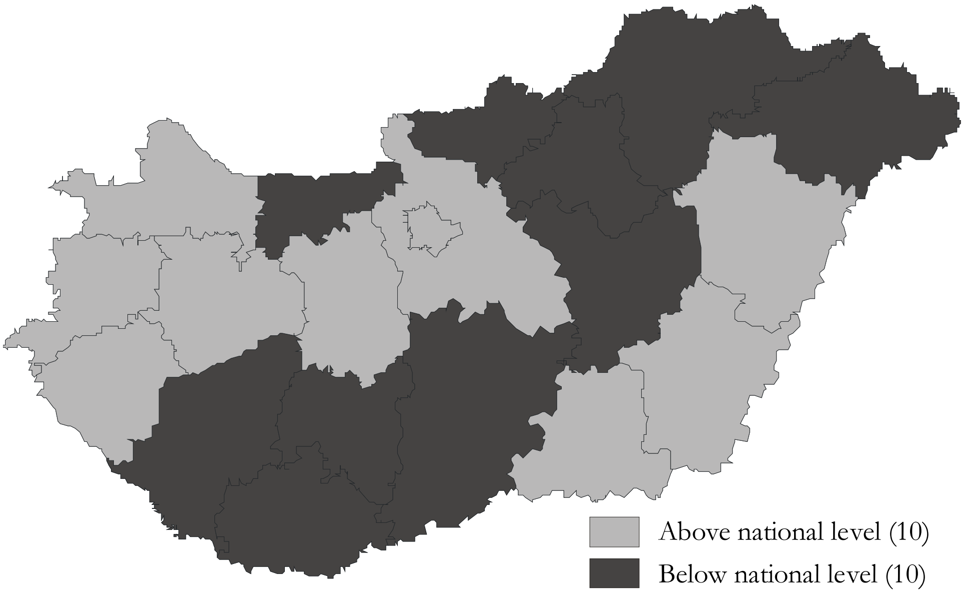
Average life expectancy at birth in the Hungarian counties and its divergence from the national average, 1990–1990



Data source: KSH Tájékoztatási Adatbázis.

Figure 9

Average life expectancy at birth in the Hungarian counties and its divergence from the national average, 2001–2014



Data source: KSH Tájékoztatási Adatbázis.

The life expectancies and its regional differences within Hungary are influenced by the socio-economic situation of the counties as well as the districts. The relative position of the counties to each other has not changed or has hardly changed in the past 25 years. The most advantaged and worst disadvantaged counties were the same at the beginning of the 1990s as today. The average level of life expectancy in the counties and its divergence from the national level shows a very typical spatial structure (Figure 8, Figure 9). The most favourable counties are in the North Western part of Hungary including the capital, while the most unfavourable areas can be found in the South Western and North Eastern parts of the country. In this latter case, the average life expectancy at birth in the Borsod-Abaúj-Zemplén and Szabolcs-Szatmár-Bereg counties always occurred at the national level over the last 25 years. The relative positions of the counties did not change between the two examined periods; only the Pest county showed an improvement, while Heves county showed deterioration according to the divergence from the national averages in life expectancy.

To determine the extent of territorial inequalities, a positional indicator has been used for providing the extent of variance. The development of extreme values can be interpreted through the difference between and the proportion of the maximum and minimum values in the data series. The differences of variance and rate of variance were summarised in a table (Table 2), based on which the most favourable and most unfavourable micro-regions/districts (LAU1) can be identified. Based on the results, we can say that the best values of statistical indicators – almost in each case – can be linked to districts situated in the Western part of the country, while the worst values are linked to districts in the Eastern part of the country.

Table 2

Extent of territorial inequalities according to the average life expectancy at birth (years), 1991, 2011

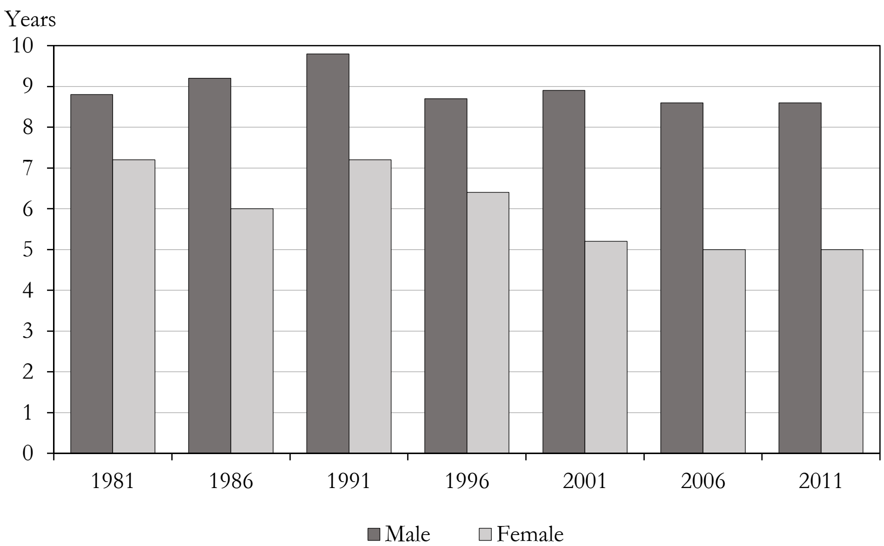
	Minimum value	District of minimum value	Maximum value	District of maximum value	Difference of variance	Rate of variance
	Average life expectancy at birth, 1991					
Together	63.5	Tokaji	71.9	Csornai	8.4	1.1
Male	57.6	Tokaji	67.4	Siófoki	9.8	1.2
Female	69.8	Tokaji	77.0	Balaton-almádi	7.2	1.1
	Average life expectancy at birth, 2011					
Together	71.3	Bodrogközi	77.9	Balaton-füredi	6.7	1.1
Male	65.9	Bodrogközi	74.5	Balaton-füredi	8.6	1.1
Female	76.6	Kadarkúti	81.6	Körmendi	5.0	1.1

Data source: http://www.ksh.hu

The volume index shows what difference can be experienced between the lowest and the highest values of the districts in life expectancy. If we examine the regional inequalities at the LAU1 level using this index, we can also see the differentiation and equalization in life expectancy (Figure 10). The difference in male life expectancy increased during the 1980s, and the health effects of the transition could strengthen this difference at the beginning of the 1990s. In the second half of the 1990s, the regional differences became moderated, but from 2001, these differences are becoming sharper (8.6 years in 2011). On the other hand, the changes in female life expectancy were not parallel with the differences in male life expectancy. The differentiation period was the result of the transformation and was followed by an equalisation period from 1996. By comparing male and female life expectancy using the volume index, we can observe a more changing position of females' index than the males'.

Figure 10

Average life expectancy at birth by sex and by volume index



Data source: http://www.ksh.hu

Based on the average life expectancy at birth, the degree of territorial inequalities decreased between 1991 and 2011. This appeared principally in the life expectancy of women: on the one hand, their life changes improved by 4.4 years between 1991 and 2011 and, on the other hand, the territorial disparities in their life expectancy were also much smaller compared to that of males in the early 1990s. At the same time, the life expectancy of males improved by 5.9 years between 1991 and 2011, but by comparison, a smaller equalisation of the territorial differences took place. Overall, in

Hungary, the increase in life expectancy during the last 20 years can be explained mainly by the improving life expectancy of males, which, however, was not accompanied by the considerable decrease of territorial disparities.

The decile ratio applied based on the cumulative per cent frequency answers the following question: according to district-level distribution of life expectancy, how many times is the average life expectancy of districts belonging to the upper 10% larger than that of the lower 10%?

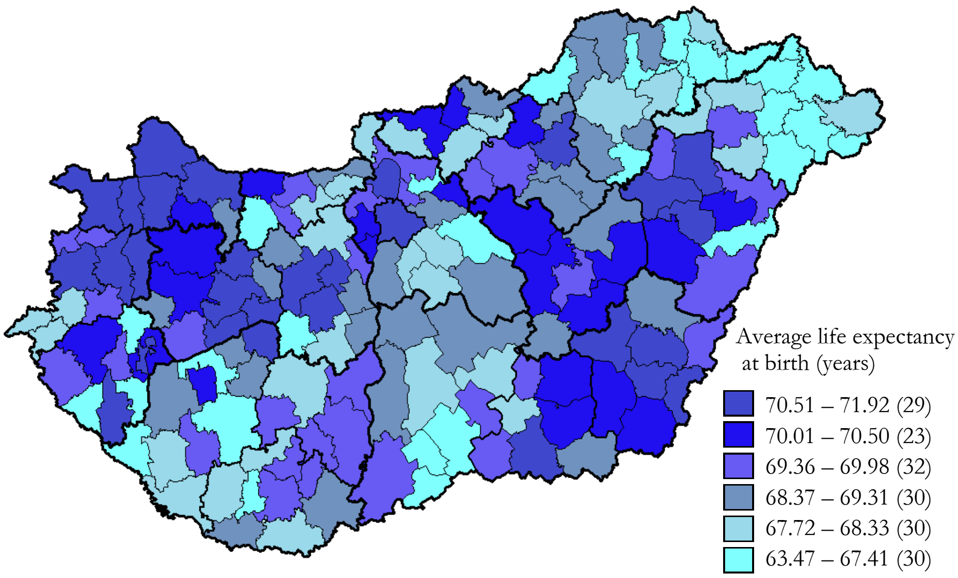
In 1991, the average life expectancy at birth was 71.6 years in 10 Hungarian districts (LAU1) with the highest life expectancy and 65.9 years in 10 Hungarian districts with the lowest life expectancy. There was only one Western Hungarian district among those belonging to the lower-tenth part, and the others were situated in the Eastern part of the country; none of the Eastern Hungarian districts belonged to those in the upper-tenth part, only the districts situated in the Western and middle parts of the country. The difference of average life expectancy between the lower- and upper-tenth part districts was 5.7 years. This difference decreased to 4.9 years until 2011; meanwhile, the average life expectancy increased to 72.1 years in the lower-tenth part and to 77.0 years in the upper-tenth part. Two districts from the Southern Transdanubia Region belonged to the former 'Eastern' districts, while there was only one district among the latter 'Western' ones that was situated in the Southern Great Plain Region.

According to the average life expectancy at birth, the territorial pattern of the country was quite mosaic in 1991 (Figure 11). Territorially coherent districts in a better or worse situation were located in the North Western, South Eastern and North Eastern parts of Hungary. The highest life expectancy could be observed in the capital, in some districts in its agglomeration and partially in North Western Hungary. The North Western–South Eastern division of the Central Hungary Region emerged even at the beginning of the 1990s: the situation of the Western and Northern sectors was favourable and that of the Eastern and South Eastern sectors of the Budapest agglomeration was unfavourable.

The Borsod-Abaúj-Zemplén, Szabolcs-Szatmár-Bereg and Bács-Kiskun counties were territorially coherent areas in bad situations that affected each or almost each district (LAU1). However, the situation of the Central and Western parts of the country improved spectacularly until 2010. For example, the number of districts with the highest values increased to the largest extent in the Western and Northern sectors of Central Hungary; in the Bács-Kiskun county, the proportion of districts with better and worse indicators was 50:50; the situation of Central Transdanubia Region turned positive regarding life expectancies; and in the Eastern part of Hungary, the chief towns of the counties and their surrounding districts appeared as territorial units offering better life chances.

Figure 11

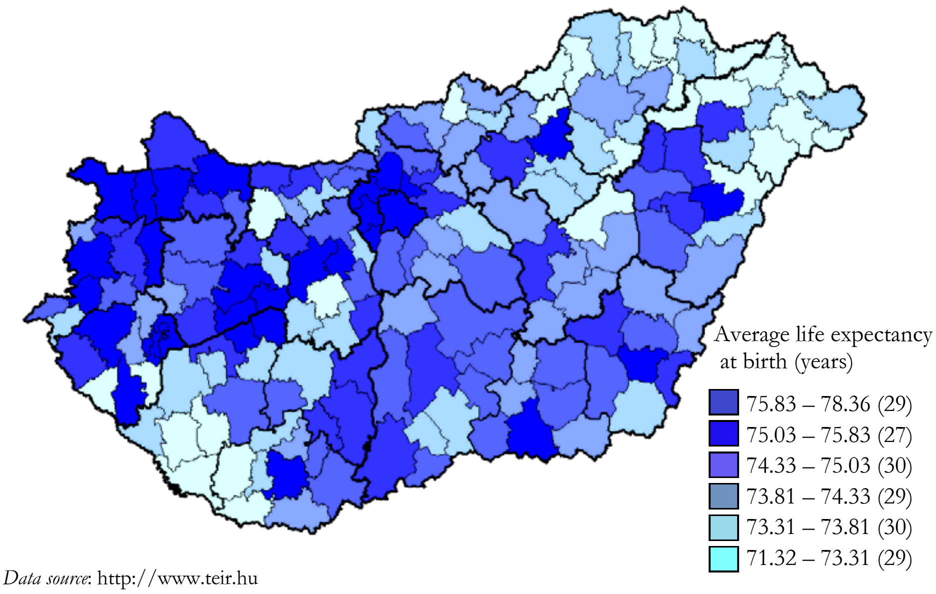
Average life expectancy at birth in the districts of Hungary at the LAU1 level (years), 1991



Data source: http://www.teir.hu

Figure 12

Average life expectancy at birth in the districts of Hungary at the LAU1 level (years), 2011



Data source: http://www.teir.hu

According to average life expectancy at birth at the LAU1 level, the spatial pattern became more mosaic after the Hungarian economic and political transformation. On the one hand, life expectancy was increasing continuously in all districts after 1996. Despite this, there is a marked differentiation between Eastern and Western Hungary. There are more districts with better values of life expectancy in the Western part of the country. The most advantageous spatial units are located around Budapest and in the North Western half of the country (Figure 12). The entire Eastern part of Hungary is in a very disadvantageous position due to its life expectancy. Therefore, a marked differentiation between the most favourable and unfavourable areas can be experienced. There are some districts in the Eastern part with better values, especially in county headquarters: we can define them as islands or hills in the Hungarian Great Plain.

Conclusions

According to statistical data, the mortality and life expectancy indicators have improved slowly and moderately, but continuously, from the middle of the 1990s in Hungary, which has led to the epidemiological change. Despite this, the health status of the Hungarian population is in some respects one of the worst in the developed countries. The unfavourable life expectancies refer in a complex way to the disadvantageous situation of health-related quality of life and its influencing factors: labour market situation, income level, living conditions, health behaviour and access to health care supplies.

The most important conclusions of the quantitative research conducted in this study are as follow:

- The improvement of average life expectancy at birth is less spectacular and large than what would result from the economic performance.
- The improvement of life expectancy draws attention to considerable gender inequalities, primarily based on the premature mortality of males and mortality surplus among middle-aged men.
- The low life expectancy is combined with significant regional disparities in the country.
- The socio-economic division of Hungary can also be demonstrated in health inequalities.
- Regarding life expectancy, the most disadvantaged areas in the country have largely lagged behind the national average, and this lagging is also a significant restrictive factor to economic development.
- The mortality trends have remained disadvantageous for North Eastern Hungary (Borsod-Abaúj-Zemplén and Szabolcs-Szatmár-Bereg counties) and South Western Hungary (Somogy and Baranya counties).

- The widening health gap between the Eastern and Western halves of Hungary had already begun to evolve during the 1970s and 1980s, but also has suggested the common origins of the health trends and the uprisings of 1989.
- Considering the significant life expectancy data, it is impossible to disregard that in the Eastern part of the country, the number of people in multiple disadvantaged positions is very high, and thus they struggle with many economic and social problems.
- The disadvantaged life expectancy in Hungary currently hits the entire adult population, but its spatial inequalities are influenced by the connection between life expectancy and economic development.

