STUDIES

Modelling Network Interdependencies of Regional Economies using Spatial Econometric Techniques[1]

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Multiregional dynamic models of economic growth rarely capture the interdependencies among regions that are geographically distant and/or often underestimate the importance of these linkages. This bias has become more and more serious because travel and transportation costs continue to decrease, while new telecommunication and information technologies enable business activities to readily take place between geographically remote locations. The conceptual framework in this study–modelling the network of regions–is based on well-known spatial econometric methods and provides alternative ways to integrate network interdependencies of economic activities into many fields, as well as modelling techniques such as spatial computable general equilibrium, input-output, and dynamic econometric models.

Keywords:
spatial econometrics,
input-output analysis,
network of regions,
interregional trade

Introduction

Both spatial econometric models and network-based regressions can be considered as special cases of cross-sectional dependence regressions, where the relationships between regions are defined by spatial proximity and the edges of the network structure, respectively. LeSage and Debarsy (2016) suggest replacing the word 'spatial' with the term 'cross-sectional dependence' when weight matrices are not created through spatial proximity, but via any other non-spatial proximity definition. In this article, I take the example of interindustry relationships to show how further development of these techniques is possible based on weight matrices that are created not only by contiguity and spatial distance algorithms, but also by defining network distance measurements. Empirically, long-distance cross-sectional dependencies can be more important than spatial ones depending on the industry; nevertheless, there are still many traditional industries where spatial autocorrelation can be dominant while other cross-sectional dependencies remain insignificant.

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For regional policy, it is essential to: identify the key industries within a given region and analyse their spatial and network dependencies, including geographically distant linkages; measure their dependencies from weaker to stronger; and know how to influence them to improve their economic performance. Before making policy decisions, it is crucial to run simulations using dynamic models, implement regional impact assessment, and take into consideration interregional and interindustry effects beyond macroeconomic aspects and regional impacts. In this respect, the main goal of this study is to provide theoretical and methodological insights about the importance of regional network interlinkages of key industries, as well as a proof of concept for future network econometrics and economic modelling research.

Problem definition

The aim of this study is to shed light on an alternative conceptual framework to build dynamic multiregional economic models in general, and to develop a new method to connect regions within multiregional models, as well as to emphasise the advantages of the new approach in the modelling of interregional and interindustry linkages in particular. The approach is based on the creation econometric equations (stochastic equations) among the spatial units instead of using identities (deterministic equations) and can be applied to many other fields other than economics.

Several methods enable to connect regions within an economic model, and it is usually difficult to find the appropriate method depending on the purpose of the model. One of the most popular approaches is based on the well-known gravity model, where the intensity of the relationships decreases as geographical distance increases. In many cases, this approach provides the most satisfactory solution; thus, it is widely accepted, and this aspect of the multiregional model is rarely questioned or criticised. In some cases, if the model considers a more detailed level of industrial classification, distant interdependencies can become more important than the ones across closer neighbours, especially in industries where transportation costs are relatively low compared to the value of the transported goods. Here, the gravity model cannot provide accurate results, as it underestimates the economic interactions among regions, which can be physically far apart. Nonetheless, in other industries, where spatial proximity does matter, the gravity model can still be the best solution. The problem occurs, for example, between regions where the gravity model predicts low trade value, although they actually exhibit strong interdependency for a given industry. There are many industry-specific examples for this phenomenon, some of which are outlined below.

Spatial econometrics provides stochastic equations for multiregional economic models to capture the interactions among nearby regions. By connecting regional variables in many different regions, these equations allow modellers to establish interregional linkages for dynamic simulations. This method can be interpreted as an extension of spatial econometric techniques where the weight matrix generates from network linkages among regions instead of traditional definitions (binary contiguity, inverse distance, etc.). In this study, the network definition is based on interregional trade data, although this is not the only way to create alternative types of cross-sectional weight matrices. Depending on the investigated phenomena, many other matrix representations of directed or undirected graphs of interregional connections are imaginable and applicable in order to build weight matrices.

In this context, the word 'network' refers to the network of regions. However, generally speaking, the word has a much wider meaning (e.g. social networks, neural networks, computer networks, etc).

Considering whether the framework of network theory can be employed to describe the interregional interindustry linkages, Rodrigues et al. (2016) illustrate the case of an input-output model in which the network approach can result in much clearer and more flexible modelling techniques than conventional matrix formulations. Additionally, they point out the advantages of the topological transformations applied to these network structures.

Cross-sectional dependence seems to be a broader concept than network of regions, as it involves many other applications that cannot be described in terms of network model.

Examples of network-based weight matrices

The following examples provide the base for a proof of concept of a multiregional model, which will be developed in the next step of this research. Network autocorrelation can usually be defined similarly to spatial autocorrelation.

The idea of defining network autocorrelation and creating weight matrices by network structures and topologies is not new and has already been accepted in social network studies. Leenders (2002) provides a clear definition: 'social influence enters network autocorrelation models through the weight matrix W, also called the structure matrix. Entry w_{ij} represents the extent to which y_i is dependent on y_j thus to what extent actor j influences i'. Doreian (1989) describes the mathematics of different types of network models (network effects, network disturbances, and their mix) that can be employed to investigate network effects on social actors. Although an overview about the methodology of weight matrices of social networks can be obtained, the cross-sectional dependence of the interregional input-output linkages seems to be a different problem. For instance, the problem size is much smaller than in the case of social networks, which is important for the algorithms running on computers. Inverting a ten-million by ten-million sized matrix seems to be difficult and CPU time consuming; nonetheless, nowadays it is not impossible, and fortunately it is not even necessary in the case of the network of regions because of the limited number of nodes.

There are software packages allowing users to generate network spatial weights. For example, in ArcMap it is possible '…to model and store spatial relationships based on time or distance between point features in the case where travel is restricted to a network dataset' (ArcMap 2017). Moreover, PySal contains functions for network constrained analysis (Rey 2016).

Some contributions in the literature apply a combination of the network and the spatial approaches; for example, Ermagun and Levinson (2016) introduce the network weight matrix as a replacement for the spatial weight matrix. Specifically, with the aim of modelling traffic flows, they define the elements of the weight matrix by network topology and structure beyond spatial proximity.

In many cases, it is possible to reduce the specification of the econometric model into a simpler estimation and inference, in order to still apply conventional techniques and software packages of spatial econometrics. LeSage (2017) develops an algorithm based on convex combinations of matrices to redefine the specification of the cross-sectional dependence regression replacing two or more different weight matrices by a single weight matrix. The latter combines all original matrices with their correspondent importance.

In the simplest version of the multiregional model suggested in this study, the equations of the network regression models can be written similarly to the ones of the spatial regression models; for example, the equation of the Network Autoregressive Model (NAR) is almost the same as the equation for the Spatial Autoregressive Model (SAR), and only the definition of the weight matrix is different:

$$y = \varrho W y + X\beta + \varepsilon \qquad (1)$$

Furthermore, in most cases the estimation methods of the spatial econometric models are also applicable to the network econometric models. Moreover, the usage of the available software packages (Geoda, R, PySal, etc.) is possible, provided that there is a flexibility to rewrite the weight matrices. For the present application, it was convenient to use the weight matrix object and the spreg.ml_lag function of the PySal package in a Python script. This 'module provides spatial lag model estimation with maximum likelihood following (Anselin 1988)', as quoted by Rey in the software documentation (Rey 2016).[2]

Because it is only a conceptual description of the alternative approach, my example consists of a simple econometric model to prove the existence of this type of network autocorrelation. To illustrate it, an apparent relationship between the compensation per employee and labour productivity measured by gross industrial product per employee is assumed. Both variables are generated in a two-dimensional state by industry tables for year 2012. In this example, the states are chosen as spatial units; thus, the word 'region' will be used as a synonym for 'state'.

[2] pysal.readthedocs.io/en/latest/library/spreg/ml_lag.html (downloaded: March 2017)

Data

Data on employment, compensations, gross industrial product, input-output accounts, and coefficients for 51 states and 71 industries were retrieved directly from the IO-Snap software, a third-party commercial data vendor.[3] IO-Snap extracts the original tables from the U.S. Bureau of Economic Analysis (BEA) website, while facilitating the aggregation and regionalisation of the tables. The use of IO-Snap was more convenient than downloading data directly from BEA and creating a new preprocessing algorithm.

The interregional trade data are from the 2012 Commodity Flow Survey Public Use Microdata File (CFS PUMS file)[4], which is downloadable from the United States Census Bureau website. Among the other things, this data file contains columns for the FIPS state code of shipment origin, the FIPS state code of shipment destination, and the NAICS code of the shipper; therefore, trade classification by industry and the origin state was also considered. In this example, regions are defined as states, but smaller or larger spatial units can also be used depending on the available data and the purpose of the analysis. The CFS PUMS file also provides information about the metro area of shipment origin, the CFS area of shipment origin, the metro area of shipment destination, the CFS area of shipment destination, and a two-digit SCTG commodity code of the shipment. By investigating the rows of the CFS PUMS file, it seems obvious that the trade matrix can also be generated for smaller spatial units. Moreover, beyond the industry by industry (IxI) analysis, commodity by commodity (CxC) and industry by commodity (IxC) analyses could also be implemented, because IO-Snap can easily use its regionalisation features to generate the necessary data. For example, the regionalisation process can be run for input-output accounts (final demand, value added, use and make tables) and tables of direct and total requirements in all three formats: IxI, IxC, and CxC. The use of a CFS PUMS file is only an example of how to create weight matrices; indeed, there are many other possible ways to collect data and develop algorithms generating weight matrices to capture the far distance linkages. For example, regional level aggregations of researchers' social network can provide the representation of the interregional innovation linkages in a simple region by region cross-sectional weight matrix format.

Generating network-based weight matrices

Aggregating the microdata from the commodity flow survey produces industry-specific state-by-state tables of shipment values for each available NAICS code. Within a given industry, this matrix represents a directed graph where the nodes are

[3] www.io-snap.com (downloaded: March 2017)
[4] www.census.gov/econ/cfs/pums.html (downloaded: March 2017)

regions and the arcs are links defined by the following condition: two regions are connected if the total value of the shipment between them is greater than a given threshold. Any threshold is arbitrary, and one of the common choices is to specify the largest value, in order for all regions to have at least one neighbour. This algorithm results in a non-symmetric matrix of first-order neighbours. The higher-order neighbours in the network case can also be calculated through a method similar to binary contiguity matrices in spatial econometrics. Using the graph theory terminology, this is equivalent to the condition of the shortest path between two nodes. The non-symmetric weight matrix, that is, the directed graph, can be employed for exploratory data analysis (e.g. calculate Moran's I in the network case) and to derive the network lagged independent variables, especially for industries' backward and forward linkages–not only for the intraregional supply chain linkages, but also for interregional trade.