In light of results and experiences, it is clear that the decade-long worsening of mortality indicators stopped in the middle of the 1990s; subsequently, the mortality rate remained stable at a high level, while the life expectancy has increased slowly. This process has lasted for almost 20 years, but the health status of the Hungarian population has not improved spectacularly during this period. Obviously, positive changes have occurred, but the predominance of their long-term effects is impeded by the dysfunction of the health care system and the phenomena of demographic crisis (demographic decline, low fertility rates and ageing).

Summary

Health inequalities are always linked to economic and social inequalities because of the unfairness of the distribution system, bad labour market positions, difficulties in the availability of health care and education, disadvantaged living and life conditions and no chance of a healthy life. Social inequalities related to health are present in every district in Hungary and mostly depend on macroeconomic conditions. The interpretation of the social factors defining health inequalities presumes that not only do the life expectancy and health status count from a health point of view but also the level and growth of already existing health inequalities with their spatial pattern.

The health status of the Hungarian population has passed through four main phases in the second half of the 20th century according to the theory of epidemiological transition (Gaál et al. 2011). The first phase lasted until the middle of the 1960s with an improving tendency of life expectancy reaching levels comparable to those seen in the most developed Western European countries for both men and women. The second phase lasted from 1966 until the end of the 1980s in which there was marked deterioration in mortality from non-communicable diseases and life expectancy led to an increasing health gap between Hungary and Western Europe. The third phase began after 1989 and lasted until the middle of the 1990s: in this period, there was a shape decline in life expectancy caused by the deepest point of the Hungarian epidemiological crisis, which was a unique situation in Central Europe

(Ádány 2008). The fourth phase started after 1996 and has lasted until the present day. During this time, Hungary has seen a strong and steady increase in life expectancy at birth among both men and women (Gaál et al. 2011).

Life expectancy in Hungary has been increasing recently but with a geographically uneven distribution. The scale of the health inequalities through spatial differences within the country is surprising. Life expectancy varies among different areas: there are clear determining inequalities in life chances mainly between the Western and the Eastern halves of the country, and the patterns of these differentials vary considerably among micro-regional territorial units. The structure of health inequalities is not confined to differences between the poor and the rest of society; instead, it runs right across the society with every level in the social hierarchy having worse health than the one above it. The main point is that health inequalities have typical spatial pattern due to the socio-economic inequalities.

The Eastern–Western and the Centre–Periphery relations have an influential role in both socio-economic development and the spatial pattern of life expectancy. It should be emphasised that some settlements have been slowly declining since 1990 even in Western Hungary, which is otherwise positioned favourably. Alternatively, in Eastern Hungary, the situation is not wholly unfavourable according to health indicators. As far as the latter region is concerned, some areas – such as larger cities or county headquarters – have improved significantly since the 1990s, and now there are better than average indicators.

Acknowledgments

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Assessing the regional impact based on destination image

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The region of Northern Hungary is historically rich in tangible and intangible heritage destinations such as fortresses, castles, and cultural routes. Former castles of the aristocracy, converted to four- and five-star hotels, are among the favourite tourist destinations in the region. Destination stakeholders of these attractions have a prime interest in designing and delivering a complex and memorable tourism experience that will attract more visitors and return visits. The responsibility of regional and local destination management lies in finding an appropriate mix of attractions and corresponding experiences, attracting visitors/guests and creating repeat patterns of return. The research, involving a sample of 360 castle hotel guests, and using Partial Least Squares structural equation path modelling, reveals significant correlation between historical interest, motivation, and perceived image, predicting guests' perception of the entire region. Visitation patterns, together with geographical embeddedness, can be further explored to increase destination competitiveness.

Keywords:
historical heritage, destination experience, castle hotels, perceived image, regional impact, destination competitiveness

Introduction

In addition to the economic benefits that the attraction of tourists to a heritage site or area can generate, the recognition of such locations may also bring with it a number of other advantages. Identification of a site or area of historic, cultural or natural importance should promote greater awareness of, and appreciation for, its value, thereby increasing the chances of its preservation in the future. Realisation of the existence and significance of such places' unique resources by local residents is likely to enhance community pride and help strengthen a sense of place and identity (Nagy–Horváth 2012). People and communities identify with or through heritage in a variety of ways, but one of the strengths of heritage, perhaps especially in its intangible dimensions, is that most heritage objects or landscapes can accommodate different, divergent or even competing demands. Integrating these elements into image analysis provides a more accurate and comprehensive picture of the representation of the destinations that people have in mind, even though image study in tourism is relatively young (Wang 2011, p. 142). In order to generate effective managerial and marketing implications regarding a destination's positioning and promotion, its image must be accurately assessed.

The formation of tourists and visitors' identities by way of relating to heritage tourism has been analysed (Ashworth 1998, Palmer 1999, 2005, Pretes 2003, Poria et al. 2003, Poria et al. 2006, Yuan–Wu 2008, Park 2010). For the definition of heritage tourism, Garrod and Fyall (2001, p. 683) quoted Yale (1991, p. 21): 'tourism centred on what we have inherited, which can mean anything from historic buildings, to artworks, to beautiful scenery'. For the purpose of this research, the definition of heritage/culture tourism is 'visits by persons from outside the host community motivated wholly or in part by interest in the historical, artistic, scientific or lifestyle/heritage offerings of a community, region, group or institution' (Park 2010, p. 128).

Pearce (2014), in his conceptualisation of tourism destinations as social constructs, enumerates a number of geographic dimensions, space and place being the main, underlying dimensions. Heritage destinations are embedded in geographical locations (territories), so research into the complexities of visitor behaviour and attitudes cannot exclude the spatial aspect (Salazar et al. 2010). Understanding visitors or guests' perception of the impact of destinations will contribute to the geographical delimitation of the destination itself. Castle hotels investigated in this study, despite their competition with each other for similar tourism segments, offer a unique product catering to a specific sub-segment of the upscale tourism market and coordinate their efforts in offering jointly organised cultural events (festivals, concerts, arts and crafts, fairs, etc.).

The research question this study addresses, by means of researching guests as a specific niche group of potential destination components, that is castle hotels, is how customer insight can assist destination marketing and management. This support is especially relevant in the case of (local and regional) Destination Management Organisations (DMO's) that are in the process of being organised and established (Aubert 2011). This study, owing to the rarity of the topic's analysis, will address more than one issue: first, it contributes to hospitality and historical heritage research by being a building block in the barely extant literature on heritage hotels, situated at the crossroads between hospitality and heritage destinations and therefore pertaining to either category, or to both categories. Second, it embraces a transdisciplinary approach to the delineation and definition of heritage hotels as autonomous heritage destinations by providing an analysis of visitors' interest and motivation factors and their perceived image of the destination, thus creating a link to the role the destination seemingly plays in the formation of the region's image. Third, it tests a novel predictive model to establish causal relationships among the aforementioned constructs (destination selection criteria, motivation and perceived image). By sketching the universe of castle hotels based on customers' feedback explaining their attitudes to culture, interpretations of historical heritage, attitudes and decision-making processes and finally their experience at the destination, heritage tourism can be understood better.

Conceptual framework

Destinations and competitiveness

Travel customers increasingly seek and respond to a diversified set of value clusters (i.e. combinations of experiences, products and prices that suit their individual preferences). Destinations must design, promote and coordinate a satisfying total visitor experience that maximises the economic contribution to the destination and stimulates return intention and referral behaviour. Destination marketers must design an ever-richer palette of options and target their value packages more skilfully to various preference patterns. Wang (2011, p. 5) argues that a comprehensive approach to destination marketing and management should include, but not be limited to, the following themes, under which a multitude of issues need to be identified, understood and addressed:

- the concept, scope and structure of destination marketing and management;
- consumer decision-making in relation to destination;
- principles and functions of place image, positioning and communication;
- strategies and tactics in destination product development; and
- strategies and tactics in destination product distribution.

> Ritchie and Crouch (2003).
>
> 'What makes a tourism destination truly competitive is its ability to increase tourism expenditure, to increasingly attract visitors while providing them with satisfying, memorable experiences, and to do so in a profitable way, while enhancing the well-being of destination residents and preserving the natural capital of the destination for future generations' (p. 2).

This explanation points to 'satisfying, memorable experiences' as an antecedent of an increase in the number of visitors (Moscardo 1996). Additionally, sustainability is required. They conclude that 10 of the 36 destination competitiveness attributes have significantly greater than average determinacy measures. The first two most important attributes and most relevant to this study are (1) Physiography and Climate and (2) Culture and History. 'Destinations vary in terms of the abundance, uniqueness, and attractiveness of cultural and historical resources they have to offer the potential tourist, including quality-of-life and contemporary lifestyle experiences' (Crouch 2007, p. 33). Mazanec et al. (2007), in their survey on compound destination competitiveness, emphasise that there are three factors contributing significantly to it; these are, in order of significance, Heritage and Culture (.91), Economic Wealth (.24) and Education (.16). Other authors, such as Martín and del Bosque (2008), postulate that there is still a lack of complete understanding of the significance and interrelationships between the attributes of destination competitiveness, and they urge the construction of appropriate causal models to explain it.

The basic premise of this study is that the deployment of destination resources and attractors through the formulation and implementation of tourism strategies adapted to changing external environments can enhance destination competitiveness. However, before designing such strategies, destination characteristics at the micro-, meso-, and macro- levels must be clearly understood. Visitor characteristics and behaviour patterns will contribute to micro-level understanding.

Laesser and Beritelli (2013, p. 2), in their paper summarising the major outcomes of the first Biannual Forum on Advances in Destination Management, state that there is a lack of complete understanding of the significance and interrelationships between the attributes of destination competitiveness, so there is a need to generate data and build appropriate causal models to describe and explain the phenomenon of destination competitiveness. 'Authenticity can be a strong differentiator, so research could develop a comprehensive theory of and practical guidelines for authenticity management'.

Castle hotels belong to the category of themed accommodation that are located in historic buildings and, as such, constitute one of the most demanded genres of tourist accommodation. These historic buildings once served a different function, were built by aristocrat families and are nowadays renovated by private investors. Converted castles abound in Europe and have become a preferred form of accommodation for luxury tourists and even business travellers (Dallen–Teye 2009). This unique form of lodging is called *parador* in Spain and *pousada* in Portugal and signifies a luxury hotel transformed from previous aristocratic edifices.

It is in these hotels that visitors can gain an insight – through the efforts of the builder family – into the lives of the historical high society and its visual arts culture, interior design, etc. These are now operated as iconic or themed high-end hotels. They function as attractions for tourists due to their unique designs, distinctive environments, operating styles and opportunities to interact with hosts and other guests. They have been recognised as significant landmarks and attract substantial numbers of foreign and domestic guests. The services offered by such heritage enterprises tend to attract wealthy, individual tourists who are also likely to spend money on diverse, ancillary tourism and recreation services (sports, gastronomy, retail, cultural, etc.), using the castles as a base for trips around the local area (Murzyn–Kupisz 2013).

Tourist attitudes in destination selection

Motivation

Tourist motivation, along with expectations, is a subset of tourist attitudes prior to, during and following the destination experience; it deals with a special subset of the wider concept of 'interest' in human motivation (Yoon–Uysal 2005, Hong et al. 2009, Kay–Meyer 2013, Pearce–Lee 2005). Effectively, the total network of biological and cultural forces gives value and direction to travel choice, behaviour and experience. Whilst the vast majority of visitor attitude authors deal with the predictive relationship between motivation, perceived image of the destination and satisfaction leading to eventual repeat visit patterns, there are a few dealing with the behavioural intentions that directly predict destination image (Dolnicar–Le 2008, Salazar et al. 2010, Kim et al. 2012, Pearce 2014). Line and Runyan (2012), in their article reviewing the hospitality marketing research published in four top hospitality journals from 2008 to 2010 for identifying significant trends and gaps in the literature, found a total of 274 articles. These articles were reviewed and classified based on research topic, industry focus and analysis technique as well as on a number of other methodological criteria. They found that the Topical Focus item 'consumer characteristics' accounted for 8.8% of the articles in total, out of which 'decision making' made up 4.4% and 'motivation' a mere 2.2%. The review shows that there is a scarcity of papers with motivation and decision making in hospitality marketing research as their focal subjects. This study strives to bridge this gap.

Sirgy and Su (2000) purport that travel behaviour is influenced by both self-congruity (match between self-concept and destination image) and functional congruity (match between a destination's attributes and a tourist's ideal expectations). In one of the early works in the framework of the post-modern perspective of tourist behaviour and experience, Urry (1990) suggests that the diversity and complexity of contemporary tourism permits travellers to choose among many alternative experiences. True travel motivation is a push factor, a patterned summary of the social, cultural and biological forces driving travel behaviour. Pearce (2011) concludes that destination selection is 'akin to individuals undertaking an imaginative, embodied leap of projecting themselves with their motivational needs and profiles into a variety of experiential settings at the destination' (p. 50). In terms of different approaches to motivation construct sequencing to date, the pre-visit dimensions investigated have included motives, expectations, and attitudes, especially towards the satisfaction of expected motivational items (Kay–Meyer 2013). Kay and Meyer (2013) used a motivation-benefit model for understanding tourist motivation towards cultural experiences.

Selecting heritage destinations

Palmer (2005) emphasises that heritage tourism assists domestic tourists in conceiving, imagining and confirming their belonging to the nation in question. Visits to heritage sites are seen as ways to encourage nationals to feel a part of and be connected to the nation's past, as it exists in the national imagination. Heritage attractions are often considered to as 'sacred centres', places of spiritual and historical pilgrimage that reveal the nation's unique 'moral geography' (Smith 1991, p. 16), and they facilitate ways in which 'individuals variably position themselves in a broader context of cultural construction and symbolic embodiment of the nation and national identity' (Park 2010, p. 120).

Heritage tourists are a heterogeneous group, both from the viewpoint of the site's relation to their personal heritage and their overall motivation for visiting. Referring to specific motivations for the visit, Poria et al. (2006) report, in their survey of foreigners' visitation patterns compared to their perception of the Wailing Wall, three categories of motivations: willingness to feel connected to the history presented, willingness to learn and motivations not linked with the historic attributes of the destination. Poria et al. (2003) used statements dealing with tourists' motivations that were based on motivating factors, such as desire for emotional involvement, education, enjoyment and relaxation. Clear patterns were found in the levels of perception. For example, those who visited because they wanted to be emotionally involved were very likely to perceive the place as part of their own heritage.

This categorisation exemplifies and supports previous studies arguing that different tourists visit historic spaces for different reasons (Poria et al. 2003, McCain–Ray 2003, Tian–Cole et al. 2002). It is common in the literature to regard tourism to historic locations as a phenomenon mainly motivated by the willingness to learn and be educated (Fakeye–Crompton 1991). Various studies have acknowledged the tendency of visitors to heritage and other cultural attractions to display higher educational attainment than the general population (Pike–Page 2014). It is hypothesised that the formation of the castle hotel guests' motivation will follow the patterns described above.

H1 Guests' interest in history will predict their motivation for destination selection.

Destination image (DI)

Image is highly complex and is therefore complicated to manage, yet it is one of the most critical factors in the competitiveness of tourism destinations; thus, destination image (DI) should receive high priority from destination promoters (Wang et al. 2010). The growing interest in this field of study derives from the recognition that 'what people think about a destination's image is strategically more important than what a marketer knows about the destination' (Chen–Hu 2009). A wide variety of definitions have been offered to describe DI throughout the years. The current understanding of DI as suggested by Pearce (2011, p. 45) is that DI is 'the expression of all objective knowledge, impressions, prejudice, imaginations, and emotional thoughts an individual or group might have of a particular place'. The challenge faced by DMOs and other destination promoters is to bring the image that people have in mind as close as possible to the desired image of the destination (Wang et al. 2010).

Destination image is defined as an individual's mental representation of knowledge (beliefs), feelings and overall perception of a particular destination (Crompton 1979, Fakeye–Crompton 1991). It has been acknowledged that tourists' perceived image of a destination plays an important role in their decision making, destination choice, post-trip evaluation and future behaviours (e.g. Baloglu–McCleary 1999, Echtner–Ritchie 1991) and that destination image and tourist loyalty are multi-dimensional constructs with derivative measurements (Zhang et al. 2014). Previous studies have used cognitive image, affective image, overall image or different combinations of the three as proxies for destination image (Baloglu–McCleary 1999, Chen–Tsai 2007). Destination image is 'a totality of impressions, beliefs, ideas, expectations, and feelings accumulated toward a place over time' (Zhang et al. 2014, p. 215). Martín and del Bosque (2008) also summarise 20 definitions of destination image. Despite the different definitional constructions, destination image is generally interpreted as a compilation of beliefs and impressions based on information processed from various sources over time, resulting in a mental representation of the attributes and benefits sought from a destination (e.g. Crompton 1979, Gartner 1993). The three-component approach represents a more commonly practiced theoretical perspective in image studies (e.g. Gartner 1993). It holds that destination image is composed of cognitive, affective and conative components (Zhang et al. 2014). The cognitive component refers to the beliefs and knowledge a tourist holds of the destination's attributes (Assaker et al. 2011). The affective component represents the feelings or emotional responses towards the various features of a place. The conative aspect of destination image is the behavioural manifestation on the tourist's side and can be understood as on-site consumption behaviours (Zabkar et al. 2010). The three components represent a layered succession in image formation; that is, a tourist forms the cognitive image, based on which he/she develops the affective image and then the conative image (Chen–Phou 2013).

Destination image plays two important roles in behaviours: (1) to influence the destination choice decision-making process and (2) to condition the after-decision-making behaviours, including participation (on-site experience), evaluation (satisfaction) and future behavioural intentions (intention to revisit and willingness to recommend) (Ashworth–Goodall 1988, Bigné et al. 2001, Cooper et al. 1993, Lee et al. 2005, Mansfeld 1992, Jalilvand et al. 2012). On-site experience can be represented mainly as the perceived trip quality based on the comparison between expectation and actual performance. However, the influence of destination image on after-decision-making behaviours has been neglected in previous studies, except those by Bigné et al. (2001) and Lee et al. (2005). Following the marketing perspective, Lee et al. (2005) argue that individuals having a favourable destination image would perceive their on-site experiences (i.e. trip quality) positively, which in turn would lead to greater satisfaction levels. Finally, existing studies on the relationship between destination image and visitor satisfaction suggest that there is a correlation between image and individual tourist spending (Arnegger–Herz 2016).

Destination image is very closely linked to 'expectation of destination attributes', and the destination image, in turn, affects visitors' intentions (Wang et al. 2010, Liu et al. 2013). In addition, their perceptions of practical travel experience affect their future intention to visit the destination (Chon 1992). The attractiveness of a destination – and the choice of it – will greatly depend on its image. Wang et al. (2010), in their seminal work on destination marketing and management, categorise destination image measurement as a necessary step in securing destination competitiveness, describing it as the consequence of travel behaviour information. It can be hypothesised that the castle hotel guests' destination will be affected by the aspects described above.

H2 Guests' perception of destination image will be largely influenced by their prior historical interest.

Regional impact (RI)

'Regional impact' is a hypothesised hybrid construct derived from various conceptual elements, which are explained in the following segment of the paper. For the purposes of this survey, is operationalised as the combination of sense of place, overall impact of destination and assessment of the significance the destination in the constitution of the impact of the area where the destination is situated.

A number of disciplines, both pure and applied, such as sociology, psychology, geography, ecology and even literary and cultural studies, have contributed to the conceptualisation of place and sense of place (George–George 2004). Many authors have investigated visitor attachment to leisure, recreation and tourism places (Lewicka 2008). The phrase 'sense of place' is typically used to refer to an individual's ability to develop feelings of connection to particular settings based on an amalgamation of use, attentiveness and emotion (Stokowski 2002). Thus, a destination *is* a destination because of the sense that it is not only a differentiated space but also a place capable of satisfying a certain set of touristic needs: functional or utilitarian, identity or emotive, contextual or situational and so on (Young–Light 2001). In other words, sense of place in the context of tourism involves an enduring commitment on the part of the tourist in their thoughts, feelings and behavioural responses to a destination; these are important elements with values. That is, the setting combined with what a person brings to it forms the essential sense of place. Place attachment is operationalised in terms of the meanings, beliefs, symbols, values and feelings that individuals or groups associate with it (Hallak et al. 2012).

Social construct theory also employs the underlying dimension of *social bonds* in understanding tourist motivation, attitude and future behaviour. Neuvonen et al. (2010) found that positive place attachment and the intent to visit related attractions loaded the highest ($p = 0.584$) in their 'social bonds' construct, predicting future intention to return to the destination. They posit that because place attachment seems to have an important role in the decision to revisit, managers should be encouraged to develop recreation services that deepen place attachment. Walls (2012) found empirical support for the effect of the physical environment latent construct on the social/self-concept value dimension in his survey of consumer value in hospitality destinations. Perceived physical environment seems to be an important factor in generating positive on-site experiences, and design (external and internal) explained the highest variance in the physical environment's construct (48.8 %).

A destination's image can be developed based on the estimation or understanding of a region's characteristics, but this is equally true for the contribution of the destination towards the building of a whole region's image (Jalilvand et al. 2012). Factors decisive to the positive impact of heritage-related projects and activities (such as restoration of historic buildings and provision of hotel services in them) on local development include their long-term orientation and stability; involvement of the local community, both in the provision of tourism services and in the exploitation of heritage for other purposes; capacity of a given area to produce ancillary goods and services; and links and dependencies between different local heritage-related activities (Andereck et al. 2005). The influence of heritage sites and projects on local and regional development may thus be economic, social or ecological, both quantitative and qualitative. It may be potentially positive but in practice neutral, or even negative, if awareness of the heritage resources is poor or they are unsustainably exploited (Murzyn–Kupisz 2013).

Understanding the impact of the castle hotel destinations on the regional level is important to destination marketers and managers. The economic effectiveness of heritage sites can be examined through immediate (direct and indirect) effects and factors that affect the region's economy. Direct economic effects are generated by tourism into the region. Heritage sites may also affect the behaviour of people and organisations operating in the region that are significant for the region's economy (Aas et al. 2005, Yuksel et al. 2010). These effects may be purely economic or may be benefits that inhabitants of the region feel they gain from the cultural sites, their willingness to pay, willingness to accept services and public funding of cultural services at the chosen cultural sites (Rollero–De Piccoli 2010, Hallak et al. 2012).

Based on the above segments on the relevant literature on visitors' motivation and visitation patterns, the following hypotheses relating to the assessment of the regional impact have been formulated, as transposed to the guests of the castle hotels:

H4 Guests' historical interest will predict their perception of how the destinations contribute to the regional impact.

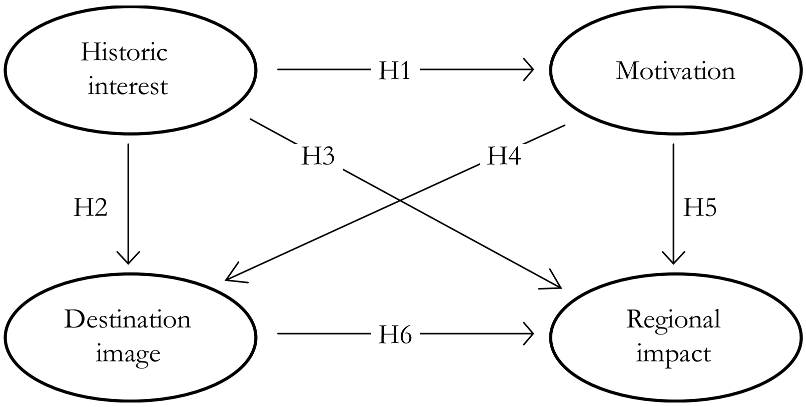
H5 Guests' motivation for destination selection will predict their perception of how the destinations contribute to the regional impact.

H6 Guests' perception of destination image will predict their perception of how the destinations contribute to the regional impact.

The above hypotheses will be tested on castle hotel guests who are not only visitors or tourists to the destination but also stay overnight. They gather a more encompassing experience than visitors do. The conceptual model below will be tested to provide an insight into the guests' perception of the regional impact of the castle hotels:

Figure 1

Conceptual model of regional impact formation with hypotheses



Source: Author's own design.

Research design

Study destination characteristics

Castles and country houses of the aristocracy of the Austro-Hungarian Empire

The abundance of castles and mansions in the present territory of the Republic of Hungary can be explained by the fact that the nobility, the proprietors of these properties, made up a proportion of the population larger than that of anywhere else in Europe other than Poland. The majority of Hungarian castles and mansions were built – for reasons of defence from intruders – in mountainous areas such as the northeastern region of the country during the 18th and 19th centuries. Once, there were 4,500 castles and mansions in the territory of the Kingdom of Hungary;

however, many have been ruined in the tribulation of history. At the end of the 20th century, there were approximately 3,500 historical buildings left standing (National Trust of Monuments for Hungary 1992).

These buildings, due to the special status of the aristocracy, had been a prerequisite of the social standing and had always been focal points of the arts during previous centuries – almost all branches of the arts (architecture, design, interior decoration, painting, furniture making, sculpture, inlay, goldsmith's works and textiles) are represented. These residences provide an insight into the social stratification of the Hungarian noble families, their wide range of relationships, habits and life styles. Therefore, a castle can be an essence or a symbol of the national cultural heritage of the period in which it was built and decorated (Godsey 1999). They were also the centre of the period's theatrical, musical and scientific life. Moreover, castles became salons of literature, especially in the Reform era (the latter part of the 19th century), when they served as scenes of reading nights.

The services offered by the castles make visits to the area more attractive to tourists, even to those who do not use them as hotels but stay in other accommodations. Most castles organise a range of events open to the general public, such as balls, concerts, plays, exhibitions, antiques auctions and seasonal fairs, offering an additional, though rather elite, cultural and leisure experience for both local residents and outsiders. Establishments offering tourist accommodation in the area often refer to the palaces as important local cultural assets. The palace owners and managers have also recognised the advantages of visibly grouping similar establishments across the district and the benefits of cooperation, especially for the promotion of the entire area and broader efforts to preserve its unique cultural landscape.

The activities of the businesses in these historic residences are respectful of, and well inscribed into, the area's cultural landscape, appreciating and creatively using its ecological and cultural resources. As such, they are inspiring the rediscovery of the area's unique pre-war traditions and revival of tourism based on its picturesque landscape, processes which strengthen the overall competitive position of the district and region in the tourism market (Murzyn–Kupisz 2013).

In the area of observation, the NUTS-II statistical unit of Hungary, that is, the Northern Hungary region, there are currently 38 castles in government or commercial utilisation: 16 function as municipal historical heritage museums and 22 as accommodation. Of the latter, 12 castle hotels proper are in commercial use, operated by business entities; the remaining 10 are managed as various types of accommodations (lower category tourist bed-and-breakfasts, hunting lodges, etc.). It has been a requirement of this survey to find locations that are comparable in order to assure the reliability of the comparison of guests' attitudes and perceptions of a given environment. The hotels included in the survey – although belonging to different categories (four- and five-star commercial accommodations) and having varied room capacities – were built in the same period, bear similar architectural characteristics (for both exterior and interior design) and possess identical amenities:

- Geographical location: small villages in mountainous areas and number of residents less than 2,000,[1] except Tarcal (2,912 inhabitants).
- Minimum one-hour drive by car from the capital.
- Buildings older than 100 years and in private ownership.
- Properties included as Listed National Heritage Buildings and therefore highly protected.
- Buildings surrounded by large, landscaped parks.
- Amenities that include wellness and open-air sport facilities.
- Comprehensive information or exhibition on the architect, builder family and former utilisation of the castle on display.
- Availability of cultural, training and leisure programs and events.
- Year-round opening.
- Renovated or extended in the last ten years.

Questionnaire design, data collection and the sample

The research instrument used for this study was a structured questionnaire implemented through face-to-face interviews at the hotel locations. The questions discussed in this survey are taken from a longer questionnaire that was distributed to castle hotel guests at five locations. For this study, a purposive-based sample design was employed (Walls 2012), and the target group delineation was as follows: hotel guests, having stayed a minimum of one night in one of the five accommodations, regardless of the distance travelled, were included, while friends, visitors, relatives and those not staying overnight were excluded from participation.

The questionnaire was designed as a survey instrument, including all constructs of the proposed model to investigate the hypotheses. The questions in the questionnaire are based on a review of the literature and specific destination characteristics. The survey instrument was revised and finalised based on feedback from five tourism experts and a pilot sample of 25 postgraduate students studying a tourism management program. Thus, the content validity of the survey instrument was deemed adequate.

Measures

The questionnaire questions included the following measures (further explained by exemplary items in Table 1).

[1] Based on the census of 01.01.2010 (KSH).

Historical Interest

As a cognitive dimension of the pre-visit tourist attitude, 'historical interest' represents the castle hotel guests' general interest in historical subjects, as well as their propensity to visit heritage sites. It is hypothesised that guests, in their selection of a castle hotel destination, are influenced by their genuine interest in history. Due to the lack of a tested and validated scale of 'historical interest', the current scale has been derived from a review of the literature and careful analysis of existing scales found therein.

Motivation

For the purposes of the current survey, a combination of items of existing and validated scales in the relevant literature (George–George 2004, Walls 2012, Wang et al. 2010, Dolnicar 2008, and Ariffin–Maghzi 2012) has been used. The 'motivation' construct includes the following sub-dimensions:

- Historic experience: Historic experience refers to the guests' motivation to stay at a heritage accommodation that offers, through its exterior and interior design, furnishings and other amenities (such as exhibits of the history of the former owner aristocrat families, restaurant services by waiters and waitresses dressed in period costumes, concerts of period music and excursions organised and delivered in the style of the owners' period) a genuine insight into the period in history when the accommodation was built and the original owners maintained it. Due to the lack of validated scales in this domain, the author's own scale has been used.
- Hedonic experience: Hospitality literature offers an ample array of hedonic experience motivation scales (Beerli–Martin 2004, Chen–Hu 2009, Chunyang–Qu 2013, Walls 2012). Hedonic experience, for the purpose of this survey, signifies physical and affective items that in the minds of the pre-visit guests would make the stay more enjoyable (predominantly services – both the variety and quality of services and the expected satisfaction guests can derive from their post-visit experience of having been at a trendy destination;(Kay–Meyer 2013, Zabkar et al. 2010, Zhang et al. 2014, Liu et al. 2013, Chen–Tsai 2007).
- External factors: External factors are seen as crucial in tourism accommodation research (Liu–Wu–Morrison–Sia Juo Ling 2013). Morrison et al. (1996), Moscardo (1996) and Lim (2009) highlighted the importance of unique and special environments in tourist accommodations. Interior design and furnishings reflect a hotel's unique character (Lim 2009). Castle hotels are typically furnished with period furniture as the buildings, owing to the special status of the former owners, had been a prerequisite of social standing

and had always been the foci of the arts during previous centuries – almost all branches of the arts, such as architecture, design, interior decoration, painting, furniture making, sculpture, inlays, goldsmith's works and textiles, are represented.

Destination Image

This measure includes the perceived image of the destination, based on the assessment of its external characteristics, by the guests just having accomplished their on-site experience (Liu et al. 2013, Chen–Tsai 2007, Zhang et al. 2014). As the experience is fresh, they can provide immediate and live feedback on these characteristics; the experience might fade or otherwise be altered as time passes and other, new experiences overshadow the on-site experience (Jalilvand et al. 2012).