In order to run a cross-sectional dependence autoregressive model, a symmetric weight matrix is required. This is derived from the original shipment matrix by adding the matrix to its transpose (to add state A → state B shipments to state B → state A shipments and vice versa). This aggregation provides a symmetric matrix, but can cause an information loss in terms of shipment direction. Nevertheless, both directions can influence the interdependencies between two regions. Therefore, the result of the model might not be misleading. A possible improvement could deal with the development of a methodology of estimation and inference with asymmetric weight matrices; in other words, a way to handle directed graphs representing network structures in econometric models.

In the first version of the network-based weight matrix (Figure 2), the rows of the row-standardised matrix are unweighted; this means that the actual shipment value is ignored, and only the existence of connections is considered using the same weight for each neighbour. In the second version, different weights are assigned to the neighbours distinguished by the shipment value. The significance of the autocorrelation and the autoregressive coefficients does not substantially change between the two non-spatial models.

The neighbours' pattern in the network case is different from the spatial case. The first pair of maps (Figure 1) illustrates that the geographically defined neighbours surround the examined states.

In the second pair of maps (Figure 2), a very different pattern of neighbours can be seen for the same states. With the network-based method, some distant states became connected, while some spatial neighbours lost their connections to the given state.

The comparison of the four maps shows that an interesting outcome might occur. There are no joint neighbours in the examined two states in the spatial case because of the far distance; however, in the network-based case, they have one common neighbour. After defining the weight matrix by trade data, physically distant regions can become connected, such as Vermont and Oregon on the right-hand side of the map, while spatially connected neighbours might remain neighbours or become unconnected.

Figure 1

Spatial neighbours of Montana and Vermont using threshold of distance method

Source: Generated using GeoDa v1.8.16.4; 1 March 2017, coloured manually.

Figure 2

Network-based neighbours of Montana and Vermont by trade in industry NAICS code 332, Fabricated Metal Product Manufacturing

Source: Generated using GeoDa v1.8.16.4; 1 March 2017, coloured manually.

Empirical results

Based on a simple example, one spatial model (with binary contiguity weight matrix) and two network models (network threshold type and network flow type) are created for each industry for which interregional trade data are available. The equation of the spatial autoregressive model (Anselin 1988) is as follows:

$$y = \varrho W_S y + a + \beta_1 x_1 + \left(\beta_2 x_2 + \ldots + \beta_k x_k\right) + \varepsilon \ , \qquad (2)$$

where the dependent variable y represents the compensation rates by states within a given industry, W is the same binary contiguity spatial weight matrix for each industry, and x_1 is the independent variable of labour productivity by states within a given industry. Although it would possible to use more explanatory variables $x_2 \ldots x_k$, in this simple example I use only one. Thus, in order to simplify the notation, x will replace x_1 henceforth. Actually, equation (2) is a generalised equation that can be written for each industry i.

First, spatial autoregressive models are implemented for each industry from IO code 212 to 55, and the cases of positive significant autoregressive parameter are listed in Table 1. In many cases, the autoregressive parameters become significant, and the spatial diagnostic of OLS estimations show more robust Lagrange multipliers for the spatial lag model than for the spatial error model (in the significant cases).

Table 1

The cases of positive significant spatial autoregressive parameter

IO code	Name	ϱ coefficient	ϱ probability	β coefficient	β probability	Spatial pseudo R^2
321	Wood products	0.3097636	0.0000031	0.3314931	0.0000000	0.7471041
331	Primary metals	0.3827188	0.0000633	0.0327501	0.0110314	0.1577813
333	Machinery	0.2343926	0.0266329	0.2006220	0.0000623	0.2931058
335	Electrical equipment, appliances, components	0.2445147	0.0083023	0.2290565	0.0000000	0.4491828
337	Furniture and related products	0.2547117	0.0027271	0.2847682	0.0000000	0.5247478
339	Miscellaneous manufacturing	0.2807512	0.0143612	0.2362123	0.0000000	0.6514770
323	Printing and related support activities	0.2422890	0.0051829	0.2539650	0.0000033	0.3709606
325	Chemical products	0.4077508	0.0036684	0.0792176	0.0000230	0.3231142
326	Plastics and rubber products	0.2209095	0.0018884	0.1839768	0.0000003	0.5240715
42	Wholesale trade	0.1469258	0.0172730	0.4867514	0.0000000	0.7071403

In the second step, the network lagged variables are created similarly to the spatially lagged variables, the only difference being the weight matrices' method. In the network-based case, I employ two types of row-standardised network matrices, while the other parts of the algorithm are mathematically equivalent to the spatial case. Thus, equation (2) can be rewritten as:

$$y_i = \varrho W_{N,i} y_i + a + \beta x_i + \varepsilon \ . \quad (3)$$

In equation (3), y_i and x_i are still vectors for all industries i, and the elements of such vectors are the values of dependent and independent variables by region, respectively.

The notation is almost the same as in equation (2), except that the weight matrices are network-based instead of spatial matrices; and *per definitionem*, they are different for each industry depending on the interregional trade data.

The results in Table 2 generate from the unweighted network-connectivity matrices, while the corresponding results of the weighted network-flow matrices are showed in Table 3. All industries have different weight matrices in both cases (compared to the other industries) according to the total trade value by industry among the states.

Table 2

The cases of positive significant network autoregressive parameter using network threshold type weight matrices

IO Code	Name	ϱ coefficient	ϱ probability	β coefficient	β probability	Spatial pseudo R^2
332	Fabricated metal products	0.7359775	0.0000032	0.3743817	0.0000000	0.6980953
337	Furniture and related products	0.5951258	0.0029552	0.3245427	0.0000000	0.4780375
323	Printing and related support activities	0.6899227	0.0000390	0.2942893	0.0000000	0.3252263
326	Plastics and rubber products	0.6577262	0.0016704	0.2150794	0.0000000	0.4991782

Table 3

The cases of positive significant network autoregressive parameter using network flow type weight matrices

IO Code	Name	ϱ coefficient	ϱ probability	β coefficient	β probability	Spatial pseudo R^2
332	Fabricated metal products	0.6186635	0.0007193	0.3723363	0.0000000	0.6798423
3364OT	Other transportation equipment	0.4214841	0.0250983	0.2114154	0.0000000	0.3346656
337	Furniture and related products	0.7259708	0.0000026	0.3320034	0.0000000	0.5111702
323	Printing and related support activities	0.7390262	0.0000001	0.2676689	0.0000003	0.3494023
326	Plastics and rubber products	0.8205607	0.0000000	0.2113470	0.0000000	0.5243172

Network autocorrelation occurs less frequently than spatial autocorrelation. In a few cases, especially in the fabricated metal products industry, network interdependencies are observed (irrespective of which type of network matrices is applied), despite the spatial autoregressive parameter is not significant. As expected, the coefficients of the explanatory variables are positive and significant in all cases, because labour productivity can explain the variance of compensations reasonably well. The PySal report summary for both network cases can be seen in Tables 4 and 5.

The conditions of the two network autoregressive models reported in Tables 4 and 5 only differ for weight matrices; net_thres and net_flow denote binary network threshold type and weighted network flow type, respectively. The results from the two types of network weight matrices do not emerge as very different.

The third step is the extension of the network autoregressive model in equation (3) to intraregional backward linkages. The interindustry weighted explanatory variable generates from the national direct requirement table:

$$y_i = \varrho W_{N,i} y + a + \beta x_i + \gamma W_B x_r + \varepsilon \ . \tag{4}$$

Note: in equation (4), vectors x_i and x_r are not in the same structure; nonetheless, they represent the same explanatory variable (labour productivity). Vector x_i contains the values of regions within a given industry, and vector x_r contains the values of industries in a given region. The transformations in W_B are implemented in all regions; thus, these lagged variables are in the same structure as the original x_i variables and could be handled as regular independent variables.

Table 4

Results of Network Autoregressive Model for NAICS 332, Fabricated Metal Product Manufacturing, using network threshold type weight matrix

```
REGRESSION
----------
SUMMARY OF OUTPUT: MAXIMUM LIKELIHOOD SPATIAL LAG (METHOD = FULL)
------------------------------------------------------------------
Data set            :    unknown
Weights matrix      :  net_thres
Dependent Variable  :    dep_var            Number of Observations:        51
Mean dependent var  :    59.6675            Number of Variables   :         3
S.D. dependent var  :     9.6399            Degrees of Freedom    :        48
Pseudo R-squared    :     0.7164
Spatial Pseudo R-squared:  0.6981
Sigma-square ML     :     25.864            Log likelihood        :  -156.157
S.E of regression   :      5.086            Akaike info criterion :   318.314
                                            Schwarz criterion     :   324.110
-------------------------------------------------------------------------------------
            Variable     Coefficient       Std.Error     z-Statistic     Probability
-------------------------------------------------------------------------------------
            CONSTANT     -17.3484699       9.7948880      -1.7711759       0.0765315
               var_1       0.3743817       0.0360905      10.3734078       0.0000000
           W_dep_var       0.7359775       0.1580331       4.6571094       0.0000032
-------------------------------------------------------------------------------------
```

Table 5

Results of Network Autoregressive Model for NAICS 332, Fabricated Metal Product Manufacturing, using network flow type weight matrix

```
REGRESSION
----------
SUMMARY OF OUTPUT: MAXIMUM LIKELIHOOD SPATIAL LAG (METHOD = FULL)
------------------------------------------------------------------
Data set            :    unknown
Weights matrix      :   net_flow
Dependent Variable  :    dep_var            Number of Observations:        51
Mean dependent var  :    59.6675            Number of Variables   :         3
S.D. dependent var  :     9.6399            Degrees of Freedom    :        48
Pseudo R-squared    :     0.6967
Spatial Pseudo R-squared:  0.6798
Sigma-square ML     :     27.643            Log likelihood        :  -157.624
S.E of regression   :      5.258            Akaike info criterion :   321.248
                                            Schwarz criterion     :   327.043
-------------------------------------------------------------------------------------
            Variable     Coefficient       Std.Error     z-Statistic     Probability
-------------------------------------------------------------------------------------
            CONSTANT     -10.5329975      11.2724135      -0.9344048       0.3500951
               var_1       0.3723363       0.0376417       9.8915891       0.0000000
           W_dep_var       0.6186635       0.1829223       3.3821111       0.0007193
-------------------------------------------------------------------------------------
```

The explanatory variable (within a given region) is weighted by the coefficients from the columns of the direct requirement table of the industry-by-industry structure, excluding the examined industry itself. There are three transformations between the matrix W_B and the original industry-by-industry table: replacing the main diagonal of the input-output table with zeros, transpose it, and the row-standardisation. This new variable in equation (4) can be considered as an explanatory variable for backward linkages. Matrix W_B has no index r; this means that the national input-output table is used in the first approximation, but there are options in IO-Snap to regionalise the table of direct requirements and replace W_B matrix with different regional $W_{B,r}$ matrices for each region.