Regional Impact

This measure is conceptualised as the perceived importance of the destination in the formation of the impact of the region where it is situated (Beritelli et al. 2013). When broken down into single components, the 'regional image' is a compound of aspects from rather diverse domains: sense of place, place attachment (environmental psychology), cultural impact and economic impact (cultural and regional studies, respectively). Due to the lack of adequate scales, a new scale has been designed. Regional impact is measured in three distinct territorial or administrative areas as used in the NUTS (Nomenclature of Territorial Units for Statistics 2013) and LAU (Local Administrative Units 2013) classifications of the European Union. Settlement level refers to the municipality level, and micro-region level refers to LAU 1 region comprising 1–50 settlements with a population of 13,000–261,000 inhabitants stretching over an area of 2,552–1,000 km^2. Regional level refers to the NUTS-II statistical unit, which comprises of 13,428 km^2 in the area under investigation and has a population of 1,289,000 inhabitants.

Table 1

Descriptive statistics for measurement subscales

Construct	No. of Items	Sample items
Historical Interest (1 = strongly disagree to 5 = strongly agree	4	'I am genuinely interested in history.' 'I am genuinely interested in visiting castles.'
Motivation criteria (1 = strongly disagree to 5 = strongly agree)		
Historic experience	3	'I think a stay in a castle hotel is deeply embedded in history.'
Hedonic experience	3	'My main motivation for selecting the destination is the quality of services it offers.'
External factors	3	'My main motivation for selecting the destination is its location.' 'My main motivation for selecting the destination is its architectural style.'
Destination image (assessment: 1 = poor to 5 = outstanding)	3	'Please assess the architectural style of the building.'
Regional impact (assessment: 1 = negligible to 5 = significant)	3	'Please assess the impact of the castle hotel on the settlement level.' 'Please assess the impact of the castle hotel on the micro-region level.' 'Please assess the impact of the castle hotel on the regional level.'

Source: Author's own design.

Part 1 of the questionnaire deals with the measurement of destination image with 20 attributes extracted from previous studies (Baloglu–McCleary 1999, Beerli–Martin 2004, Etchner–Ritchie 1993, Walmsley–Young 1998). Part 2 deals with the measurement of destination quality with 20 items covering the five aspects of attractions: accessibility, amenities, activities, available packages and ancillary services (Buhalis 2000). Part 3 deals with the measurement of single-item overall satisfaction and two-item behavioural intentions (i.e. likeliness to revisit and willingness to recommend), following Bigné et al. (2001), Sirakaya et al. (2004) and Tian-Cole et al. (2002). Respondents are asked to indicate their agreement level for each item for the first three parts on a five-point Likert-type scale, from 'strongly disagree (L' 1)' to 'strongly agree (L' 5)'. Part 4 presents the respondents' demographic information with seven items, such as gender, age, education level, occupation, travel party and past visitation experience via a categorical scale. Data were subsequently analysed using the SmartPLS statistical software.

The interviews were conducted by tourism and hospitality undergraduate students selected based on academic criteria and under the guidance of the author. Hotel guests were approached by the researchers at the end of their stay once they had had the opportunity to gain an experience at the destination.

A pilot survey took place in March 2012, and the main data collection was conducted between early April and the end of June 2012, with Easter holidays, a traditional period for tourist travel, falling into the data collection period. The questionnaire was pre-tested mainly to examine the adequacy of the research instrument as well as the clarity of the questionnaire. The interviews were carried out mainly on weekends when there was a likelihood of higher visitor frequency at the destinations. A total of 360 valid questionnaires were collected. Our sample is, thus, a convenience sample; it was not our objective to reach a representative sample – as the visitors themselves (due to higher room rates) originate from more affluent layers of society – but to provide diversity among the personal attributes and perceptions. This diversity of tourists, in turn, enables the generalisation of the findings (Poria et al. 2006, p. 167). In addition, it should be noted that female guests were more approachable and more willing to reply.

Model analysis with SmartPLS

Analysis of the conceptual model was conducted through SmartPLS (Ringle–Wende–Alexander 2005) using two steps: (a) validating the outer model and (b) fitting the inner model (Chin 1998). The former was accomplished primarily through convergent and discriminant validity. SmartPLS offers an alternative method to traditional (covariance-based) Structural Equation Modelling (SEM) technique for modelling relationships among latent variables and generating path coefficients for structural models (Hair–Ringle–Sarstedt 2011). PLS-SEM is a causal modelling approach aimed at maximising the explained variance of the dependent latent constructs. This is contrary to CB-SEM's objective of reproducing the theoretical covariance matrix without focusing on the explained variance.

Sample characteristics

Features such as gender, age, education level and length of stay are illustrated in Table 2 below.

Table 2

Demographic characteristics of the sample

Variable	Per cent (%)
Gender	Male: 39.5
	Female: 60.5
Age	
Under 18 years	6.7
19–24 years	18.4
25–44 years	43.1
45–64 years	24.7
65+ years	7.1
Education level	
Primary	9.1
Secondary	22.6
Vocational	14.3
Tertiary	53.6
Other	0.4
Length of stay	
One night	21.8
Two to three nights in the week	18.6
Long weekend	51.9
Full week	5.8
Over a week	1.9
Repeat guests	27.8

Source: Author's own calculations.

Outer model analysis

The quality of the reflective measures was assessed using the convergent validity and discriminant validity of the latent variables.

Table 3

Outer model analysis

Outer loadings (Cronbach's α)	Constructs: Historical Interest (0.7629)	Motivation (0.7611)	Destination Image (0.7749)	Regional Impact (0.8784)
(12) Connecting with one's history offering stability in a crisis	0.7208			
(14) Genuine interest in history	0.7706			
(19) Stays in historic accommodations embedded in history	0.8005			
(9) Interest in visiting historical heritage sites	0.7619			
(8A)Trendy destination		0.5686		
(8B) Setting		0.4064		
(8C) Location		0.3787		
(8D) Architectural style		0.7023		
(8E) Service variety		0.6257		
(8H) Service quality		0.6315		
(8F) Reviving history in a castle hotel		0.7558		
(8G) Historic interior design		0.7297		
(32) Assess external image of the destination			0.7948	
(33) Assess internal image of the destination			0.8419	
(34) Assess park of the destination			0.8438	
(32) Impact on settlement level image				0.8872
(33) Impact on micro-region level image				0.9339
(34) Impact on regional level image				0.8686

Source: Author's own calculations.

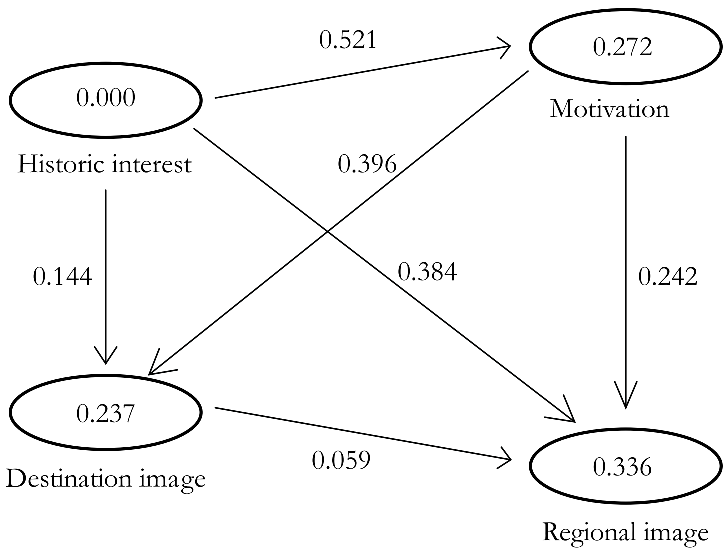
The outer model analysis revealed important features of the latent constructs. Based on the guests' perception of the destination characteristics, *historical interest* is mostly explained by their perception of the stay in the castle hotel as being embedded in history (α=0.8005). *Motivations* is mostly explained by the item suggesting that the guests want to revive history in a castle hotel (α=0.7558). *Destination image* was best explained by the item that suggested that the landscaped park, a conventional attribute of these castle hotels and usually extended over a large stretch of land, had the highest explanatory power (α=0.8438). Finally, among the items for *regional image*, guests identified the impact of the castle hotel on the micro-regional level as being the most important. As an initial interpretation of the outer model analysis, it can be said that castle hotel guests do believe that by staying at such accommodations, they can have a grasp of the times when the original owners built the edifice and used it for their everyday living and can thus share this experience with them. Second, the dominating *motivation* factor is the revival of a historic period, and this factor, together with other cognitive factors such as appreciation of the architectural style of the building, are more important than the hedonic factors. Third, the destination image is found to be dominated by the assessment of the landscaped park, an essential amenity of the destination. It appears that the image of the destination is characterised, if not defined, by this very amenity. Fourth, castle hotel destinations' regional impact is best explained by their impact on the micro-regional level, meaning that their impact, both socio-economic and cultural, is felt in a much larger spatial area than the destination itself. These findings have several implications for the marketing and management of destinations and will be discussed in the *implications* section.

Results summary of the model

The structural equation modelling procedure resulted in the predictive model presented in Figure 2; the corresponding quality assessment results are listed in Table 4.

Figure 2

Predictive model for regional impact formation



Source: Author's own design and calculations.
Note that values inside the construct circles represent R^2, whereas values on the paths represent path coefficients.

Quality assessment criteria reveal that the model has an excellent fit. The first criterion to be evaluated is typically internal consistency reliability. The traditional criterion for internal consistency is Cronbach's α, which provides an estimate of the reliability based on the inter-correlations of the observed indicator variables (Hair et al. 2013). As Cronbach's α assumes that all the indicators are equally reliable, is sensitive to the number of items in the scale and generally tends to underestimate the internal consistency reliability, the SmartPLS model uses another measure called composite reliability, its recommended threshold being 0.60 to 0.70 in exploratory research and between 0.70 and 0.90 in more advanced stages of research. As Table 4 shows, the individual constructs of the measurement model satisfy the threshold criteria for both Cronbach's α and composite reliability. The other measure of measurement model assessment is convergent validity, which refers to the extent to which measures correlate positively with alternative measures of the same construct, the logic being that items that are indicators of a specific construct should converge or share a high proportion of variance. In the current measurement model, both the outer loadings of the constructs and the average variance extracted (AVE) satisfy the threshold criteria of AVE > 0.50 and outer loadings of the constructs above 0.40. Location (outer loading 0.3787) has not been eliminated because its elimination did not lead to an increase in either the composite reliability or AVE (Hair et al. 2013). Discriminant validity has been assessed by examining the cross loadings of the indicators, and the indicators' outer loading on the associated construct should be greater than all of its loadings on other constructs.

Table 4

Structural model quality assessment

Latent variables	AVE	Composite reliability	R^2	Cronbach's α
Historical Interest	0.5837	0.8485	0	0.7629
Motivations	0.3774	0.8222	0.2718	0.7611
Destination Image	0.6841	0.8665	0.2371	0.7749
Regional Impact	0.8046	0.9251	0.3358	0.8784

Source: Author's own calculations.

Two main indicators were used to evaluate the relationships between the paths in the PLS structural model: R^2 (coefficient of determination) values and the standardised path coefficient. The bootstrapping method was used to test the significance of paths in the study model (whether path coefficients differ significantly from zero). Figure 2 and Table 5 show the results of testing the paths between model constructs.

The first critical criterion for assessing a PLS structural model is each endogenous latent variable's R^2. R^2 measures the relationship of a latent variable's explained variance to its total variance by the exogenous latent variables in the model.

Regarding measuring the power of R^2, three levels were suggested: 0.670, substantial; 0.333, moderate; and 0.190, weak (Chin 1998, Urbach–Ahlemann 2010). In other words, the dependent variable *regional impact* explains 33.5 % of the total variance of the measurement model. While R^2 for *regional impact* had moderate power, *motivations* and *destination image* had slightly less moderate power in any case above the 1.90 threshold for weak power. *Historical interest*, being an exogenous construct, does not have an R^2 value.

Three levels of cut-off were adopted to assess the strength of the path coefficients: 0.2, weak; 0.2–0.5, moderate; and more than 0.5, strong (Cohen 1988, Sridharan et al. 2010). The analysis substantiates that all relationships in the structural model have statistically significant estimates.

Discussion

In order to further reveal the model's latent characteristics and structures, total t-values and total affects have been measured and yielded the results presented in Table 6.

Table 6

Structural model path coefficients, total effects and hypotheses test results

Relationships	Path coefficient	Strength	Total effect	Strength	t-value	Hypothesis accepted
Historical Interest -> Motivations	0.521	strong	0.521	strong	45.7303***	yes
Historical Interest -> Destination Image	0.144	weak	0.350	moderate	27.1225***	yes
Historical Interest -> Regional Image	0.384	moderate	0.530	strong	48.0984***	yes
Motivations -> Destination Image	0.396	moderate	0.396	moderate	25.6671***	yes
Motivations -> Regional Image	0.242	moderate	0.265	moderate	16.9517***	yes
Destination Image -> Regional Impact	0.059	weak	0.059	weak	3.8197***	yes

Source: Author's own calculations *** $p < 0.01$ level.

In the next phase, the bootstrapping method was employed to assess the significance of path coefficients. Critical values for the two-tailed tests are 1.65 (significance level = 10 %), 1.96 (significance level = 5 %) and 2.57 (significance level = 1 %). As in our measurement model, all the observed paths proved significant at the 0.01 level, and all six hypotheses as depicted in Figure 1 and listed in Table 6 were accepted.

Destination image has been found to be most significantly predicted by *motivation* factors (0.396), followed by *historical interest* (total effect: 0.350, both values having moderate strength; Cohen 1998). *Regional impact* values have been found to be as follows: micro-region level (0.9339), followed by settlement level (0.8872) and finally regional level (0.8686).

Observing the path model coefficients as displayed in Table 6, we can conclude that the strongest predictive correlation prevails between *historical interest* and *motivations* (0.521), followed by *historical interest* predicting *regional image* (total effect being higher than the actual path coefficient by 0.146, thus the mediating effects of the other latent constructs cannot be neglected), *motivations* predicting *destination image*, *motivations* predicting *regional impact* (mediating effect: 0.023) and finally *destination image* predicting *regional image*. The most significant predictor of the perceived *regional impact* is thus *historical interest* (total effect: 0.530), meaning that visitors' prior cognitive knowledge predicts their view of the importance the destination has in the regional image. Mediating effects, detected in three instances, stand for the indirect relationships between the latent constructs. Their existence signifies that (1) *destination image* is predicted by *historical interest* by the interplay of *motivations* and (2) *regional impact* is predicted by *historical interest* through the interaction of *destination image* and *motivations*.

It ensues from the results that the visitors assess that the castle hotel destinations, beyond the obvious influence they exert on the socio-economic life of the settlement they are situated in, do indeed have a wider circle of impact. This impact is most palpable on the micro-region level, signifying that the destinations – according to the visitors – function as micro-region economic hubs in terms of provision of supplies, labour and services. The recognition of this sub-region function can help destination marketers and managers in many ways, as discussed below in the Conclusion section.

The results of the survey align with findings pertaining to various domains in the literature of tourist/visitor behaviour research, among which the most notable are cognitive interests and attitudes, place attachment and formation of the destination image, in order. For example, Chunyang and Qu (2013), working with their conceptual model depicting the relationship between travel motivation, tourism destination image and tourism expectation, found that (a) the cognitive image of the destination significantly influences the affective image of the destination; (b) travel motivation has a direct and indirect effect on tourist expectation, mediated by the cognitive image of the destination; and (c) cognitive image of the destination has a direct and indirect effect on tourist expectation, mediated by the affective image of the destination.

Conclusion

This study is the first to introduce motivation as a multidimensional and multifaceted construct including historical experience and test it in the castle hotel environment. It follows from the finding that castle hotel guests' primary motivation is the revival of a period in history corresponding to the era in which the original owners of the edifice in question lived there. It is also the first to design and deploy a predictive model describing the significance of the regional impact of such destinations. The significance of this contribution lies in its theoretical and practical implications. Owing to the regional impact, the theoretical implication lies in the provision of a tool that can be used to assess the level of territorial impact of the destination has, and this, in turn, can contribute to the understanding of destination characteristics in terms of territorial delineation. Based on the magnitude of the socio-economic and cultural impact of castle hotels, it is unquestionable that they constitute autonomous destinations.

Implications for management

Understanding the guests of any given destination will help marketers and managers to appropriately design and deliver experiences. At first glance, the findings of the study identified the most important factors in both motivation categories. Castle hotel guests value the revival of an historical experience at the accommodation above any other motivation, including hedonistic motivations such as quality and diversity of services. Marketing and management can enhance the experience by adding or diversifying the historic aspect of the stay and fully deploying the characteristics of the physical structures. Destination image was best characterised by the landscaped gardens, which are a fundamental amenity of each castle. The experience of the gardens can also be enhanced by additional services or programs that are articulated around this feature.

The study equally revealed that guests assessed the destination's impact to be most relevant on the micro-region level, a territorial unit well above the actual destination's land area. This signifies that destinations' cultural as well as socio-economic impact is felt on the micro-regional level. Wang (2011, p. 14) states that the DMO is the entity responsible for marketing the whole destination by 'treating the destination as one entity' and 'positioning the destination as one place' for people to visit. It must equally assume the role of the advocate to the tourism industry and convey the message of the importance of tourism, its impact on the area and local economy and the advantages of tourism to the local economy.

The study tested the validity of a novel predictive model that can be used to analyse significant direct and indirect relationships between latent constructs, and the results proved the model to have an excellent fit. The model can, therefore, be a useful tool when assessing the significance of various perception factors of destination guests and/or visitors.

Contributions to practice can be made based on the knowledge gained from the findings, namely

1) the relative importance of motivations customers have when deciding on a heritage hospitality destination;
2) heritage as a discrete motivation and attractor when visiting a hospitality destination;
3) the importance of place attachment as a factor in attracting visitors; and

4) the conceptual model used to assess the impact on the socio-economic and cultural life of a given territorial administrative unit – in the case of our sample population, it is the micro-region.

Limitations and future research directions

Although the present study significantly contributed to the literature on visitor behaviour and specifically to the understanding of how interest, motivation and destination image can predict the perceived image of regional impact, it has several limitations. The study made a tentative bid to shed light on the possibilities of customer segmentation in view of better understanding of consumer/tourist behaviour with respect to memorable experience (Wang 2011, Walls 2012). A sound knowledge of micro-level characteristics of these touristic attractions, together with destination characteristics, can contribute to effective planning and delivery of marketing: combining existing and proposed products can lead to memorable and authentic experiences.

First, the addition of more castle hotel/heritage destinations in different geographical regions and/or an international scope would have increased the external validity of the results. Second, the current study analysed the motivations of domestic guests only. Thus, future research may be conducted on different geographical locations, both domestically and internationally, examining domestic and international guests' motivations. The validity of the findings can be substantially increased through an international scope where the range of motivation factors can be extended and relevant cultural differences in consumer behaviour can be detected. Notably, recent studies on visitor information search and distribution emphasise the importance of understanding visitors' pre-trip and at-destination experience (Pearce 2014). A further research project could be designed to explore geographical embeddedness, in the framework of a holistic view of destinations, depicted by regional impact in this survey.

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Identifying settlements involved in Hungary's transit traffic

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As one of the transit countries in Europe, Hungary plays a significant role both in the east-west and north-south passenger traffic of the continent. Approximately one-third of foreigners (14 million) arriving yearly in Hungary travel through the country. A turnover like this can generate changes at the micro level in the everyday life of affected settlements and have social, economic, and physical impacts. In order to examine this, it is important to identify settlements involved in transit. The study introduces methodological approaches that can be applied to outline the crystallising points of transit tourism in Hungary. With the help of GIS-based delineation and the logit model the settlements involved in transit have been identified. The study concluded that settlements involved in transit traffic (1) are located at the intersections of roads enabling the shortest travel time between different border sections, (2) possess a motorway junction, and (3) are situated at the intersection of two main roads. Finally, it is shown that transit impacts the local economy of these settlements.

Keywords:
transit tourism,
tourist spending,
Hungary

Introduction

Hungary is a transit country, in terms of not only freight transport but also passenger traffic. Approximately one-third of foreigners arriving yearly in Hungary are just visitors on transit to another country. With regard to Hungary's central location within East-Central Europe, its seven neighbouring countries (of which three belong to the Schengen Area, which provides transit without border control), accessibility of the European road networks and volume of international transit traffic present a significant challenge to regions involved in this phenomenon. Transit traffic does not necessarily appear in a hermetically sealed corridor (such as motorways intersecting borders), which is almost independent from the socio-geographic environment, but rather it frequently becomes part of the local milieu. The nature of transit traffic presupposes stopping occasionally (when the driver and passengers take rest), having a meal and filling the car with petrol, which takes place either at rest stops along motorways that provide appropriate infrastructure or in settlements, that is, in the local residents' milieu. Therefore, transit is a contradictory phenomenon: it can be interpreted as a temporary traveling activity, which is fast and short between the place of departure and the destination. However, it also involves the use of the tourism infrastructure of affected regions with varying intensity.

Since 2014, the Hungarian Central Statistical Office has been measuring the travelling activity of foreigners not involved in freight transport, which gives us a relatively reliable picture of the characteristics of transit traffic at the macro level (HCSO 2013). We are aware that the proportion of transit passengers between 2004 and 2011 increased from 29% to 34%, their number exceeding 14 million. Their expenditure was 95 billion forints in 2011, which accounted for 8% of the expenditure of foreigners staying in Hungary. The figures speak for themselves: a turnover like this can generate changes at the micro level in the everyday life of affected settlements and have social, economic and physical impacts (Puczkó–Rátz 1998). In order to examine these changes and impacts, it is important to identify the settlements involved in transit traffic, that is, review the towns and villages where the demand of transit passengers is realised (presumably due to their location and infra- and suprastructure facilities).

The present study seeks to identify methodological approaches that can be applied to outline the crystallising points of transit traffic in Hungary and identify settlements where the characteristics of invisible tourism related to transit traffic can be investigated. In addition, the possibilities and limitations of quantifying the economic impacts of transit are examined in settlements involved in the phenomenon. Although the study examines the phenomenon of transit traffic primarily at the level of settlements, we should not forget that impacts (due to the multiplier effect) appear on the whole economy.

Theoretical background

Even though the phenomenon of transit traffic appears in many European countries, the study of this type of mobility does not belong to mainstream Hungarian and international research focusing on transportation, migration or tourism.

Transit traffic, viewed from the perspective of transportation geography, focuses primarily on road and rail freight transport. Some studies focus on the infrastructure and its development (Hall et al. 1991, Erdősi 2005, Fromhold–Eisebith 2007) and the logistics (Kerschner–Petrovitsch 1998) of transit traffic, whereas others deal with costs (Kraus 1991, Fielding 1995, Bulis–Skapars 2013), environmental issues (Kalas 1992) and geopolitical aspects (Fleischer 2007, Ruppert 2007). Researchers are more interested in urban transit (Viton 1992, Knowles 2012) than the characteristics of international cross-border freight transportation.

Studies related to migration make up a significant group within the literature on transit, which discuss the characteristics of legal and illegal traffic. Although works dealing with the relationship between transit and legal migration primarily focus on the load of the transportation infrastructure of regions functioning as corridors (Williams–Baláz 2009), in case of the illegal migration flows of refugees (Dacyl 2002), health care (Castañeda 2011) and various socio-economic questions (DeMaria Harney 2011) are in the forefront.

Tourism researchers pay surprisingly little attention to transit-related issues, which is probably due to the statistical approach of the notion (Próbáld 2002). Studies that realise the touristic aspects of the behaviour of transit passengers or the role of the infra- and suprastructure created for the fulfilment of their demands are hard to find. This research theme primarily appears in studies discussing the tourism of former socialist countries in East-Central Europe and Southeast Europe, wherein the flows of guest workers to Western Europe are also highlighted (Bakic 1988, Johnson 1995, Baláz–Mitsutake 1998). Microstates with special geographical locations are also involved in international transit, among which Gibraltar has an outstanding position in passenger traffic arriving from Spain and heading towards North Africa (Seekings 1993). Transit plays a decisive role in not only land transport but also air transport; for example, retail establishments located in transit areas of airports play a role in passing transit passengers' time and motivating their spending (Achen–Klein 2002). Researchers are also interested in measuring transit traffic; although it cannot replace classical traffic counts, useful additional information can still be gathered by registering the spatial and temporal characteristics of phone calls (Ma et al. 2013). Finally, the special touristic behaviour of travellers using recreation vehicles is still an unknown area in the relationship between tourism and transit (Green 1978).

Transit as crypto-mobility

Edit Lettrich's (1970) dissertation on the geography of Austria uses the term 'Europe's transit corridor' for the Alpine state. Due to the favourable processes (especially the introduction of the free movement and development of the infrastructure that contribute to the deepening of the integration) following the eastern enlargement of the European Union (EU 2004, 2007), the term 'transit country' cannot only be used for Austria but also for Slovenia, the Czech Republic and Hungary. Besides the east-west and north-south freight transport, the role of the cross-border flow of the workforce and demand for tourism in the Mediterranean region is becoming more important. Consequently, transit is East-Central Europe's special characteristic feature, as countries in the region experience a continuous increase in the volume of transit traffic due to the enlargement of the Schengen Area and development of the road network. EU professionals have also realised the touristic aspects of the phenomenon, and, among other things, they emphasise the need for the measurement of transit. Article 5 of the new EU Regulation[1] says the following with the aim to renew the methodology of tourism statistics:

> *'…the growing importance of short trips and same-day visits contributing substantially in many regions or countries to the income from tourism […] means that the production of tourism statistics should be adapted.'*

Thus, the former interpretation of tourism, which supposes an overnight stay, should be widened, whereby trips lasting for less than 24 hours, such as excursions (shopping and visiting friends and relatives) realised chiefly in border regions and transit should also be taken into account. As the paradigm of tourism (Michalkó 2012) excludes the discussion of the demand and supply stemming from the needs of participants in freight transport under the aegis of tourism, freight traffic should be disregarded. Nevertheless, it should be noted that road corridors for freight traffic contain numerous infra- and suprastructure facilities that truck drivers also use. Thus, petrol stations with complex services, accommodation and catering establishments along the roads not only fulfil the demand of passengers but also freight traffic. Therefore, an examination should be conducted in this context as well, even though the demand from freight traffic is not regarded as part of tourism expenditure.

If transit appearing in passenger traffic is discussed under tourism, then it is presupposed that it has (as in the case of conventional tourism mobility) important crystallising points. However, while a stay at a registered accommodation establishment is included in tourism statistics, services used during non-conventional tourism mobility rarely appear in databases (suitable for spatial and temporal comparisons). Therefore, in order to explore the geographical aspects of transit, a methodological apparatus needs to be created, which takes into account the special characteristic features of the phenomenon and is based on a statistically measurable fact. This is a serious challenge, as crypto-mobility, that is, a quasi-invisible travelling activity should be made visible. In order to achieve this goal, we should start with special characteristic features of transit that grab the moment of that stops occurring due to any reason. Buying fuel and shopping in retail establishments certainly belong to this category, and we should also not forget about visiting tourist attractions and, in some cases, staying in accommodation establishments.

[1] Regulation (EU) No 692/2011 of the European Parliament and the Council of 6 July 2011, concerning European statistics on tourism and repealing Council Directive 95/57/EC.

It is strange, but staying in accommodation establishments makes it possible to detect crypto-mobility. As there are no statistics on the number of visits to settlements, reliable estimates of the number of visitors arriving in settlements can only be made by considering the number of overnight guests in registered accommodation establishments. This is particularly true of points of the tourism space that do not possess infrastructure (e.g. spas or museums) that would enable the counting of visitors. In these settlements, the number of visitors can only be deduced from the turnover of registered accommodation establishments. During the creation of the methodological apparatus, we should start with the special crypto-mobile characteristic feature that supposes that more intensive transit activity can be detected in settlements where some transit passengers stay in accommodation establishments. The hypothesis can also be formulated, as transit will be more intensive where some transit passengers stay a night; that is, peak points will mark the group of settlements involved in the phenomenon.

Methodological advances

Identifying settlements involved in transit using GIS techniques

The first step of the investigation was to identify the group of settlements that could be involved in transit. During the identification process, GIS techniques were applied. The following aspects were taken into account during the identification process:

a) If a transit passenger enters Hungary at any border crossing point, then he/she leaves the country at a border section other from which he/she arrived.

b) Based on the nature of transit, it is presupposed that transit passengers choose the route that offers the shortest travel time between the point of entrance and exit

Based on these conditions, the shortest travel times among all the border-crossing points[2] of Hungary were calculated. Settlements along each route were sorted and summed up. (It was suggested that not only settlements along roads but also neighbouring settlements could profit from transit. However, this phenomenon was regarded as exceptional and/or isolated; therefore, the original framework of the identification was considered to be adequate.) *Based on the selection process, 956 out of the 3,152 settlements in Hungary were involved in the investigation; in other words, these settlements were regarded as potential crystallising points of transit.* Further investigation was conducted among these settlements.

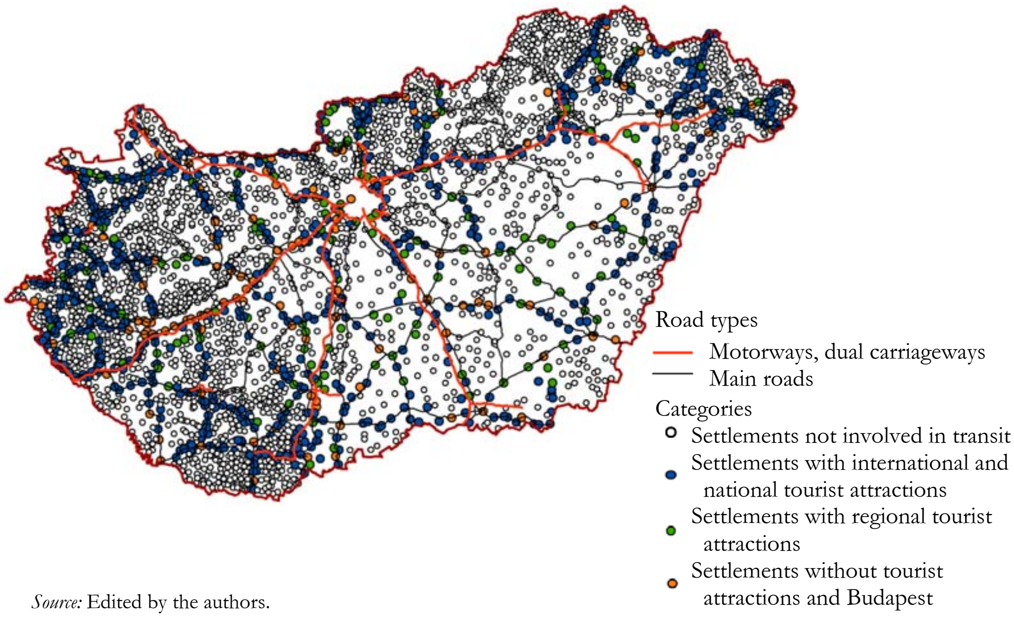
[2] These include all border-crossing points included in the questionnaire applied by the HCSO called 'Foreigners' tourism and other expenditures in Hungary (OSAP 1943)'. We did not want to make distinctions between these border-crossing points, even though we were aware that at some border-crossing points, transit is not present and only conventional cross-border traffic appears. Theoretically, such a narrowing could be legitimate; however, it would have made the selection process attackable.

Exploring the role of tourism by expert judgement

The 956 settlements included in the study were categorised into three groups based on the expert's judgement[3] of the role of their tourist attractions. The first group comprised settlements with international and national tourist attractions; the second group contained regional attractions; and the third group included settlements without significant tourist attractions.