Table 6

Results of the network autoregressive models with backward linkages

IO Code	ϱ coefficient	ϱ probability	β coefficient	β probability	Spatial pseudo R^2	γ coefficient	γ probability
212	–0.2068741	0.1738937	0.0877126	0.0000000	0.4117533	0.0451872	0.0172671
327	0.4593082	0.0420149	0.1537810	0.0007127	0.2416895	0.0309428	0.1032600
332	0.6407994	0.0003017	0.3621068	0.0000000	0.6934640	0.0189350	0.1391610
333	0.3286246	0.2139013	0.1944382	0.0000760	0.3505849	0.1272176	0.0096165
334	–0.1889946	0.5149651	0.0715192	0.0000050	0.3450205	0.2490942	0.0041148
337	0.7469666	0.0000002	0.2953514	0.0000000	0.5151907	0.0574779	0.1666706
315AL	0.2018436	0.3359634	0.2917739	0.0000000	0.6145860	0.1577364	0.0014496
323	0.7860992	0.0000000	0.2602953	0.0000002	0.3492147	0.0312487	0.0347412
326	0.8192370	0.0000000	0.1940023	0.0000000	0.5505027	0.0149876	0.0536604
42	0.0655316	0.7516733	0.2917696	0.0000444	0.7508864	0.2056734	0.0002273

The backward linkages parameter explains the effect of changes in labour productivity in the supplier industries on compensations in the considered industry.

Given this, a possibility is to estimate the econometric equations with a multidimensional weight matrix defined as a combination of interregional and interindustry linkages:

$$y = \varrho W_N y + a + \beta x + \gamma W_B x + \delta\left(W_N \times W_B\right) x + \varepsilon . \quad (5)$$

The notation × between W_N and W_B is not the regular matrix multiplication. Instead, this transformation results in a three-dimensional weight matrix from the two-dimensional matrices, and can be defined by the elements of the original matrices using the following formula. Specifically, denote $z_{i,r}$ the elements of the new variable in industry i, $n_{r,s,j}$ the elements of matrix W_N in industry j, $b_{i,j,r}$ the elements of matrix W_B in region r, where indices r, s represent the regions (s = origin, r = destination), while indices i, j denote related industries (j -> i) in the supply chain:

$$z_{i,r} = b_{i,j,r} n_{r,s,j} x_{j,s} . \quad (6)$$

The projections of the multidimensional weight matrix (into the interregional plane) are not symmetric; in other words, they represent the directed graphs of interregional backward linkages. Developing a methodology through which econometric equations are defined by multidimensional weight matrices will make it possible to examine the effects of interregional supply chain linkages in an econometric context.

Dynamic multiregional modelling framework

The simple econometric equations representing the stochastic relationship between compensations and labour productivity only aimed to illustrate the opportunities behind the network-based weight matrix definition. In dynamic multiregional models, more sophisticated equations and econometric models are needed. These new equations will define the interlinkages among the most important regional variables (TFP, labour, capital, factor prices, R&D expenditures, etc.) and create dynamic interregional dependencies for simulations.

The network-based econometric equations, created from the new type of weight matrices, connect the variables in the multiregional model and establish interdependencies among regions; however, several other types of interregional equations can be added to the model to run dynamic simulations. The regional social accounting matrices can be linked by using different types of equations: identities, gravity model, and stochastic equations (spatial, network-based, and other cross-sectional econometric models). The best solution seems to be a mix of different types of equations, especially when the network-based estimation is not significant or is not possible to implement because of the lack of data.

Regional policy implications

The impact assessment can be implemented by changing the initial values of the exogenous variables. In this way, the shocks added to the system are defined as the differences between new and original values of the variables. This technique represents a powerful tool to investigate the dynamics of the multiregional model responding to an economic shock.

The dynamic simulations highlight the consequences of changes in the policy variables, which can be implemented by using macroeconomic and multiregional models separately, or by developing a mixed macroeconomic-multiregional model. The multisectoral regional blocks of the suggested model can support the identification of key industries within regions, while distinguishing spatially and network dependent sectors. Different types of industries justify different policies, depending on the observed interregional, backward, and forward linkages.

Conclusions and further research

The methodology to create network-based regions' weight matrices has been outlined, and the existence of multiregional network autocorrelation has been proved through a simplified econometric example.

The construction of interregional linkages in the multiregional modelling framework via network and spatial econometric equations is more convenient than the burdensome creation of the identities to connect regions' social accounting matrices. Collecting reliable data for these problematic identities also seems to be laborious or sometimes even impossible. Moreover, the assumptions of the spatial computable general equilibrium modelling framework (e.g. short-term spatial equilibrium of the labour market) are not verifiable. In this new approach, the long-term dynamic simulation using the interregional econometric equations can provide results as reasonable as the ones from spatial computable general equilibrium models. As for the macroeconomic and the intraregional blocks of the integrated model, the computable general equilibrium approach and the identities creation through the social accounting matrix are still recommended. The most appropriate solution might be a mixed type of econometric, input-output, and computable general equilibrium model, where the interregional linkages are simulated by network, gravity, and spatial econometric equations replacing the conventional identities.

In the future, an alternative way to build a lightweight version of dynamic multiregional models will be developed by using the network econometrics equations.

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Continuing divergence after the crisis: long-term regional economic development in the United Kingdom

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This study examines the trends of regional economic development in the United Kingdom before, during, and after the economic crisis. The United Kingdom is historically characterised by persistent and significant regional economic disparities, which further grew during the global financial crisis and seem to remain stable at higher levels. Salient features of the economic spatial structure are the well-known North-South divide and, in parallel, London's dominance over the rest of the country (the 'London problem'). Our research is primarily descriptive. Specifically, it combines a literature review covering the latest relevant contributions and empirical data analysis. Based on important current policy initiatives, our analyses will also address the issue of a more spatially balanced development.

Keywords:
regional economic inequality, United Kingdom, global financial crisis, economic rebalancing

Introduction

From a socio-economic perspective, the United Kingdom (UK) is a relatively developed nation amongst the member states of the European Union (EU). According to Eurostat data, its GDP per capita was around 130 per cent of the EU average between 2000 and 2014, but it heavily deteriorated during and after the 2008 global financial crisis (from 146 to 127 per cent). Nowadays, even the most economically backward region (West Wales and the Valleys) reaches around 80 per cent of the EU average, while the leading region (Inner London West) is at more than 600 per cent (at the NUTS 2 level). The EU Regional Competitiveness Index (RCI) ranks four UK regions in the top 10 most competitive ones in the EU[1], and even the least competitive region, Northern Ireland, ranks 145 out of 262 (Annoni et al. 2017). The regional RCI variation in the UK is relatively high amongst the most developed EU countries, but this measure is moderate compared to South Eastern European countries, and even to France and Italy. Regional inequalities are historically high in the UK: they have been present since the period of industrial development in the

[1] London and regions covered by its commuting zone (rank 1); Berkshire, Buckinghamshire, and Oxfordshire (rank 2); Surrey, East and West Sussex (rank 5); and Hampshire and Isle of Wight (rank 10).

19th century, and deepened during and after several periods of recession, as well as in boom periods (Marshall 1990, Gardiner et al. 2013). The investigation of the spatial processes in the country allows us to draw important conclusions about sources and dynamics of economic disparities, providing useful lessons for other countries, as well.

Our study emphasises that the increasing extent of spatial inequalities across the country cause not only a 'regional' but also a 'national' problem (McCann 2016), which thus needs substantial attention from policymakers. There has long been a debate over the existence of a trade-off between spatial disparities and national growth in an economy, that is, whether policies aiming to reduce regional economic inequalities are efficient for the country as a whole (Martin 2008). The theoretical models of the New Economic Geography claim that uneven geographical development may create higher rates of national growth through various increasing returns effects stemming from the spatial agglomeration of economic activities (Gardiner et al. 2013). For this reason, different courses of economic policy placed different emphasis on promoting regionally balanced economic growth in the UK (and, certainly, in other countries as well). Gardiner et al. (2013) argue that spatially unbalanced development and growth may bias or even compromise national economic policy, as it occurred in the UK during and after the global financial crisis in the second half of the 2000s.

This study examines the extent to which the UK economy is imbalanced and whether the crisis has reinforced trends of regional divergence. Our research methodology combines a literature review covering the latest relevant contributions and descriptive empirical data analysis. In the third section, we focus on the long-run trends behind the UK's regional problem. The fourth section outlines the consequences of the financial crisis, while the fifth one maps the opportunities for rebalancing the UK's economy including the 'northern powerhouse' initiative and the ones related to devolution. The last section summarises our findings.

Rising regional inequalities in the United Kingdom

According to McCann (2016), the basic problem of the UK economy is represented by its large interregional economic inequalities, which co-exist with a highly centralised and top-down governance system. This long-standing problem emerges in several aspects: uneven geographical development, sectoral composition, balance between consumption and investment, between the size of the public sector relative to the private sector, and merits of export-led growth relative to domestic-led expansion (Gardiner et al. 2013). A well-known feature of the UK regional problem is the so-called **North-South divide**. The concept is present in current economic policy debates in the UK and has deep historical roots (Baker–Billinge 2004). Regional disparities in economic and social conditions have been a persistent feature of the UK since the mid-19th century (Martin et al. 2016). They were triggered by industrial specialisation, and later expanded and diminished in several waves (Gardiner et al. 2013). Until the inter-war period, booming heavy industries were largely concentrated in northern England, Scotland, and Wales, or 'outer Britain' (Morgan 2002); however, later these areas became depressed as their economies structurally decoupled from the 'new economy' in the South (Mandelson 2001).

According to the classification by Gardiner et al. (2013), the North consists of the following regions: West Midlands, Wales, Yorkshire-Humberside, North West, North East, and Scotland, while the South includes London, South East, South West, East of England, and East Midlands (*Table 1*). Geographically, the dividing line is usually drawn between the Wash on the northern edge of East Anglia and the Severn Estuary in the South West of England.

Table 1

'Northern' (grey) and 'Southern' (white) regions in the United Kingdom

NUTS 1 Code	NUTS 1 Name	GDP per capita (UK = 100.0)*
UKI	London	166.5
UKJ	South East	107.6
UKH	East of England	93.1
UKM	Scotland	92.4
UKK	South West	90.1
UKD	North West	84.9
UKF	East Midlands	81.9
UKE	Yorkshire and The Humber	81.5
UKG	West Midlands	80.7
UKN	Northern Ireland	77.3
UKC	North East	73.8
UKL	Wales	70.7

* GDP per capita is calculated as the average between 2008 and 2014.
Source: Author's elaboration based on Eurostat data.

Business cycles and economic shocks' patterns across the UK regions are less correlated than those between EU countries, and London's economy is becoming increasingly disconnected from the rest of the UK; in other words, there is little or no economic cohesion between the different parts of the country. Moreover, regional interests are diverging, which poses difficulties in the country governance (McCann 2016).[2] While London and the South East region cover around 8.5 per cent of the area, 27 per cent of the population, and 28 per cent of the employment within the UK, these regions account for 38 per cent of the country gross domestic product (*Table 2*).

[2] 'The UK has "gone south"[…].' (McCann 2016, p. 27).

Table 2

Shares of the NUTS 1 regions with respect to area, population, employment, and GDP of the United Kingdom, 2014

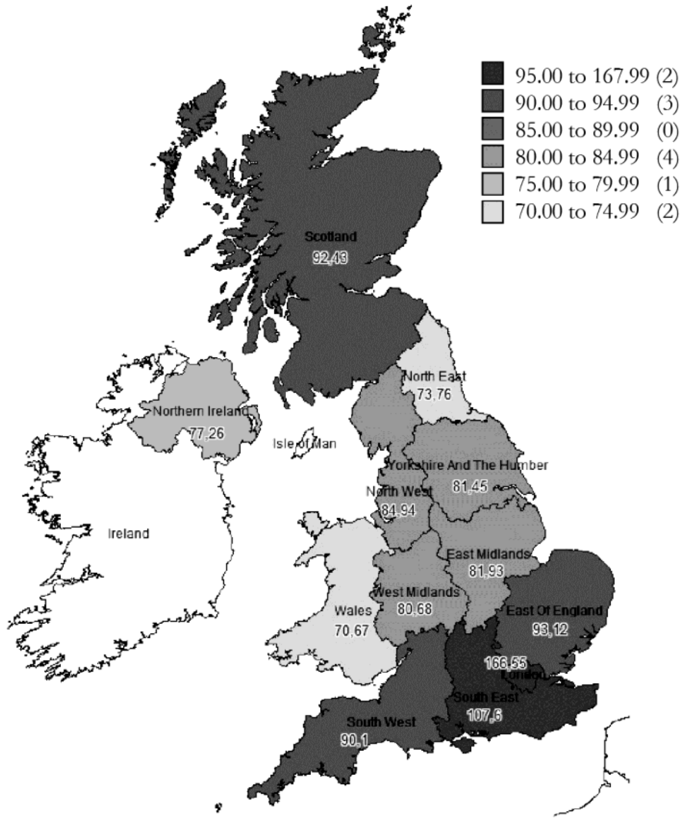
	Area		Population		Employment		GDP	
	km^2	%	1 000 persons	%	1 000 persons	%	Million euros	%
North East	8,573	3.52	2,614.8	4.06	1,143.3	3.87	66,700	3.00
North West	14,112	5.80	7,120.4	11.06	3,143.8	10.64	209,557	9.43
Yorkshire-Humber	15,369	6.31	5,356.7	8.32	2,408.7	8.15	148,869	6.70
East Midlands	15,594	6.41	4,614.0	7.17	2,132.9	7.22	133,084	5.99
West Midlands	12,964	5.33	5,691.3	8.84	2,478.4	8.38	160,458	7.22
East of England	19,084	7.84	5,981.7	9.30	2,819.3	9.54	194,081	8.73
London	1,574	0.65	8,477.3	13.17	4,157.1	14.06	509,402	22.91
South East	19,067	7.83	8,828.3	13.72	4,170.2	14.11	335,161	15.07
South West	23,860	9.80	5,396.7	8.39	2,488.4	8.42	169,288	7.61
Wales	20,742	8.52	3,095.1	4.81	1,320.3	4.47	75,976	3.42
Scotland	78,418	32.21	5,337.5	8.29	2,509.7	8.49	172,744	7.77
Northern Ireland	14,078	5.78	1,837.3	2.86	787.6	2.66	48,078	2.16
United Kingdom	243,435	100.00	64,351.2	100.00	29,559.7	100.00	2,223,398	100.00

Source: Author's calculation based on Eurostat data.

Then, we investigate to what extent basic economic indicators, GDP per capita time series, and employment data provided by Eurostat reflect the classification by Gardiner et al. (2013). *Figure 1* maps GDP per capita at the NUTS 1 level; the values are expressed in current prices (in euros) between 2008 and 2014, taking the UK average as 100. This map approximately corroborates the regions' grouping (North and South) mentioned earlier. Scotland seems to be a positive outlier amongst the northern regions, while East Midlands a negative outlier in the South. The position of West Midlands has been debated over the previous decades; economically, it currently belongs to the North.

Figure 1

Regional dispersion of the average GDP per capita (current prices, in euros) between 2008 and 2014 at the NUTS 1 level, UK average = 100.00



Source: Author's elaboration based on Eurostat data.

The North-South divide is a stereotype, and characterising the UK economy with this phenomenon is a simplification. Nonetheless, in broad terms, the divergence between these two major areas is undeniable (Martin et al. 2016). Gardiner et al. (2013) show that, in some cases, the existence of such a divide can be questioned, since local areas of economic depression and deprivation can be found in the South, while there are areas of growth and prosperity also in the North. The authors highlight that the picture is more complex at the local level than it is at a regional scale (*Table 3*). For example, even London includes some areas of high unemployment and poverty. However, the basic argument on the existence of a North-South divide is that areas of economic depression and deprivation are more numerous in the North, while areas of economic prosperity abound in the South (Gardiner et al. 2013).

Table 3

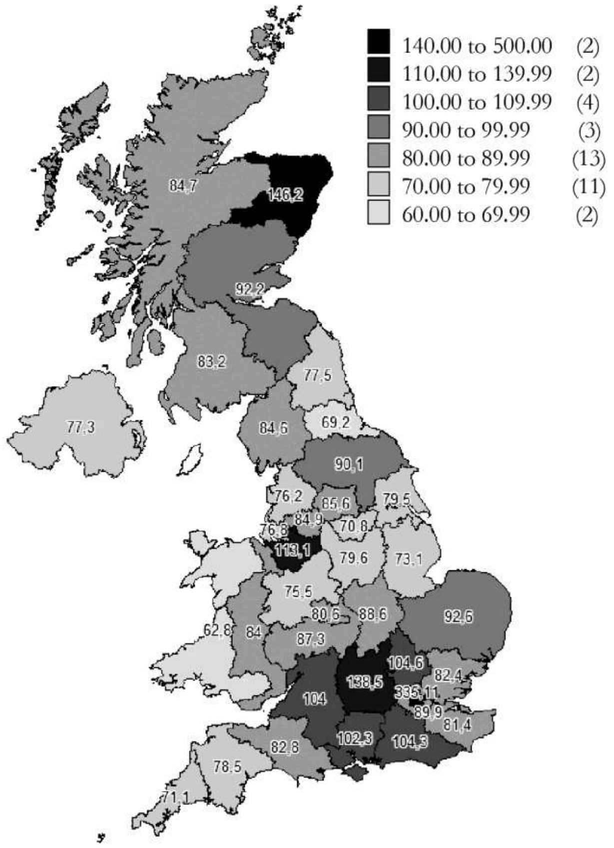
Regional differences at the NUTS 2 level in the United Kingdom ('North': grey, 'South': white)

NUTS Code	NUTS 2 Name	GDP pc*
UKI3	Inner London - West	497.5
UKI4	Inner London - East	172.7
UKM5	North Eastern Scotland	146.2
UKJ1	Berkshire, Buckinghamshire and Oxfordshire	135.8
UKD6	Cheshire	113.1
UKI7	Outer London - West and North West	106.8
UKH2	Bedfordshire and Hertfordshire	104.6
UKJ2	Surrey, East and West Sussex	104.3
UKK1	Gloucestershire, Wiltshire and Bristol/Bath area	104.0
UKJ3	Hampshire and Isle of Wight	102.3
UKH1	East Anglia	92.6
UKM2	Eastern Scotland	92.2
UKE2	North Yorkshire	90.1
UKI6	Outer London - South	89.5
UKF2	Leicestershire, Rutland and Northamptonshire	88.6
UKG1	Herefordshire, Worcestershire and Warwickshire	87.3
UKE4	West Yorkshire	85.6
UKD3	Greater Manchester	84.9
UKM6	Highlands and Islands	84.7
UKD1	Cumbria	84.6
UKL2	East Wales	84.0
UKM3	South Western Scotland	83.2
UKK2	Dorset and Somerset	82.8
UKH3	Essex	82.4
UKJ4	Kent	81.4
UKG3	West Midlands	80.6
UKF1	Derbyshire and Nottinghamshire	79.6
UKE1	East Yorkshire and Northern Lincolnshire	79.5
UKK4	Devon	78.5
UKC2	Northumberland and Tyne and Wear	77.5
UKN0	Northern Ireland	77.3
UKD7	Merseyside	76.8
UKD4	Lancashire	76.2
UKG2	Shropshire and Staffordshire	75.5
UKI5	Outer London - East and North East	73.3
UKF3	Lincolnshire	73.1
UKK3	Cornwall and Isles of Scilly	71.1
UKE3	South Yorkshire	70.8
UKC1	Tees Valley and Durham	69.2
UKL1	West Wales and The Valleys	62.8

* GDP per capita is calculated as the average between 2008 and 2014; the UK average is set at 100.
Source: Author's calculation based on Eurostat data.

Figure 2

Regional dispersion of the average GDP per capita (current prices, in euros) between 2008 and 2014 at the NUTS 2 level, UK average = 100



Source: Author's elaboration based on Eurostat data.

The region that most challenges the North-South classification is Scotland. According to McCann (2016), the UK can be considered as consisting of three different economies: London and its hinterland (South East, East of England, and South West), Scotland, and the rest. In terms of GDP, productivity, and employment, Scotland has improved within the UK, with only the recovery (austerity) after the crisis causing a temporary deterioration in its relative performance. This seems to suggest that the relative catching-up of Scotland is not a direct consequence of the increased devolution in the past few years, but rather a longer-term phenomenon.[3] Some of the contributing factors can be the increased importance of oil industry

[3] See Greg et al. (2016) for an analysis of the Scottish long-term economic development in the context of devolution from the cities' perspective.

and green energy, as well as the economic vibrancy of some first- and second-tier cities such as Aberdeen. Given the possibility of Scotland's independence, economic stability becomes crucial for public finance sustainability and overall prosperity (Harris–Moffat 2016, Armstrong–McLaren 2014).

As per the GDP per capita at the NUTS 2 level between 2008 and 2014, the evidence is certainly more mixed (*Table 3* and *Figure 2*). On average, the values range between 63 per cent (West Wales and the Valleys) and 497 per cent (Inner London–West)[4] of the national average. Out of the 40 regions at the NUTS 2 level, only ten regions exhibit a GDP per capita above the national average, and two of them are in the 'North' (North Eastern Scotland, 146 per cent and Cheshire, 113 per cent).

In most regions, the evolution of the regional GDP per capita was more or less stable before and after the global financial crisis relatively to the national average (*Table 5*), though with some exceptions. London constantly advanced (from 163 to 171 per cent)[5], and the North East, the North West, and Scotland also improved their position by around 2 to 3 percentage points.[6] The largest deterioration was observed in the West Midlands (from 87 to 80.5 per cent)[7], Northern Ireland (from 80 to 75 per cent) and the East of England (from 97 to 92 per cent).[8] As pointed out by Martin (2015), the long boom between the early-1990s and 2007 reinforced regional inequalities. The variation coefficient of GDP per capita is around 30 per cent at the NUTS 1 level, and around 70 per cent at the NUTS 2 level, with an increasing trend (*Table 4*). As per McCann (2016), business cycles and economic shocks' patterns across UK regions are today less correlated than those between EU countries. At the NUTS 1 level, the scale of interregional differences in GDP per capita is comparable to the corresponding international differences across 17 European countries and across 22 OECD countries, while at the NUTS 3 region level, these differences are comparable to those across 22 European countries and 27 OECD countries (McCann 2016).