Figure 1

Settlements included in the study based on their tourist attractions



Source: Edited by the authors.

[3] We recognise that the introduction of the methodology of expert judgement for the evaluation of tourist attractions would significantly exceed the scope of the present study; therefore, at this point, only the most important cornerstones of the evaluation process are presented. During the work, we started with the recommendations of the methodological manual (compiled by Gábor Michalkó and Tamara Rátz) for the systematic cataloguing and assessment of Hungary's tourist attractions published in 2006 under the coordination of the Hungarian Tourism Ltd. The following factors were used for categorising tourist attractions: regulations (e.g. Act CXII of 2000 on the Adoption of the Spatial Plan of Lake Balaton Resort and the Lake Balaton Regional Development Rules), official databases (e.g. the OGYFI register of the National Public Health and Medical Officer Service), surveys and registers of the HCSO (e.g. number of guest nights and supply of spa and wellness hotels), ratings published by professional organizations (e.g. list of rated festivals by the Hungarian Festival Association) and websites of settlements. For instance, settlements were given international and national ratings if the guest turnover requiring accommodation was dominated by foreign demand and if they possessed the highest rankings in databases (e.g. settlements along the shore of Lake Balaton, spas, wellness hotels, and top-rated festivals). Other towns and villages were grouped into the category of settlements with regional tourist attractions that possessed lower rankings in the reviewed sources (e.g. towns located further away from Lake Balaton, settlements without a spa, but having medical water for bathing, festivals with good rankings). Settlements that were not included in the reviewed databases and did not identify tourist attractions on their homepages were grouped into the category of settlements without significant tourist attractions.

First, we wanted to find whether there are anomalies in which the tourism activity of a settlement significantly differs from its role deduced from the settlement's tourist attractions.[4] In order to analyse this, the revenues of accommodation establishments of affected settlements were reviewed according to the categories of tourist attractions. Revenues between 2008 and 2011 are shown in Table 1.

Table 1

Number of settlements included in the study according to revenues and categories of tourist attractions

(number of settlements)

Category/revenues (HUF)	0–5 million	5–25 million	25–50 million	50–100 million	100–1000 million	Above 1000 million	Sum total
1 (without significant tourist attraction)	584	71	29	6	3	1	694
2 (regional attraction)	45	25	17	17	31	5	140
3 (national or international attraction)	14	7	12	7	53	29	122
Sum total	*643*	*103*	*58*	*30*	*87*	*35*	*956*

Source: Calculations by the authors.

The strength of the stochastic correlation between qualitative and quantitative variables is measured by association indices (Cramer 1946, Everitt 2002).

In this case, the independence of variables (X and Y) is measured by the following:

$$\Psi^2 = \sum_{i=1}^{I}\sum_{j=1}^{J}\frac{(p_{ij} - p_{i.}\cdot p_{.j})^2}{p_{i.}\cdot p_{.j}},$$

where pij=P(X=xi, Y=yj), i=1,2,….I, and j=1,2,…, J.

By the normalisation of Φ^2, we get the following statistics (Davenport et al. 1991): Pearson's correlation:

$$P = \sqrt{\frac{\Psi^2}{\Psi^2 + 1}}$$

Cramér's V:

$$T = \sqrt{\frac{\Psi^2}{\sqrt{(I-1)\cdot(J-1)}}}$$

[4] When a settlement possesses international, national, or regional tourist attractions, then it is logical that the volume and structure of guest turnover generated by it is different. However, when there is no attraction worth visiting, overnight guests staying in registered accommodation establishments use the primary tourism suprastructure of the settlement for other purposes. In our assumption, this activity is linked to transit.

According to our calculations based on the above theory P=0.35, T=0.21. In other words, only a moderate stochastic relationship has been found between the tourist attraction and the revenue. *That is, it has been shown that there is no functional relationship between the role of tourist attractions and tourist revenues. In fact, only a loose stochastic relationship can be found.*

Identifying settlements affected by transit

In most cases at the level of settlements, tourist attractions and revenues are proportional to each other, but significant anomalies can be observed (Table 2). Two directions of the differences between the variables above can be distinguished. In the first case, the tourist attraction is much greater than the revenue (blue colour), while in the second case, revenues are significantly higher than the tourist attractions (red colour). In this study, the latter group is dealt with in detail.

Seventy-five settlements have been found (Table 2 shows settlements without significant tourist attractions, where the revenue of accommodation establishments was over 25 million forints and settlements with a regional tourist attraction, where the above revenue was over 100 million forints), where unambiguously more revenue is realised than would be logical according to the paradigms of tourism (Michalkó 2012) based on the role of tourist attractions. Consequently, a group of settlements has been identified wherein a different behaviour can be observed as compared to conventional tourism.

Table 2

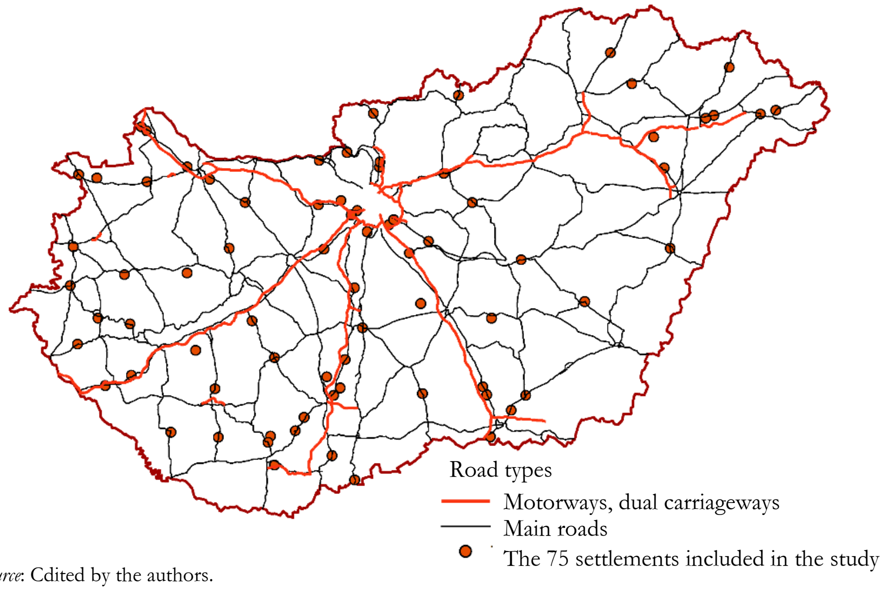
Grouping of settlements included in the study

Category/revenue (HUF)	0–5 million	5–25 million	25–50 million	50–100 million	100–1000 million	Above 1000 million	Sum total
1 (without significant attraction)	584	71	29	6	3	1	694
2 (regional attraction)	45	25	17	17	31	5	140
3 (national or international attractions)	14	7	12	7	53	29	122
Sum total	*643*	*103*	*58*	*30*	*87*	*35*	*956*

Source: Calculations by the authors.

Figure 2

Geographical location of settlements included in the study



Source: Cdited by the authors.

In order to successfully evaluate the special tourism geographic features of the 75 settlements involved in transit, all the settlements (956) included in the study were categorised into two groups. While one group (group 2) comprised the above 75 settlements, the other (group 1) contained the remaining 881 settlements. After that, the proportion of revenues from foreigners related to the potential transit passengers was examined (Table 3).

Table 3

Number of settlement groups according to the proportion of revenues from foreigners

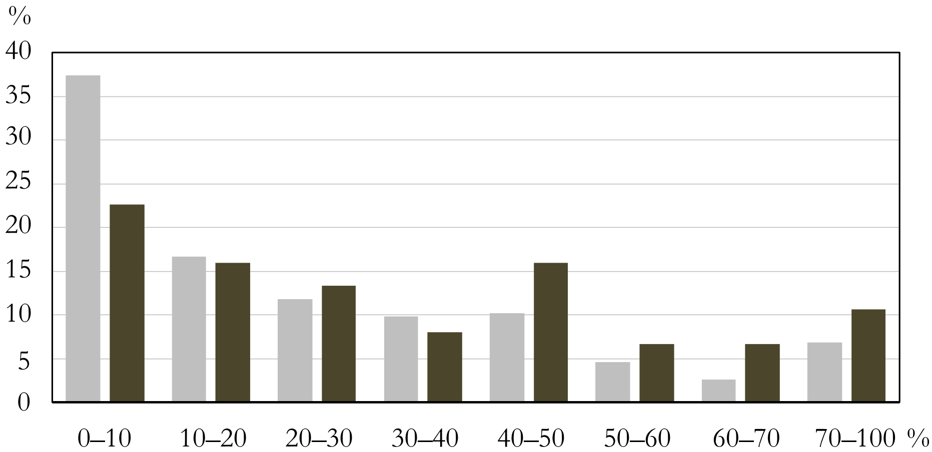
Proportion of revenues from foreigners, %	Group		Total
	1	2	
0– 10	114	17	131
11– 20	51	12	63
21– 30	36	10	46
31– 40	30	6	36
41– 50	31	12	43
51– 60	14	5	19
61– 70	8	5	13
71–100	21	8	29
No revenue	576	0	576
Total	*881*	*75*	*956*

Source: Calculations by the authors.

In the case of settlements belonging to the second group, proportions of revenues from foreigners are significantly higher. The percentage distribution of the two groups of settlements according to the proportions of revenues from foreigners shows that in some cases, revenues from foreigners are independent of the settlement's tourist attractions. The reasons behind overnight stays can be traced back to other factors.

Figure 3

Percentage of settlements belonging to separate groups according to revenues from foreigners



Source: Edited by the authors.

Examining the probability of transit tourism with the logit model

With the help of the logit model, this part of the study further examines settlements that have been identified in the previous chapter as the crystallising points of transit tourism. Here, our aim was to identify qualities, properties and locations of settlements that may make transit tourism relevant and characteristics that increase the probability of transit tourism in a particular settlement.

Introduction of the logit model

In some examinations, the target variable is binary, that is, it has two possible values, such as survival or death, success or failure, etc. In these cases, it is almost natural to assume that the explanatory variables play a role in the probability of the result; therefore, the probability of the event can be regarded as the dependent variable. The basic idea of the logit model is the use of logit value of the probability as a dependent variable (Cramer 2003). The logit transformation maps the interval between 0 and 1 between negative and positive infinity. Its formula is the following:

$$\text{logit}(Y) = \ln(Y / (1-Y)).$$

Thus, the regression equation is as follows: $logit\ (Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_r X_r + \varepsilon$

The notion of the odds ratio brings us closer to the understanding of the use of the logit models. The odds are defined as the quotient of two complementary probabilities. The odds ratio is the ratio of two odds. That is, it shows how the probability of an event would change if group A possessed the properties of group B. The exponential exponents of slopes in the above equation are the odds ratios (Cramer 2003).

Settlements involved in transit as reflected by the logit model

In this case, the binary target variable applies to transit tourism. The value is zero if the phenomenon is not detectable in the settlement and one where it is present (75 identified settlements). Naturally, we are aware that transit tourism in Hungary may not only be detectable in settlements identified in this study; however, the distinction between the two groups of settlements is still considered relevant, as impacts are much stronger in the case of the 75 settlements identified than in the rest of the settlements. The table below shows independent variables that try to explain the presence or absence of transit tourism at the settlement-level with the help of the logit model. It has been assumed that these are indicators in the official statistical practice that indicate the presence of the most important services, which play a major role in satisfying the demand induced by transit (i.e. the presence of a railway station is considered relevant and not transit going through the settlement). On the other hand, sets of indicators that indicate the presence of demand and services induced by freight traffic have also been included in the study. Lastly, it is important to examine the distance of settlements that are potentially involved in transit from some settlements playing a prominent role.

Table 4

Set of variables included in the study

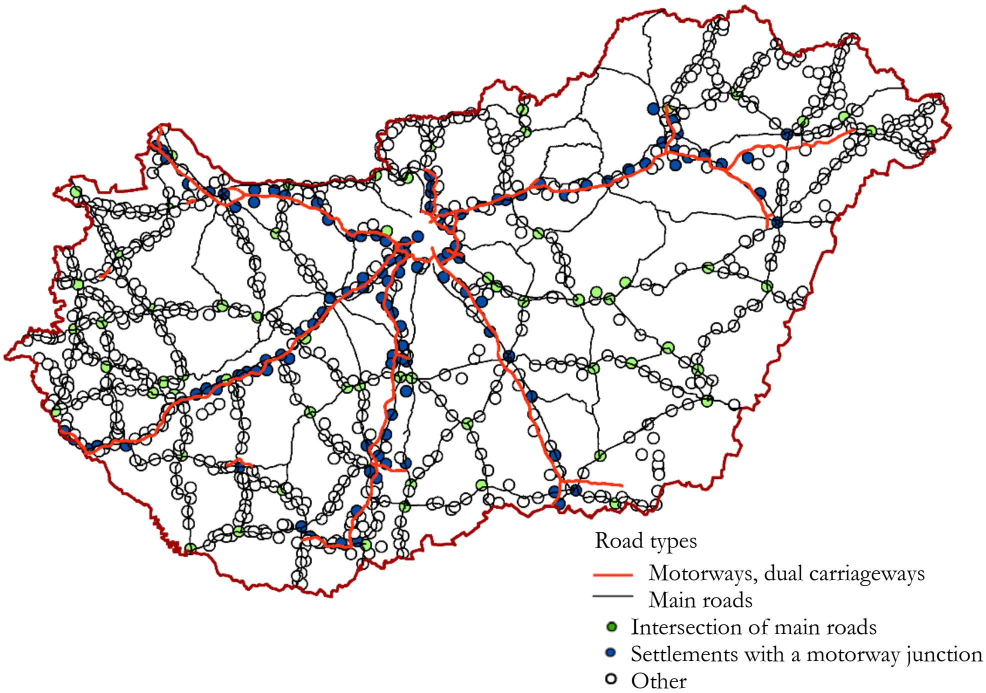
The presence of an industrial park (yes–no), 2012
Capacity of public accommodation establishments (number of bed-places), 2011
Presence of a railway station (yes–no), 2011
Presence of a petrol station (yes–no), 2011
Number of active enterprises with 50–249 employees (including legal forms bound to transform and ceasing legal forms, during the year according to business demography), 2010
Number of active enterprises with 250–499 employees (including legal forms bound to transform and ceasing legal forms, during the year according to business demography), 2010
Number of active enterprises with 500 or more employees (including legal forms bound to transform and ceasing legal forms, during the year according to business demography), 2010
Distance from the district seat, 2012
Distance from the county seat, 2012

Source: Edited by the authors.

All of the above variables and their subclasses have been built in the model. According to our logit model, it can be concluded that the presence of petrol and railway stations and the proximity of county seats do not increase the odds of transit tourism in a settlement. Transit tourism does not depend directly on these variables, nor does it depend on other variables listed in the table. It has been found that the economic and demographic characteristics of settlements do not have a significant impact on the crystallising points of transit tourism. Therefore, it is assumed that the geographical position or location may play a greater role in transit tourism. After all, there is a strong correlation between the spatial distribution of settlements involved in transit tourism (Table 4.) and road junctions. The following figure shows different categories of settlements: category 1. presence of a motorway junction in the settlement, that is, a main road intersecting the motorway; category 2. intersection of main roads; and category 0. all other settlements (without special location in terms of road transport).

Figure 4

Categorisation of settlements in Hungary according to the road network



Source: Edited by the authors.

Table 1, which shows the categorisation of settlements included in the study according to revenues and tourist attractions, has been split up according to the above categories of intersections (settlements having a motorway junction, settlements where main roads intersect and settlements without special location in terms of road transport):

Table 5

Settlements with a motorway junction according to the categories of tourist attractions and revenues of accommodation establishments

Category/revenue, million HUF	0–5	6–25	26–50	51–100	101–1000	1001+	Total
1 (without significant attraction)	47	5	5	4	2	1	64
2 (regional attraction)	9	1	1	1	7	2	21
3 (national or international attraction)	4		2		18	14	38
Total	*60*	*6*	*8*	*5*	*27*	*17*	*123*

Source: Edited by the authors.