[4] Figure 2 indicates the average value for Inner London (336.11 per cent), computed as the average of Inner London West (497.5 per cent) and Inner London East (172.7 per cent). The average value of Outer London is 89.85 per cent, computed as the average of Outer London East and North East (73.3 per cent), Outer London South (89.5 per cent), and Outer London West and North West (106.8 per cent).

[5] Nevertheless, Outer London deteriorated significantly from 101 to 92 per cent, while Inner London improved from 301 to 341 per cent. By 2014, the Inner London West NUTS 2 region reached 495 per cent of the national average GDP per capita.

[6] Specifically, North Eastern Scotland substantially improved (from 117.5 per cent in 2000 to 150 per cent in 2014), while the other two NUTS 2 regions of Scotland nearly stagnated.

[7] Out of the 3 NUTS 2 regions in the West Midlands NUTS 1 region, the West Midlands NUTS 2 region heavily deteriorated (from 91.5 to 79 per cent, while the other regions nearly stagnated.

[8] The highest drop was observed in Bedfordshire and Hertfordshire (from 114 to 103 per cent, while East Anglia and Essex lost only 2 and 4 percentage points relative to the national average, respectively.

Table 4

Variation coefficient and ratio of the maximum and minimum value of the GDP per capita at the NUTS 1 and NUTS 2 levels between 2000 and 2014

	2000	2002	2004	2006	2008	2010	2012	2014
	NUTS 1							
CoV*	27.1	25.8	24.7	25.0	26.8	27.0	28.4	29.6
Max/min	2.33	2.27	2.19	2.22	2.36	2.34	2.36	2.43
	NUTS 2							
CoV*	59.4	56.5	57.0	58.9	64.1	68.2	70.3	68.0
Max/min	7.27	7.00	6.91	7.03	7.80	8.11	8.11	7.85

* The coefficient is expressed in percentage points.
Source: Author's computation based on Eurostat data.

Table 5

Evolution of GDP per capita (current prices, in euros) between 2000 and 2014 at the NUTS1 level

NUTS 1 Name	2000	2002	2004	2006	2008	2010	2012	2014
North East	20,000	21,700	23,300	25,700	22,900	21,300	23,800	25,500
North West	23,600	25,700	26,700	29,300	26,400	24,900	27,100	29,400
Yorkshire-Humber	23,000	24,700	26,000	28,200	25,500	23,700	26,000	27,800
East Midlands	23,800	24,800	25,300	28,000	25,200	23,800	26,400	28,700
West Midlands	24,900	25,700	26,300	28,300	25,000	23,300	26,200	28,100
East of England	27,800	29,200	29,700	32,500	29,400	27,100	29,800	32,200
London	46,600	47,500	49,000	54,200	50,400	47,300	54,200	59,700
South East	31,600	33,700	33,300	35,900	32,800	31,100	35,100	37,800
South West	25,400	27,000	28,000	30,100	27,600	26,600	28,900	31,200
Wales	20,200	20,900	22,300	24,400	21,400	20,200	23,000	24,600
Scotland	25,600	27,300	28,400	31,700	28,800	26,500	29,300	32,300
Northern Ireland	23,000	23,400	24,600	27,600	24,700	22,400	24,800	26,100
United Kingdom	28,600	30,000	30,800	33,900	30,900	28,900	32,200	34,900

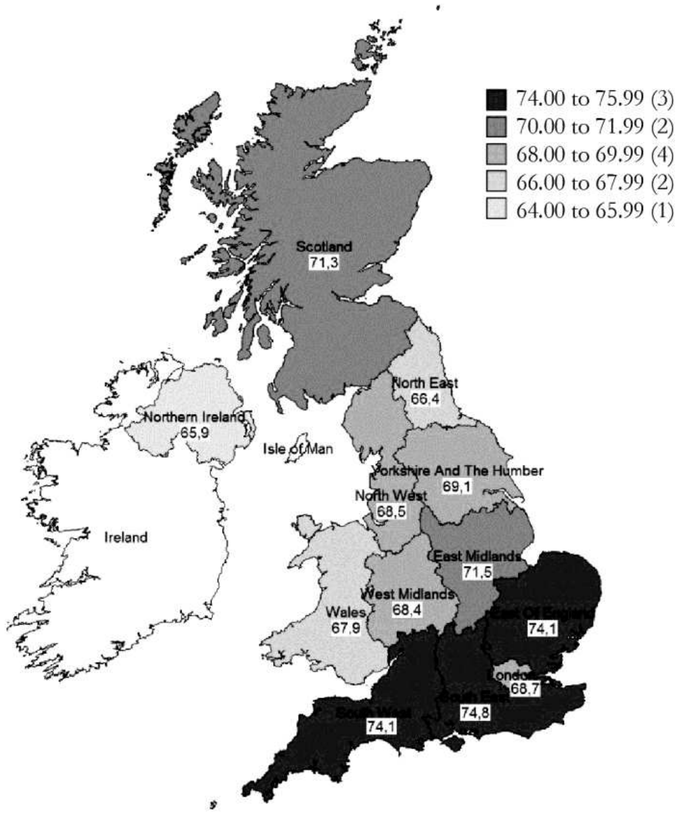
Source: Author's elaboration based on Eurostat data.

Population in the UK has been growing constantly from 58 million in 2000 to 65 million in 2015, at a 0.66 per cent average annual rate. The growth rate has been positive in every NUTS 1 region since 2003. However, there are significant differences before and after the crisis. Specifically, the annual population growth rate steadily increased before the crisis (from 0.37 per cent in 2001 to 0.82 per cent in 2008), but during the recovery, this tendency stopped, and the growth rate stabilised around an annual average of 0.76 per cent. There has been a sharp increase in the yearly population growth rate of London between 2004 and 2009, and after the crisis it remained high at around 1.5 per cent. The lowest, though increasing, growth rates were measured in the North East, which moved from -0.2 per cent in 2001 to 0.42 per cent in 2015. After 2008, Northern Ireland, Scotland, and Wales experienced diminishing, but still positive population growth rates. After 2013, rates have increased in all NUTS 1 regions except for Wales and Northern Ireland. Considering the period after the crisis, a geographic division emerges: the highest average annual population growth rates were measured in the 'South' (0.69 to 1.5 per cent), while the lowest ones in the 'North'(0.33 to 0.66 per cent).

As for the **employment** data, *Figure 3* firmly supports the North-South classification by Gardiner et al. (2013). Typically, South East, South West, East of England, East Midlands, and Scotland are above the national average employment rate (71 per cent), while London is on average significantly below this level (*Figure 4*).

Figure 3

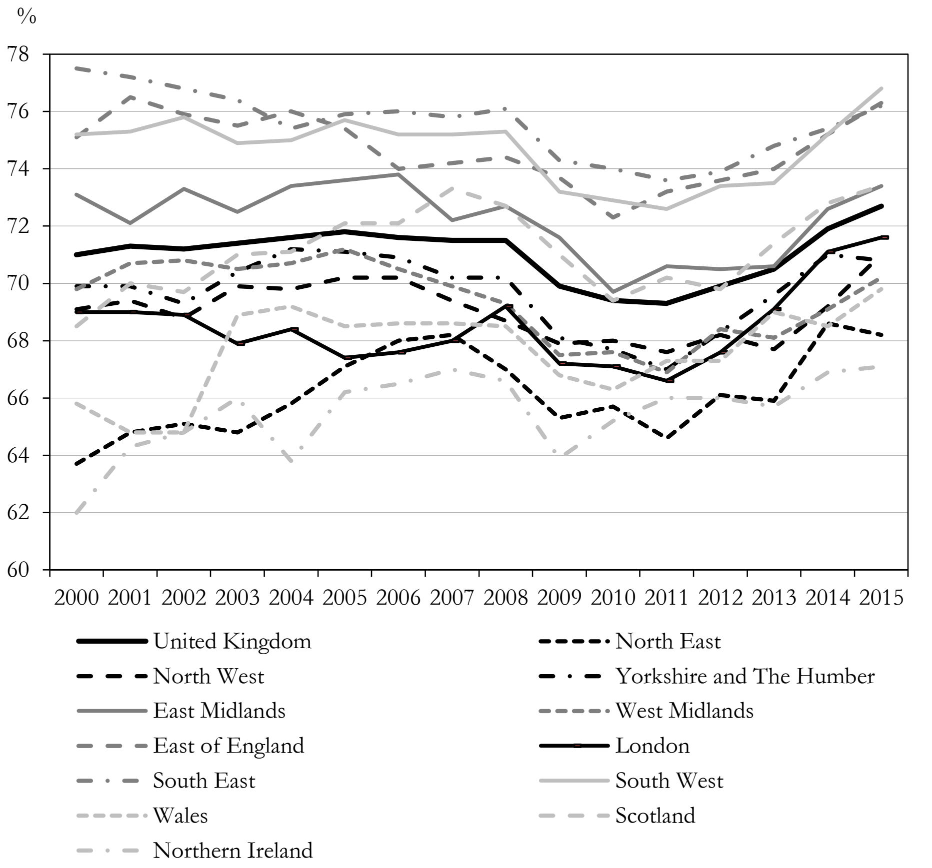
Average annual employment rate between 2008 and 2015 in the NUTS 1 regions of the United Kingdom



Source: Author's elaboration based on Eurostat data.

Figure 4

Evolution of the employment rates between 2000 and 2015 in the United Kingdom

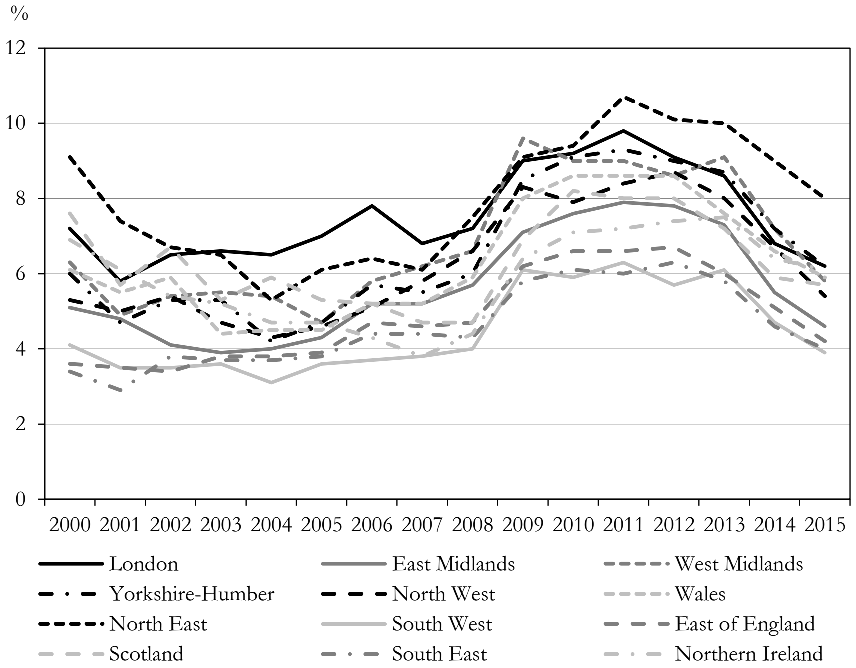


Source: Author's elaboration based on Eurostat data.