Table 6

Settlements located at intersections of main roads according to the categories of tourist attractions and revenues of accommodation establishments

Category/revenue, million HUF	0–5	6–25	26–50	51–100	101–1000	1001+	Total
1 (without significant attraction)	14	5	2	–	1	–	22
2 (regional attraction)	4	2	3	2	9	2	22
3 (national or international attraction)	2	1	1		9	9	22
Total	*20*	*8*	*6*	*2*	*19*	*11*	*66*

Source: Edited by the authors.

Table 7

Settlements without special location in terms of road transport according to the categories of tourist attractions and revenues of accommodation establishments

Category/revenue, million HUF	0–5	6–25	26–50	51–100	101–1000	1001+	Total
1 (without significant attraction)	523	61	22	2	–	–	608
2 (regional attraction)	32	22	13	14	15	1	97
3 (national or international attraction)	8	6	9	7	26	6	62
Total	*563*	*89*	*44*	*23*	*41*	*7*	*767*

Source: Edited by the authors.

This means that invisible tourism can be detected in 5.2% of the settlements belonging to category 0 (without special location in terms of road transport), while this figure is 17.1% for category 1 (motorway junction) and 21.2% for category 2 (intersection of main roads).

Our logit model has been modified according to these findings, so that only two variables are used to explain the presence or absence of invisible tourism in a particular settlement. One of the variables is the above-mentioned node character (the value is 1 if there is a motorway junction in the settlement, that is, a main road intersects the motorway or the settlement, while the value is zero in all other cases), and the other is the distance from the Austrian border (the range between the minimum and maximum values was divided into five equal parts, and settlements were given values from 1 to 5 on a ratio scale), as this direction is assumed to be the greatest in volume because of Europe's east-west divide and flow of guest workers.

Variables selected for the model are significant, but the explanatory power of the model is not too strong. This is indicated by Nagelkerke's R^2 and Cox and Snell's R^2 (Cramer 2003).

Table 8

Tests of the fit of the logit model

Test	Cox and Snell's R^2	Nagelkerke's R^2
Value	0.061	0.136

Source: Edited by the authors.

The results of the model are summarised in the following table, where exp(B) is the partial odds ratio, whereas the Wald column is suitable for testing the Wald statistics.

Table 9

Results of the logit model

Variables	B	Wald	Exp(B)
Distance from the Austrian border	0.271	6.451	1.311
Node character	1.851	51.057	6.366

Source: Edited by the authors.

In the output of the logistic regression, the Wald statistics, which are analogous with the t-test of linear regression, have also been indicated.

According to our results (Table 9.), the node character of the road network has a partial odds ratio of 6.366. That is, if the distance from the Austrian border is kept constant, then the odds of invisible tourism increase by 6.4 times on average if a settlement is located on an intersection.

The odds ratio in the case of the distance from the Austrian border indicates (Table 9.) that when the variables of motorway junctions are kept under control (they are changed in none of the settlements), then with the increase in the variable of the distance from the Austrian border, the odds of invisible tourism increase by 31% on average.

The Austrian neighbourhood or the proximity of Austria alone increases transit tourism only slightly in these settlements. That is, when persons travel through Austria, it is likely that they will not stay in Hungary, or if they do, then they do not stay only near the border where accommodation is presumably more expensive.

The distance from the Austrian border was replaced in our logit model with the distances from the Slovenian, Croatian, Serbian, Romanian, Ukrainian and Slovak borders. In these cases, the presence or absence of invisible tourism in a settlement is also explained by two variables. One of the variables is the distance from the above countries, while the other is the previous node character. The distances of borders are also measured on a ratio scale. The range between the minimum and maximum values was divided into five equal parts, and settlements were given values from 1 to 5.

The explanatory power of the models is still poor (Appendix 1). Based on these results (see below), it can be stated that, regardless of the models, the odds of transit tourism increase by 5.7–6.3 times when the settlement is situated at a junction of roads. In addition, the distance from the Austrian border has the strongest explanatory power. The proximity of other borders has poor explanatory power (Appendix 2.). The reason for this is probably that Hungary is linked to Germany and Austria (the most important countries for Hungary within the EU in terms of trade) through this border, and transit traffic from and to these countries is significant. On the other hand, Romanians and Bulgarians, who make up one-third and 9% of the transit traffic in Hungary, also cross this border section (HCSO 2013). Their main purpose is to work in Western Europe. As a result, the significance of this border section is increased by the transit traffic of both Hungarians and other nations.

Effects of transit traffic on regional development

In the following part of the study, we examine whether the phenomenon of transit can have a detectable effect on the level of development and processes of settlements. According to our hypothesis, it naturally can; however, the degree of the impact depends on several factors. It must be noted that transit depends on, first, the level of development of the neighbourhood of the settlement and, second, the level of development of the particular settlement. In our opinion, the impact of transit tourism on the level of development of a particular settlement is much more limited when the settlement is located in a developed neighbourhood and is relatively developed, as opposed to the degree of the economic impact on relatively underdeveloped settlements located in peripheral neighbourhoods.

Figure 5 illustrates the above effects. The spatial modelling of the level of development was carried out by applying Luc Anselin's Local Moran I cluster (Anselin 1995).

The Local Moran statistics are suitable for showing areas that are similar to or different from their neighbours. The bigger the Local Moran I value, the closer the spatial similarity. However, in case of negative values, we may conclude that the spatial distribution of the variables is close to a random distribution. Concerning the Local Moran I, calculations were performed in order to get the per capita income for 2012. During our work, the results of the Local Moran statistics were compared with the initial data in order to examine whether the high degree of similarity was caused by the concentration of the high or low values of the variable (Moran Scatterplots). First, the standardised values of the observation units were plotted on the horizontal axis of the graph, whereas the corresponding standardised Local Moran's I values (average neighbour values) were plotted on the y-axis. The scatterplot places the municipalities into four groups according to their location in the particular quarters of the plane:

1. High–high: area units with a high value, where the neighbourhood also has a high value.
2. High–low: area units with high value, where the neighbourhood has a low value.
3. Low–low: area units with low value, where the neighbourhood also has a low value.
4. Low–high: area units with low value in which the neighbourhood has a high value.

The odd-numbered groups show a positive autocorrelation, while the even-numbered groups a negative one.

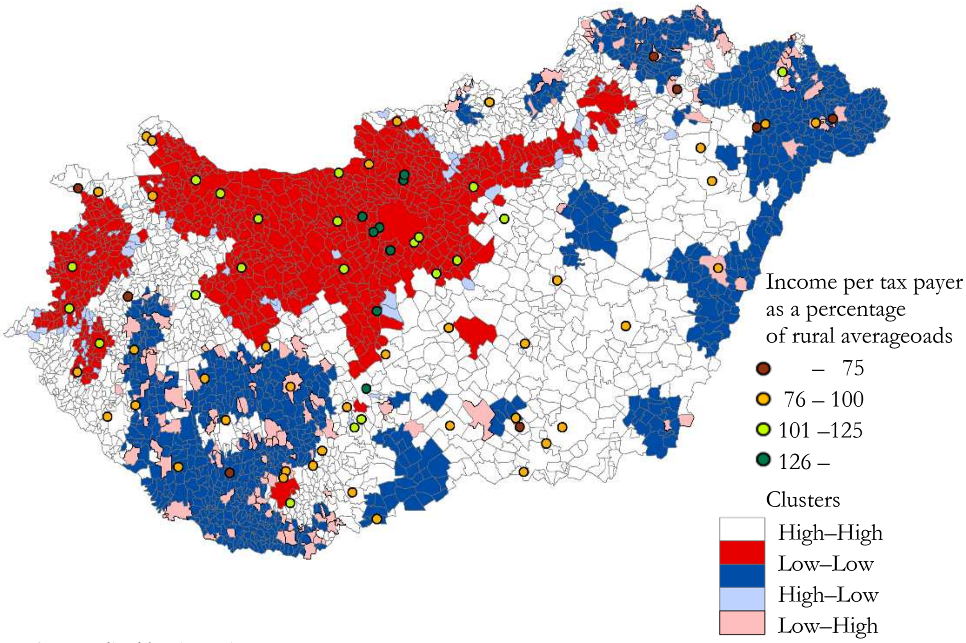
Calculations were made using the GeoDa software. The neighbourhood was defined by using Euclidean distance. The threshold distance was set to a minimal distance, which ensured that each municipality had at least one neighbour. The Local Moran's I calculations were performed by using the EB rates module, as this module is able to perform calculations on specific data with regard to the differences in the orders of magnitude of territorial units. The event variable was the per capita income, while the base variable was the population of the municipalities. This was necessary in order to resolve the problem of huge differences in the order of magnitude of Hungarian settlements and ensure the accuracy of the calculation.

According to the results, Budapest and its agglomeration, the northern part of Transdanubia, and the western borderland are in the most favourable position (high–high cluster). Settlements along the M3 and M6 motorways are also linked to this area. There are also some smaller 'hot spots' outside these areas (Pécs, Paks and Kecskemét). These areas can be regarded as the most important and competitive regions in Hungary in economic terms, which are in sharp contrast to the areas of northeastern Hungary, eastern borderland and southern Transdanubia (low–low cluster). The latter areas are characterised by economic stagnation, or recession. There are also some settlements (out of the 75 settlements identified) that belong to the remaining two clusters or are their immediate neighbours, which may have some impact.

The colouring (representing the economic power) of the 75 settlements was done according to the per capita income level as a percentage of the rural average. The figure shows that the settlements included in the study are located in different regions and have different economic conditions; therefore, the role of transit tourism in their economy varies from settlement to settlement.

Figure 5

Local similarity of the per capita income and level of development of the selected settlements, 2012



Source: Edited by the authors.

The rest of the study focuses on the question of whether the impact of transit can be confirmed and/or quantified in the level of development of the settlements potentially involved in transit. This was examined using a shift-share analysis. The literature on this method is quite substantial, and there are also numerous works in the field of tourism (Houston 1967, Stevens–Craig 1980, Selting–Loveridge 1992, Andrikopolous–Carvalho 1990, Fuchs–Rijken–Peters–Weiermair 2000, Sirakaya–Choi–Var 2002, Toh–Khan–Lim 2004, Yasin–Alavi–Sobral–Lisboa 2004). Our research was based on these works; therefore, detailed description of the method and introduction of different approaches are not included in this paper.

The aim of our shift-share analysis was to examine to what extent the industrial output of a particular settlement determines the per capita income conditions in the year 2012 (which can be regarded as the level of development of settlements) and what role do other local factors play, which are only connected to geographical location.

During the shift-share analysis, data were grouped according to two dimensions. The first is the geographical dimension. In this case, the already used categorisations were applied. The first group comprised settlements that are potentially not involved in transit: they do not belong to the group of identified settlements. All settlements belonging to the following groups are potentially involved in transit; therefore, they are not mentioned here again. The second group included settlements that do not possess significant tourist attractions. The third included settlements that do not possess significant tourist attractions, but due to some reasons described earlier in this paper, are probably involved in transit. Settlements in the fourth group possess regional tourist attractions but are not involved in transit. The fifth group contained settlements that possess regional tourist attractions and are involved in transit. Finally, settlements with national or regional tourist attractions were placed in the sixth group.

The second dimension was created according to the industrial output of a particular settlement. The figures of per capita business tax were examined, and settlements were categorised into five groups based on the most significant brake points of the data series.

The research question during the investigation was the following: to what extent do the economic (industrial) output and other local factors (some of them including the potential role of transit) explain the level of development of settlements?

In Table 10, all income surplus columns have a value of 100 for groups of settlements that are more developed than the national average, whereas they have a value of –100 if settlements are less developed. The income surplus/deficit can be divided into two parts. The geographical component refers to the degree of the role of local processes connected to the groups of settlements in the total income surplus or deficit. The economic component refers to the extent of the role of the local industry in the level of development.

Table 10

Components of income surplus or deficit, 2012

(percentage)

Groups of settlements	Total income surplus/deficit	Geographical	Economic
Group 1	–100	–28	–72
Group 2	–100	–31	–69
Group 3	100	169	–69
Group 4	–100	–131	31
Group 5	100	–72	172
Group 6	100	38	62

In general, it can be concluded that the role of the economic component is somewhat more important than that of the geographical one, as the absolute values of the economic component are bigger than those of the geographical component in case of the three groups. However, the case is the opposite in groups 3 and 5, which are the most interesting to our research. In the group of settlements that do not possess tourist attractions but are involved in transit (Group 3), the level of development in comparison with the national average is primarily due to the geographical location, that is, their involvement in transit. On the other hand, in case of settlements that possess regional tourist attractions and are involved in transit (Group 5), the relatively higher level of development (although they are less developed than the national average) is not due to the geographical location but the economic conditions.

Table 11

Components of changes in expenditure, 2012

(percentage)

Countries	Total income surplus	Total income deficit	Positive geographical component	Negative geographical component	Positive economic component	Negative economic component
Group 1	0.0	70.5	0.0	53.0	0.0	74.4
Group 2	0.0	24.9	0.0	21.4	0.0	24.9
Group 3	0.6	0.0	3.0	0.0	0.0	0.6
Group 4	0.0	4.5	0.0	16.2	2.0	0.0
Group 5	4.8	0.0	0.0	9.4	12.0	0.0
Group 6	94.6	0.0	97.0	0.0	86.0	0.0
Total	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*

Table 11 shows the above-mentioned facts in detail. It can be seen how small the income surplus of Group 3 is in national comparison and how small is the contribution of transit tourism to this surplus. In contrast, our initial hypothesis proved to be true, as the contribution of transit to the local economic conditions and processes can clearly be detected; therefore, its role may not only be important in Hungary but also in settlements with similar economic conditions located in other countries.

Conclusions

As one of the transit countries in Europe, Hungary plays a significant role both in the east-west and north-south passenger traffic of the continent. Transit passengers, who primarily arrive in Hungary by car, cover the distance between two border sections by using motorways and/or main roads, while taking occasional rests in order to satisfy their various needs. Stops often take place in settlements where service providers build their business on transit traffic. In order to eliminate these towns and villages from destinations involved in traditional tourism, factors that reliably indicate the probability of the presence of transit tourism should be explored.

The study took two methodological approaches. First, a GIS-based delineation was made, and groups created by this method were examined according to their statistical characteristics. Settlements involved in transit were identified partly with the help of this model and the logit model, which took into account additional features. It was presupposed that a foreign transit passenger also stays in a settlement, where no significant tourist attraction can be found; therefore, in this case, their stay is due to the favourable location of the settlement. Thus, when the percentage of guest nights spent by foreigners is above average in a settlement situated at the intersection of the shortest routes between border-crossing points, despite the fact that there is no significant tourist attraction, then the presence of transit can be presumed. Seventy-five settlements were identified that satisfied the above criteria; therefore, further examinations were carried out among these settlements.

With the help of the logit model, we sought factors that influence or presume the presence of transit traffic coupled with an overnight stay in a settlement. We concluded that obvious objects, such as a border-crossing point or petrol station, play only a minor role in generating transit coupled with an overnight stay. However, a transport hub situated at the intersection of a main road and a motorway or two main roads has a significant impact on overnight stays. When a settlement has a motorway junction or is situated at an intersection of main roads, the probability of its involvement in transit increases by 17.1% and 21.2%, respectively. Among the factors contributing to the interruption of a transit trip, the proximity of the border plays a minimal role. Only in the case of the Austrian border section, we detected that the distance between the intersection and the border is inversely proportionate to the probability of an overnight stay; consequently, the demand for accommodation establishments suitable for the interruption of transit increases near the Austrian border.

In sum, it can be concluded that in the transit traffic of foreigners arriving in Hungary, a prominent role is played by settlements that

– are located at the intersections of roads, enabling the shortest travel time between different border sections;
– possess a motorway junction; and
– are situated at the intersection of two main roads.