Figure 5 shows the evolution of the **unemployment** rates in the United Kingdom at the NUTS 1 level in the 2000s. Among the southern regions, London is a negative outlier, with the highest unemployment rates in the years before the global financial crisis. The rate peaked at 12 per cent in 2011 in Inner London–East, and at 11.1 per cent in Outer London–East and North East. On average, these NUTS 2 regions reported the highest unemployment rates after 2000. The lowest average unemployment rate (3.9 per cent) was measured in North Eastern Scotland (Aberdeen and Aberdeenshire) between 2000 and 2015, and remained at quite a low level (between 3 and 4.8 per cent) during and after the crisis. North Yorkshire (4.2 per cent) and Cheshire (4.6 per cent), though located in the 'North', are also among the regions with the lowest unemployment rates.

Figure 5

Evolution of the unemployment rates between 2000 and 2015 in the United Kingdom at the NUTS 1 level



Source: Author's elaboration based on Eurostat data.

Eurostat data highlight marked differences across NUTS 1 regions with respect to **education attainment**. Since the beginning of the 2000s, the share of people aged 25 to 64 with less than primary, primary, and lower secondary education has been decreasing constantly all over the country, from an average of 35.6 per cent in 2000 to 20.3 per cent in 2015. In parallel, the share of people aged 25 to 64 having tertiary education has been constantly increasing after the Millennium, from 28.5 per cent in 2000 to 41.6 per cent in 2015. However, cross-sectional (between regions) standard deviation has also increased. In 2015, only London, Scotland, the South East, and the South West regions were above the national average (41.6 per cent) with respect to the share of people aged 25 to 64 with tertiary education (*Table 6*). Among the NUTS 2 regions, though in the South West, the lowest share was reported in Cornwall and the Isles of Scilly (32 per cent), while the highest one was measured in Inner London–West (69.5 per cent). The East of England and East Midlands also positioned below the national average. The lowest share was reported for Northern Ireland and the North East. This North-South gap is partly a consequence of out-migration of the better qualified to more prosperous regions, where a higher proportion of better jobs is offered (Adams et al. 2003). The significant disparities with respect to education attainment (the variation coefficient is around 15 per cent) point to the importance of related policy interventions as a central part of regional development policy.

Table 6

Share of tertiary education attainment of people aged 25 to 64 in the NUTS 1 regions, 2015

NUTS 1 Name	%
London	55.1
Scotland	47.1
South East	44.7
South West	41.8
Wales	38.8
East of England	37.2
North West	37.2
West Midlands	36.2
East Midlands	35.9
Yorkshire and The Humber	35.4
North East	35.0
Northern Ireland	33.6
United Kingdom	41.6

Source: Author's elaboration based on Eurostat data.

Productivity is widely recognised as the most important long-run driver of economic growth (Harris–Moffat 2016). As showed in *Figure 6*, in the long term southern regions tend to outperform northern ones in terms of productivity, measured as the nominal gross value added per hour worked. Scottish productivity, especially in Aberdeen city and Aberdeenshire, is similar to that of regions in the South East, owing to the great variety of its industries, while East Midlands and South West seem to exhibit lower performances amongst the southern regions. Rural and remote areas, as well as those regions that are dependent on agriculture and tourism usually lag behind, while large cities tend to be quite productive (Boren 2015). Regional inequalities in the UK are amongst the highest of any advanced OECD country, even by excluding the case of London (McCann 2016).

According to the Office for National Statistics (2017a), the very high levels in the Greater London region lead to a skewed distribution of productivity across the UK. As a result, relatively few regions show productivity levels above the UK average: in 2015, only 47 out of 168 NUTS 3 regions across England, Scotland, and Wales had a gross value added per hour worked above the UK average, of which 21 were in London. The analysis shows that, in the South of England (South East, South West, and East of England), productivity levels were well above the UK average in the most productive areas, while the lowest labour productivity levels in 2015 were generally found in rural or coastal areas outside Greater London (*Table 7*).

Table 7

Regional productivity index at the NUTS 3 level in 2013
(UK less Extra-Regio = 100.0)

NUTS Code	NUTS Name	Productivity Index
	Top 10	
UKI11	Inner London – West	146.8
UKJ11	Berkshire	133.3
UKI12	Inner London – East	133.2
UKJ23	Surrey	124.7
UKJ13	Buckinghamshire CC	118.6
UKM50	Aberdeen City & Aberdeens.	118.5
UKF11	Derby	116.5
UKM25	Edinburgh, City of	115.7
UKK14	Swindon	113.5
UKJ12	Milton Keynes	112.9
	Bottom 10	
UKM24	Scottish Borders	75.4
UKM32	Dumfries & Galloway	75.4
UKD41	Blackburn with Darwen	74.4
UKG11	Herefordshire, County of	74.3
UKK30	Cornwall and Isles of Scilly	72.2
UKL12	Gwynedd	72.2
UKL11	Isle of Anglesey	71.8
UKM66	Shetland Islands	71.5
UKL14	South West Wales	69.2
UKL24	Powys	62.1

Source: Author's elaboration based on Office for National Statistics data.

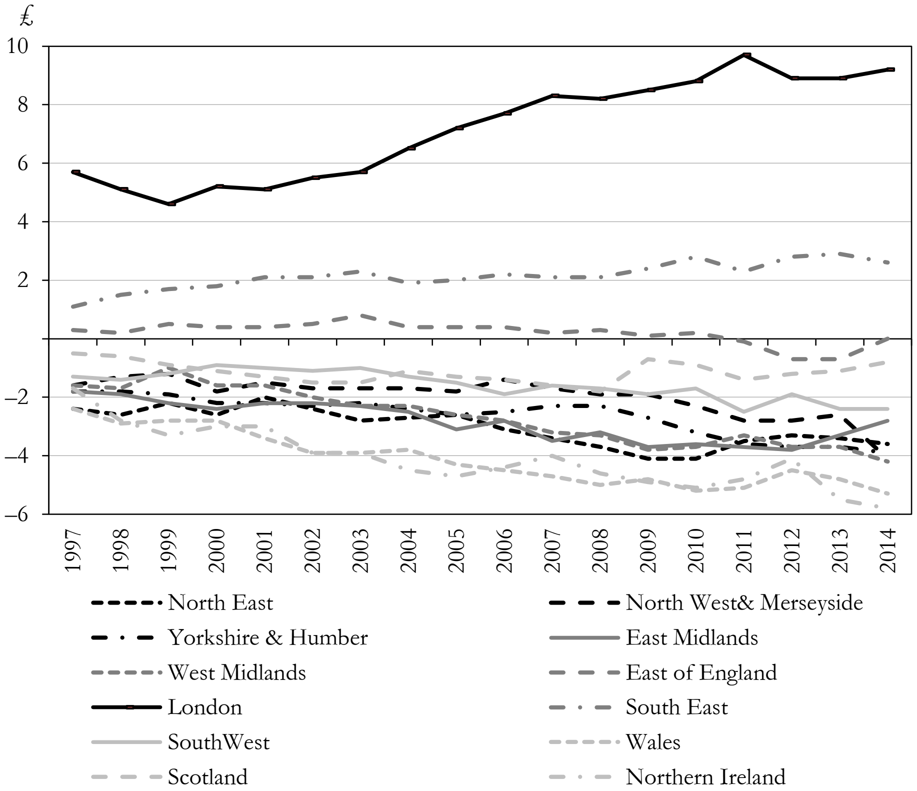
In the Midlands, two NUTS 3 regions exhibited productivity levels above the UK average in 2015: Solihull (West Midlands) and Derby (East Midlands), where car or aerospace manufacturing plants are located. In the North of England (North West, North East and Yorkshire, and The Humber), in 2015 only Chesire emerged as a positive outlier. The county is renowned for its agricultural industry and its leading role in several high-tech, high-skill industrial sectors (Billington 2011). In Scotland, four NUTS 3 regions[9] exceed the average UK productivity level. Harris

[9] Aberdeen city and Aberdeenshire (North East Scotland), Edinburgh (Eastern Scotland), South Ayrshire (South West Scotland) and Inverclyde, East Renfrewshire, and Renfrewshire (South West Scotland).

and Moffat (2016) analyse in detail the productivity gap between Scotland and the rest of the UK. Specifically, they identify 'place' and 'non-place' effects: the former considers the effect on productivity if plants with exactly the same characteristics were relocated from the rest of the UK to Scotland. In other words, such effects measure advantages or disadvantages associated with location. 'Non-place' effects, instead, show whether in Scotland there are too many or too few plants with characteristics not directly related to location which can be associated with lower or higher productivity. In terms of results, both positive and negative 'place' effects emerge in different industries, while 'non-place' effects turn out to be negative in all sectors. Harris and Moffat (2016) also suggest that Scotland suffered more than the rest of the UK from the closure of relatively highly productive foreign-owned plants. At the NUTS 3 level, all the twelve regions in Wales and the five in Northern Ireland fall behind the UK average.

Figure 6

Productivity gap between the UK average and the NUTS 1 regions, 1997-2014



Source: Author's elaboration based on Office for National Statistics data.

The impacts of the global financial crisis

In the UK, spatially unbalanced growth is politically recognised as having contributed to the 2008 financial crisis as well as a hindrance to future economic stability (Martin 2015). This means that regional economic inequalities increased not only in boom phases, but also during and after the crisis at even greater pace, resulting in an increasing concentration of economic activities around the capital city.

The global financial crisis caused a 24.3 per cent drop in GDP per capita between 2007 and 2009. As a response to the recession in 2008 and 2009, in the labour market, the UK experienced a prolonged fall in productivity, a stronger employment performance, a rapid growth in part-time and self-employment, and a dramatic decrease in real wages. However, these tendencies differ across regions (Bell–Eiser 2016). In the literature, London and the South East emerged as more resilient than other (older industrial) regions (Fingleton et al. 2012, Industrial Communities Alliance 2015, Bell–Eiser 2016).

The crisis resulted in a 2 percentage points' drop in the average employment rate between 2008 and 2011; however, the rate recovered to nearly 73 per cent by 2015, and it has been constantly increasing since 2012 (*Figure 4*). The relative position of the NUTS 1 regions has not changed much after the crisis, excepting Scotland, which improved a lot (from 68.5 per cent in 2000 to 73.4 per cent in 2015).[10] London proved quite resilient after the crisis, since it recovered its pre-recession employment level and rate substantially before the other regions (Bell–Eiser 2016). More in detail, during the recovery, there was a significant rise in part-time work relative to full-time work, which sheds light on the phenomena of underemployment (people work part-time but wish to have a full-time job) and hidden unemployment (partial inactivity). Job-to-job moves were relatively rare, and employees tended to keep their jobs, though under less favourable conditions. Similar phenomena were captured by Green and Livanos (2015) in the concept of involuntary non-standard employment, consisting of involuntary part-time and involuntary temporary work. The authors point out that weaker regional economies experienced larger than average shares of involuntary non-standard employment (North East, Wales, West Midlands, and Northern Ireland), while the opposite occurred in core regions.

Labour demand fell during and after the crisis due to the programme of fiscal consolidation and the decrease in public sector employment. The latter affected the regions disproportionately, since the regions outside London and the South East are more dependent on it as compared to other ones (*Table 8*). As per the Office for National Statistics (2017b), Northern Ireland presents the highest proportion of

[10] Actually, inequalities exist in Scotland: the highest employment rate was measured in North Eastern Scotland (77.2 per cent) and in the Highlands and Islands region (74.6 per cent), while Eastern Scotland (72.5 per cent) and South Western Scotland (67.9 per cent) have lower rates.

public sector employment relative to the private sector: specifically, it has fallen from 31 to 25 per cent since the crisis (the UK average has fallen from 22 to 17 per cent). Similar figures also apply to Wales, Scotland, and the North East of England. The lowest proportion of public sector employment was measured in London: it was around 19 per cent in 2009 and has fallen to 14.6 per cent in 2016. In the South East, the proportion changed from 18 to 15 per cent and in East of England and East Midlands from 19 to 15 per cent. The other four regions (Yorkshire and the Humber, North West, South West, and West Midlands) reported proportions near the UK average.

Table 8

Employment change between 2009 and 2016 in the public and private sectors (2009 = 100.0%)

NUTS 1 Region	Public sector	Private sector
North East	–20.9	+17.4
North West	–17.0	+11.7
Yorkshire-Humber	–18.1	+13.9
East Midlands	–14.5	+14.4
West Midlands	–16.1	+15.8
East	–12.6	+17.2
London	–9.0	+28.6
South East	–12.0	+10.3
South West	–18.9	+16.7
Wales	–18.0	+16.5
Scotland	–14.7	+12.9
Northern Ireland	–10.4	+19.2
UK	–15.1	+16.4

Source: Author's elaboration based on Office for National Statistics data.

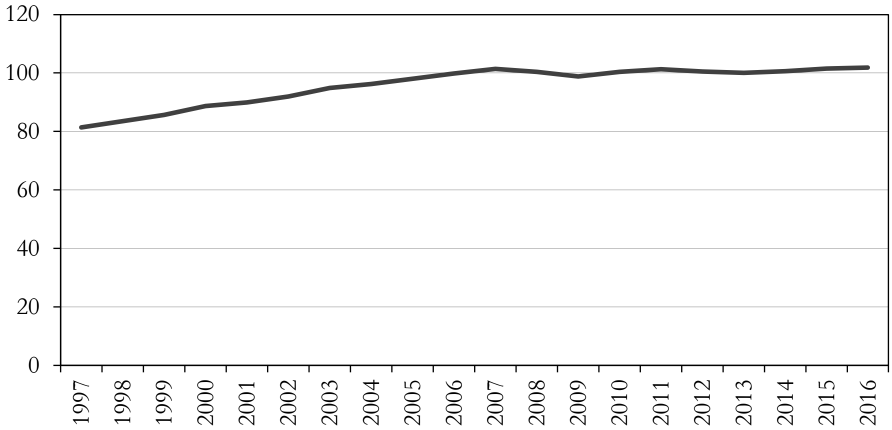
According to Eurostat data (*Figure 5*), during the global financial crisis, the highest increase in the unemployment rate was measured in the North East (from 6.1 per cent in 2007 to 10.7 per cent in 2011); moreover, high increases were experienced in Yorkshire and the Humber (3.8 percentage points), Northern Ireland (3.4 percentage points), Wales (3.4 percentage points), Scotland (3.3 percentage points), and London (3 percentage points). On the other hand, the South East and East of England resisted more to the crisis, as the increase in unemployment rates was relatively low (1.6 and 2 percentage points, respectively). In the recovery phase, unemployment rates have decreased in all NUTS 1 regions, though to a different extent. In London, the decrease was 3.6 percentage points (from 9.8 per cent in 2011 to 6.2 per cent in 2015); similarly, it was around 3 percentage points in the Midlands, in Yorkshire and the Humber, and in the North West. The smallest decrease (1.1 percentage points) was reported in Northern Ireland: from 7.2 per cent in 2011 to 6.1 per cent in 2015, which suggests that this region is the least resilient.

The regional differences in the impacts of the crisis on the labour market can be explained, among other important factors, by internal and international migration flows, as well as by the structure of the immigrant labour force (Bell–Eiser 2016).

Harari (2017) shows that, historically, UK labour productivity has grown by around 2 per cent per year, but it has stagnated since the 2008-09 recession (*Figure 7*). Labour productivity at the end of 2016 exceeded the pre-recession peak level (the value in fourth quarter of 2007) by 0.1 per cent only. In 2016, the annual productivity growth was 0.3 per cent. The reasons behind this productivity puzzle are numerous: falling productivity in the oil and gas and financial sectors; weak investments reducing the quality of equipment; the banking crisis generating lack of lending to more productive firms; employees being moved to less productive roles within the firm; and slowing rates of innovation and discovery, as well as population ageing. However, these factors are not sufficient on their own to entirely explain the phenomenon (Barnett et al. 2014, Harari 2017). The GDP growth realised in the past few years is mainly attributable to the increase in the hours worked (that is, increasing employment and decreasing unemployment) rather than productivity growth, which means that the labour market performance has been relatively strong during and after the crisis. As a result, wages and living standards have stagnated since the end of the crisis, and real wages fell during the recovery to a level around 10 per cent lower than before the recession (Gregg et al. 2014, Bell–Eiser 2016). Nominal wages have been frozen and even cut during the recovery, which resulted in decreasing wages in real terms due to the inflation. These trends were particularly evident in London.

Figure 7

Productivity index in the UK (output per hour worked), 1997-2016 (2013 = 100)



Source: Authors elaboration based on Office for National Statistics data.

After the crisis, only London, South East, Scotland, East Midlands, and North East regions were able to restore their productivity to above the pre-crisis level as compared to the national average. East of England fell below the national average, while Scotland almost reached it from a lower level.

Policies for improving economic balance

In response to the crisis and the subsequent recession, the UK government assigned key importance to the need to spatially rebalance the economy, in order to reduce its dependence on London and the South East by powering up northern cities (Martin 2015).[11] There is currently much interest in this issue not only at the central government level, but also within the major cities, regions, and nations (Martin et al. 2016).

The need for active policies for spatial rebalancing did not emerge as new. The so-called Barlow Report (Report of the Barlow Commission on the Distribution of the Industrial Population, 1940) raised concerns about the fact that concentration of economic activity and growth in London and the South East could lead to problems of congestion, urban sprawl, and inflation (Gardiner et al. 2013). The Commission not only recommended the development of new industrial capacity outside the core region, but even highlighted the importance of controlling London's growth to reduce the disparities between North and South, resulting in the so-called 'planned decentralisation'. As a consequence, measures were needed to relocate population and industries to the slow growing regions. Regional policy then prompted a more balanced distribution of employment through direct interventions. Martin (2015) argues that, in contrast to the Barlow Commission proposition, no fixed amount of economic growth or activity has to be distributed across the national economy. In other words, it is useless holding back prosperous areas in order to promote activity in the less prosperous ones. Instead, it has to be ensured that the less prosperous areas are able to realise their full economic potential. To this aim, proper and fair access to both public and private resources is needed. A hindering factor for the development outside the core region is that economic, financial, and political power is too concentrated in London.

Two main arguments support the view that greater spatial balance is needed across the UK (Gardiner et al. 2013, Martin et al. 2016). The first one is related to social equity: sustained outward migration of the relatively most enterprising, qualified, and skilled people from the slow-growing regions damages both economic potential and social cohesion of such regions (Rowthorn 2010). The second one is the economic efficiency argument, for which the persistent existence of underutilised resources (labour, capital, and infrastructures) in less prosperous regions is

[11] As David Cameron said: '(We need) a plan to breathe economic life into the towns and cities outside the M25' (Cameron 2010).

economically inefficient and hinders national economic growth, in addition to inducing higher social benefits (Gardiner et al. 2010).

The significant extent of regional inequalities poses challenges for the national economic policies. Due to the economic divergences within the UK, the country cannot be regarded as an optimum currency area (McCann 2016). London is a recurring source of inflationary pressure (Martin 2015), and a more even geographical distribution of economic activity would lower such pressure in factor markets. According to Gardiner et al. (2011), reducing regional disparities may enhance national economic management, while a highly spatially imbalanced economy can distort both fiscal and monetary policies. The authors explain that in regions of persistent high activity, the rate of inflation that maximises growth is likely to be higher than the corresponding optimum rate in low-activity regions. Monetary policy instruments and a large part of fiscal policy measures are set centrally and, therefore, are not able to account for regional differences. With large spatial disparities, the effects of common policy instruments are different throughout the country and are not evenly effective. The risk is that national economic policy instruments are set in a way that favours core regions. For example, according to Eddie George, the Governor of the Bank of England between 1993 and 2003, unemployment in the North was an 'acceptable price to pay to curb inflation in the South'. McCann (2016) points out that such risk is not just potential now, since, according to the rhetoric typical in the London popular press, national UK public policy should strive at all costs to maintain London's performance (p. 114).

It is now recognised that the growth of the UK economy has been too dependent on a narrow range of activities, especially finance, and on the mega-region of London and the Greater South East. A new 'local growth agenda' included Local Enterprise Partnerships (after the abolition of Regional Development Agencies), a regional growth fund, local enterprise zones, city deals, as well as various other measures such as infrastructure projects (Martin 2015).

The so-called 'northern powerhouse' initiative[12] was introduced by Chancellor George Osborne in 2014, stating that northern cities (Manchester, Liverpool, Leeds, and Newcastle) are characterised by individual strength, but collectively they are not strong enough. Grouping the cities sufficiently close to each other would rebalance the economy (Osborne 2014). However, London growth is not hindered in any way (Martin 2015). The idea of the 'northern powerhouse' is based on promoting growth in and devolving fiscal powers to a group of northern cities sufficiently close to each other that, combined, would rival London and the South East. The main objectives are to increase jobs and incomes, redress the North-South divide, and lift the nation's stagnant productivity. However, the success of this initiative is not guaranteed (Martin–Gardiner 2017, Hayton et al. 2016). Experience shows that the

[12] A similar initiative has been launched by the government for the Midlands under the 'Midlands Engine Strategy' (HM Government 2017) in Spring 2017.