The proximity of borders can stimulate the interruption of a transit trip more strongly than the average only in the case of the Austrian border; therefore, the odds of settlements located in the affected zone to become a part of transit traffic are higher.

According to our research results, the contribution of transit to the local economic conditions and processes can be detected.

It seems probable that behind these results, an important psychological factor of the nature of transit can be found: intersections and transport hubs are seen as prominent stations during the trip, representing the fulfilment of the desire to reach a place, the completion of a stage (deserved rest) and a place for preparing for the next stage. Naturally, psychological factors mingle with rational ones, which can be observed in the involvement of settlements near the border between Hungary and Austria, as transit passengers prefer to stay at Hungarian accommodation establishments due to the more favourable price-quality ratios.

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Appendix 1

Countries	Cox and Snell's R^2	Nagelkerke's R^2
Austria	0,061	0,136
Croatia	0,056	0,123
Romania	0,054	0,120
Serbia	0,057	0,126
Slovakia	0,054	0,119
Slovenia	0,054	0,119
Ukraine	0,054	0,119
Total	*0,070*	*0,154*

Appendix 2

Variables	B	Wald	Exp(B)
Distance from the Croatian border	1,821	50,313	6,180
Character	–0,133	1,578	0,875
Distance from the Romanian border	1,807	49,179	6,089
Character	–0,060	0,354	0,942
Distance from the Serbian border	1,739	44,599	5,691
Character	–0,183	2,892	0,833
Distance from the Slovak border	1,833	49,932	6,256
Character	0,030	0,074	1,030
Distance from the Slovenian border	1,823	50,570	6,190
Character	–0,008	0,007	0,992
Distance from the Ukrainian border	1,833	50,498	6,251
Character	0,039	0,146	1,040

VISUALIZATIONS

Mapping the position of cities in corporate research and development through a gravity model-based bidimensional regression analysis

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In her seminal work entitled 'The Global City', Saskia Sassen (1991) specified New York, London, Tokyo, Frankfurt and Paris as leading examples of global cities. Furthermore, she defined the most important characteristics of global cities (Sassen 2001: 4), one of which is that global cities are major sites of production of innovation. Since Sassen's global city notion was first introduced, significant changes have occurred in the world economy, which can be characterised by, for example, the massive economic growth of developing countries, especially that of China, and rapid technological changes due to fast-growing industries such as nanotechnology, biotechnology and information technology (Nicolini and Nozza 2008; Dernis et al. 2015; Csomós and Tóth 2016a). As a result of these developments, global cities have been continuously losing their privileged position as major sites of production of innovation, and new competitors have emerged in developing countries, even in the home countries of the global cities.

In this analysis, we illustrate the position of 475 cities as centres of corporate research and development (R&D)[1] in 2014. The volume of R&D in a given city is calculated based on the combined R&D investments of leading R&D investor

[1] Our analysis is based upon the hypothesis that the 'production of innovation' requires conducting advanced R&D activities. Therefore, there is a close connection between R&D activities conducted by companies and the innovation produced by them.

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companies headquartered in it. The world's leading R&D investors are annually listed by 'The 2015 EU Industrial R&D Investment Scoreboard' (Hernández et al. 2015). We use a bidimensional regression analysis based on a gravity model to describe the spatial structure of global corporate R&D (for more information on the model, see Dusek, 2012, Tóth et al. 2014, Csomós and Tóth 2016b). The grid is fitted to the coordinate system of the dependent form, and its interpolated modified position makes it possible to further generalise the information about the points of the regression. The white arrows show the direction of movement and the grid shading refers to the nature of the distortion. Areas indicated with green refer to concentration and movements in the same directions (convergence), which can be considered as the most important gravitational centres.

We find four significant regions where corporate R&D is highly concentrated: the West Coast and the East Coast of Northern America, Western Europe and East Asia.

The West Coast of Northern America: The focal point of this region is the San Francisco Bay Area (including San Jose and the cities of the Silicon Valley), the largest corporate R&D centre in the world in terms of annual corporate R&D investments. In 2014, leading companies headquartered in the San Francisco Bay Area invested $81 billion in R&D activities, which corresponded to almost 11 per cent of the total expenditure on R&D by businesses worldwide. Most companies in this region operate in information technology, one of today's fastest-growing industries. Seattle, Los Angeles and San Diego are also significant nodes in corporate R&D.

The East Coast of Northern America: The centre of this region is still New York, investing more than $43 billion in corporate R&D; however, thanks to the rapid growth of the biotechnology (and information technology) industry, Boston seems to be the most dynamically growing gravitational zone in the region. Major cities such as Washington and Philadelphia and some second-tier cities (for example, Bridgeport and Hartford) have a partial, but not negligible, role in corporate R&D.

Western Europe: Although Paris and London are definitely the major single corporate R&D centres in Europe, the most important gravitational zone can be detected around the combined areas of Switzerland and Southern Germany, with the leading roles played by Basel and Zurich in Switzerland and Stuttgart, Munich, Mainz, Mannheim and Frankfurt am Main in Germany. Both Paris and London have a complex structure in corporate R&D, having no extremely dominant industry, whereas the Swiss and German cities generally have a leading industry; for example, Basel's most dominant industry is pharmaceuticals in terms of the total expenditure on R&D by headquartered companies. Outside this zone, there are some middle-sized isolated R&D centres, such as Helsinki (Finland), Toulouse (France), Madrid (Spain), Amsterdam (Netherland) and Rome (Italy).

East Asia: Five out of the 10 largest R&D centres in the world, in terms of combined R&D expenditure by headquartered companies, are located in East Asia. Tokyo, as the world's second-largest single corporate R&D centre, surpasses in the region. Seoul comes second in East Asia, thanks to its globally significant electronics industry. The South Korean capital is followed by two Japanese conurbations, Osaka and Nagoya. These cities are different in that Osaka has a complex corporate R&D structure, while Nagoya's corporate R&D is largely determined by the automotive industry. Furthermore, it seems that a new gravitational zone is emerging in East Asia with the leading role of Beijing.

It is predicted that the Chinese capital will soon became one of the world's most important corporate R&D centres, because the total expenditure on R&D by Beijing-based companies has recently been growing very fast.

South American, South African, Indian and Australian cities have a minor role as corporate R&D centres.

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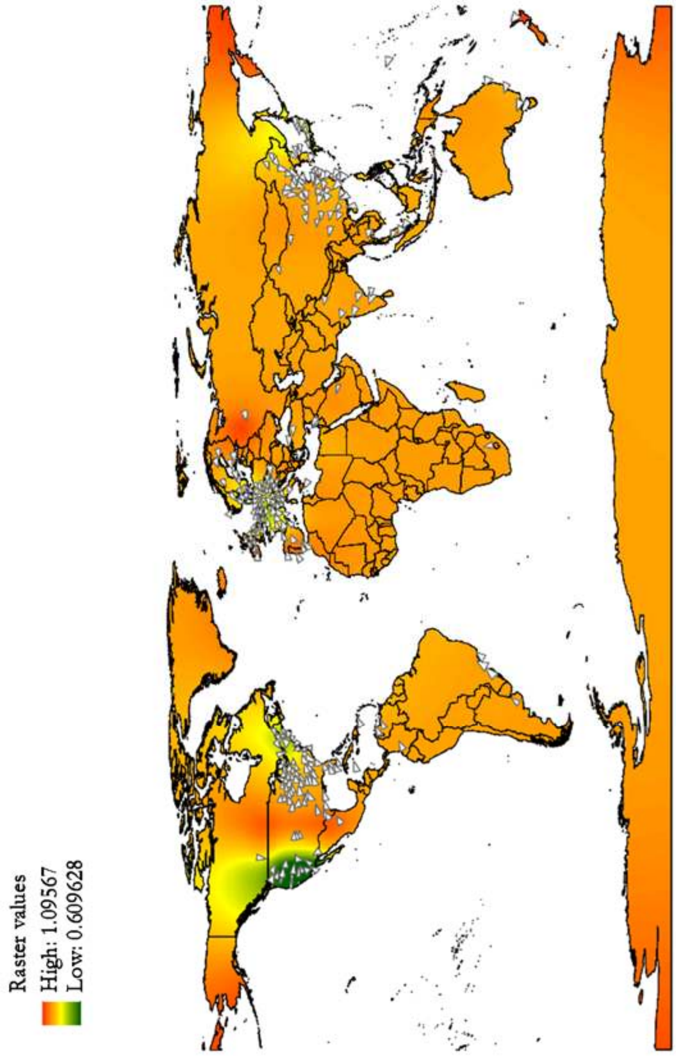
Software: ArcGIS, Darcy 2.0 (http://thema.univ-fcomte.fr/production/logiciels/16-categories-en-francais/cat-productions-fr/cat-logiciels-fr/294-art-darcy).

Figure 1

Directions of the distortion of gravitational space compared to geographical space



Commuting links between settlement hierarchy levels in Hungary

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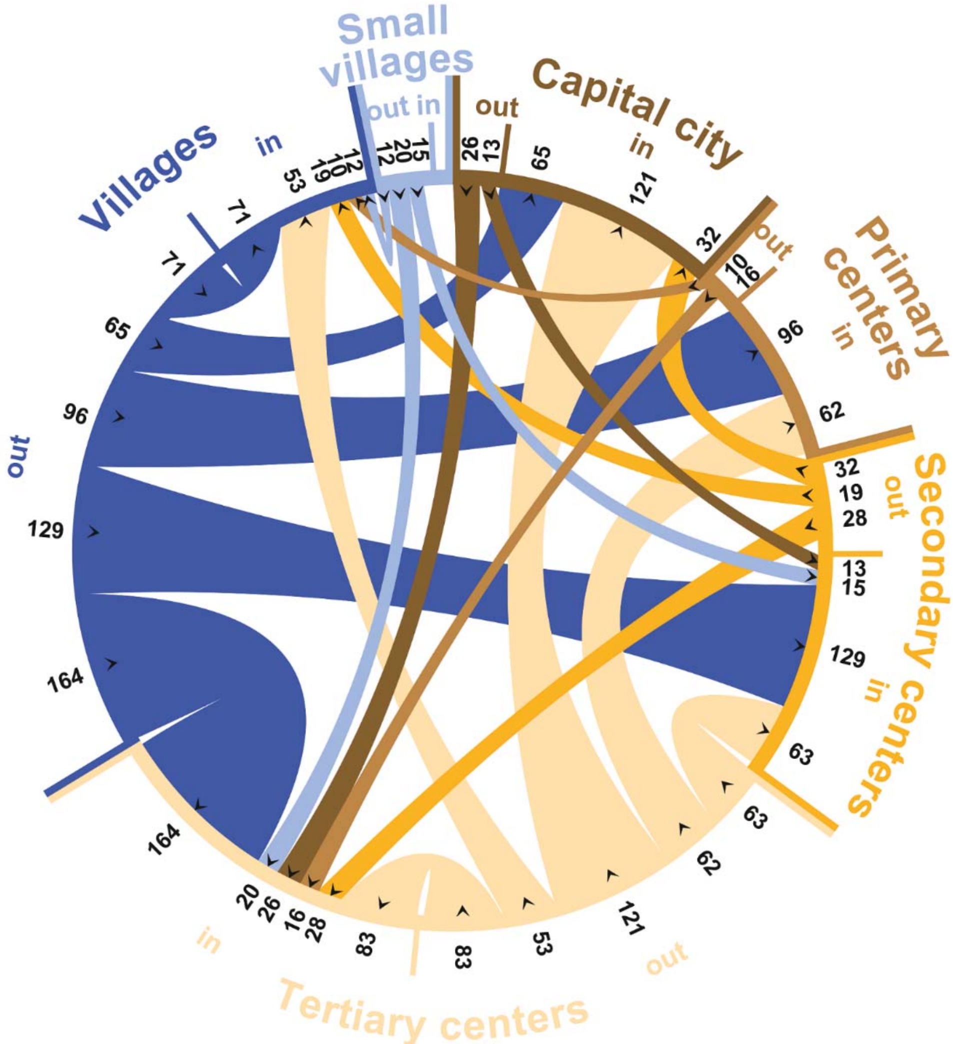
The interaction between the home and workplace has been a central component of urban and regional economic theories (Clark et al. 2003). According to the latest data, in 2011, one-third (1.3 million) of the employed persons commuted daily in Hungary. Compared to 2001, the ratio increased by 4.1 percentage points (up to 34%), and this fits into the global trends as the separation of the location of residence and workplace is becoming more and more common (Reggiani and Rietveld 2010). The phenomenon is fuelled mostly by suburbanisation. This process was at its peak in the 2000s when many people moved from big cities to the surrounding areas, mainly families with stable wealth conditions. The employed members of these families typically kept their jobs at the city of the previous residence.

Who are defined as commuters?

Data about commuting in Hungary are available only via censuses. The latest census was conducted in 2011, and according to the definition, daily commuters are employed persons whose workplace and residence are not in the same municipality. Persons, who do not commute daily but frequently (e.g. every 2–3 days) are also considered daily commuters.

Commuting links between the settlement hierarchy levels in Hungary, 2011*



* The diagram was created using the Corel Draw programme.

What are the hierarchy levels?

We intended to classify Hungarian municipalities based on their position in the hierarchy. As of 1 January 2014, towns were classified into four groups – capital city, primary centres, secondary centres and tertiary centres, and villages were classified into two – villages and small villages.

The classification of towns was carried out using a wide variety of statistical data: we used (altogether 23) indicators considered effective to measure town functions and its extent (e.g. data on population, economics, administrative service, education, etc.). The value of each indicator was normalised, and if more than one indicator covered the same function (e.g. for the health care service function, we used the number of general practitioners and number of hospital beds), their values were averaged for that particular function. By averaging the normalised values for the functions, each town was assigned a composite-indicator value; then based on it, they were classified into four groups by the Natural Breaks method developed by George Jenks (Jenks 1967).

Villages were divided into two groups based on population: villages are municipalities with population of over 500 persons and small villages are municipalities with population of under 500 persons.

We note here that our classification of towns was based purely on legal status. We did not examine whether they effectively have real town-functions.

Hierarchy levels	Number of municipalities
Capital city	1
Primary centres	8
Secondary centres	29
Tertiary centres	308
Villages	1,684
Small villages	1,124

Commuting-relations consisting of more than 10,000 commuters are shown only in the chord diagram, and values are displayed in thousand commuters. Commuters working in different or unknown localities or abroad are not included.

Commuting can be the result of either individual choice (e.g. persons moving to the suburban zone for better life conditions without changing the workplace) or external force (e.g. people living in smaller settlements facing difficulties finding an appropriate workplace locally). In the latter case, people typically commute to a near settlement at a higher hierarchy level.

Overall, significantly more people commute to the capital city and to primary and secondary centres than out of them. Most of the people commuting to the capital city live in tertiary centres (121 thousand persons), and the primary and secondary centres host the most commuters from villages (96 and 129 thousand persons, respectively). Spatial structure is the reason for this difference: Budapest has many tertiary centres in the neighbourhood, whereas the suburbs of primary and secondary centres are dominated by villages. Commuting between the three highest hierarchy-levels is not significant because the distances between towns belonging to them are typically greater.

Commuters living in a tertiary centre or a village have the workplace typically in a settlement that is higher in the hierarchy, although several commute to settlements on the same level in the hierarchy (from tertiary centre to tertiary centre: 83 thousand persons; from village to village: 71 thousand persons). Commuting from tertiary centres to villages is also remarkable.

In conclusion, the village-town (suburb zone-centre) commuting relation is still dominant, but commuting on the same hierarchy-level (from town to town and village to village) and from the centre to the suburb zone is also increasing. The growing intensity and dispersity of commuting points to the trend of polycentric development should be considered as a modern (post-modern) process (Bertaud 2003, Lin et al. 2012).

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