'march of the makers' envisaged by Osborne (2011) failed to happen, and finance, which has less vertical (and regional) spill-over effect than manufacturing, remained the main source of economic growth.

Recent policy agendas are centred on two major issues (McCann 2016): governance decentralisation and devolution; and improvement of regional and interregional connectivity to counterbalance the highly London-centric infrastructure system. However, outcomes will not necessarily be as envisaged. Martin (2015) suggests that the impact of the existing economic development policies on a greater spatial balance is expected to be small, since such measures remain piecemeal, 'add-on', and marginal to the basic structures and workings of the UK's national system of fiscal, monetary, and economic management, which generally favours London and its hinterland (Martin 2015).

In questioning whether London is good or bad for the rest of the country, Martin (2015) summarises the main approaches. One argument is that productivity benefits spread across the country, the economy of Greater London generates demand for goods and services in the rest of the UK, and London is a major contributor to the taxes which, in turn, help fund welfare payments and public spending across the whole nation (City of London Corporation 2011). On the contrary, McCann (2016) states that there is no evidence of widespread and beneficial economic spatial spread effects from London to other regions. There are no real spread effects at all, and this results in the weak long-run productivity performance of the country as a whole (McCann 2016). The counter-argument states that London is 'a different country', an 'island', a quasi-independent 'city-state', 'Planet London' (O'Brien 2012), or that the UK is actually a 'Disunited Kingdom' (Ganesh 2015). Specifically, the region has detached from the rest of the UK in terms of prosperity, economic growth, global orientation, and cyclical behaviour (Martin et al. 2016). Sturgeon (2014) depicts London as a 'black hole' which drains talent, investment, and business from the rest of the country, Europe, and the world.

According to Martin (2015), 'London is indeed a very "different creature" from the rest of the country's urban system, and its economy is most certainly partly driven by unique political forces.' The UK has one of the most centralised national political and financial systems amongst the OECD countries, and London receives huge amounts of public spending: around 14 percent of the total UK spending (*Table 9*). The balance between regions seems to improve when measured on a per capita basis. On the other hand, London and the South East are significant net contributors to the UK economy (Oxford Economics 2007). For this reason, it cannot be claimed that the agglomeration of activities in London is purely 'market-driven'. Spatial imbalances in the UK relate to a major spatial imbalance in the location and operation of the key levers of economic, financial, political, and administrative power (Martin–Gardiner 2017). Cities and regions outside London see the national policy as London-centric and ignoring their needs and conditions (Wilcox et al. 2014). It seems that, while state expenditures attempt to relieve regional disparities through welfare spending and redistribution, they do not really support extra growth in peripheral regions, since the allocated state capital and research spending is distorted towards London and the South.

Table 9

Total identifiable expenditure on services by country and region in real terms

	2010-11 outturn		2011-12 outturn		2012-13 outturn		2013-14 outturn		2014-15 outturn	
	£ million	£ per head	£ million	£ per head	£ million	£ per head	£ million	£ per head	£ million	£ per head
North East	25,813	9,979	25,158	9,690	24,925	9,578	24,720	9,470	24,498	9,355
North West	68,127	9,705	66,376	9,407	66,651	9,408	65,770	9,259	65,652	9,204
Yorkshire-Humber	47,320	9,005	46,801	8,850	46,547	8,755	46,158	8,648	46,453	8,667
East Midlands	38,012	8,434	37,405	8,244	37,586	8,229	37,548	8,166	37,866	8,165
West Midlands	50,097	9,001	49,451	8,817	49,363	8,748	49,100	8,653	49,650	8,690
East of England	48,474	8,347	46,860	7,993	46,803	7,923	47,308	7,945	47,467	7,887
London	88,040	10,921	85,819	10,460	84,051	10,116	84,073	9,989	84,092	9,848
South East	69,532	8,106	67,526	7,804	68,098	7,805	69,220	7,872	68,877	7,762
South West	44,461	8,451	44,156	8,330	44,326	8,301	44,915	8,352	45,023	8,302
Scotland	55,993	10,641	55,654	10,501	55,978	10,535	55,082	10,339	55,520	10,382
Wales	31,367	10,284	31,323	10,223	30,583	9,949	30,515	9,900	30,649	9,912
Northern Ireland	20,453	11,332	20,436	11,264	20,466	11,223	20,270	11,078	20,457	11,115
UK identifiable expenditure	587,689	9,364	576,964	9,117	575,378	9,032	574,680	8,965	576,205	8,920

Source: Author's elaboration based on HM Treasury (2016).

Martin (2015) claims that national political-administrative and economic governance systems, together with their territorial structures, can significantly influence the geography of economic growth and development through their macro-economic policies, taxation and spending priorities, funding of infrastructures, welfare programmes, and measures for crises management (e.g. current fiscal austerity programmes). As previously mentioned, due to the high centralisation of governance, policies are often London-centric and do not address the problems of less developed areas. The high levels of political centralisation and regional economic inequality are interdependent phenomena. In large and highly diverse economies like the UK, the top-down centralised governance system may not be really appropriate, and may even exacerbate the dislocating and decoupling of the national economy (McCann 2016, Martin–Gardiner 2017). A foremost priority of the national economic policy is to maintain London competitiveness, while disproportionately less attention is paid to the potential comparative advantages and growth prospects of northern regions and centres.

Martin et al. (2016) propose five novel elements for a policy model favouring a more spatially balanced economic development in the UK. These include decentralisation and devolution of governance in England; a new institutional framework to coordinate policies for spatial imbalance; decentralisation of public administration and employment; fiscal devolution; and, finally, financial system decentralisation. Recent policy initiatives toward rebalancing are rather fragmented and ad hoc. According to McCann (2016, p. 454), 'Whitehall exhibits only a very limited ability to think spatially'. Nonetheless, recent regional economic trends suggest that central governance is not sufficiently committed to reduce the increasing spatial disparities, and better tendencies will not arise until radical, comprehensive changes will occur in favour of peripheral regions. Since the phenomenon of large interregional inequalities poses a national problem, finding an effective solution is of national interest.

Summary

We studied several facets of regional economic disparities in the UK, and presented various evidences underlying the tendencies for increasing spatial imbalances before, during, and after the economic crisis. Data mostly support the well-known phenomenon of the North-South divide in terms of production and labour market developments, with Scotland representing the most significant exception. The economy of London and the South East definitely dominates the country's economic landscape and poses a great challenge for the national policy. During the recovery after the recession, south-eastern regions proved relatively resilient, while northern ones have been recovering more slowly. The primary reasons behind this are the difference in the dependence on the public sector and the vulnerability to austerity measures. A marked, unexpected, and unprecedented issue of the post-crisis period is the productivity puzzle, where the productivity growth rate substantially deviates from the pre-crisis level and does not tend to improve. Output growth is largely based on employment growth, while productivity has been mainly stagnant, and real wages have fallen dramatically.

Presently, the 'regional problem' poses challenges for the economic development of the whole nation and requires active policy attention. There are some significant, promising policy initiatives for powering up less prosperous regions and cities; however, these measures might not be sufficiently radical, effective, convincing, and coherent. The economic performance of the UK as a whole is excessively dependent on London and the financial sector. As a result, national economic policy places too little attention on the potential competitive advantages of northern regions and subordinates northern interests for the sake of London's prosperity. Some aspects of the mechanisms behind regional inequalities were not investigated in this study, including disparities on the housing market, innovation, and urban structure. These issues leave room for further research.

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Economic resilience and hybridization of development – A case of the Central European Regions

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economic resilience,
regions,
regional resilience,
hybridization,
Central Europe

This paper addresses the initial diagnosis and evaluation of economic resilience among European Union (EU) countries, focusing on the Central European regions. Empirical analyses show variety considerable differences in the economic positions of territorial units, which calls for the concept of hybridization, enabling the interpretation of different patterns of development in a territorial dimension. The main aim of this paper is to capture the phenomenon of hybridization development by demonstrating the high economic differentiation that determines the difference in resilience across the EU.

Introduction

This article introduces the study of economic resilience and analyses its effects in EU countries, focusing on the regions of Central Europe. Discovering and building territorial adaptability accounts for global socio-economic trends and leads to the combination of existing businesses with new technologies. Consequently, unsustainable growth dynamics are impacted by external distortions. In the case of countries and regions, this means that parallel occurrences of the growth and stagnation stages occur, resulting in multiple trajectories of change.

The diversity and multiple trajectories of economic change can be interpreted in terms of hybridization of development, which in recent years has often been referenced as a concept that explains the unconnected, and highly diverse development trends (Patkar–Keskar 2014). Hybridization is perceived as an intrinsic component of the modern growth dynamics that determine the level of resilience spanning the spatial organisation of socio-economic systems. The main reason for hybridization in the business and territorial sphere is the need for rapid transformation of production in a cosmopolitan, consumer-oriented, and globalised world (i.e. the searching and building of adaptability as a main driving force of resilience).

Is hybridization of development explained by the randomness of economic processes or can it be regarded as a new pattern of development? Contemporary developmental effects, including often unexpected industry and technology links, may be interpreted as random without a detailed analysis. Nevertheless, more detailed identification of such processes reveals a hybrid of solutions and effects. In general, accounting for the above considerations, one can hypothesize that building the adaptability of economic systems (i.e. their resilience) in the globalised and digital world results in new patterns of development that often take the form of hybrids.

Bearing in mind the above-mentioned considerations, this paper aims to capture the phenomenon of hybridization development by demonstrating the high economic differentiation that determines the difference in economic resilience across the EU, with particular emphasis on Central Europe. The article covers issues related to a theoretical introduction to the economic resilience of regions, initial empirical research on economic resilience of the EU countries and regions of Central Europe, and formulation of conclusions linking the issue of resilience with the hybridization category. In the methodological section, attempts have been made to carry out quantitative comparative analyses of territorial units (the EU countries [n=28] and the Central European regions at NUTS 2 level [n=53]) based on indicators (both classical and the author's) of GDP size and dynamics. The lifespan of conducted analysis covers the period of 2000-2014.

Regions' economic resilience

The regional resilience concept has increasingly become a supporting concept for the diagnosis of regions and cities and development of programming in the last decade. Its roots go back to the debate about sustainable development, which links resilience with climate change and exogenous shocks (Simme–Martin 2010). The resilience concept is triggered by both general notions (i.e. adaptive capacity, determined by learning skills, entrepreneurship, innovations, and self-organisation (Hudson 2010)) and the vulnerability of a system to external shocks such as financial crises, energy crises, and floods (Bosher–Coaffee 2008).

In terms of adaptive capacity, the regional resilience concept may lead to a few essential lines of research. The first refers to the identification of attributes, factors, and indicators for measuring resilience, which permits deep diagnosis of regional and urban systems (descriptive dimension). The second is focused on the planning and implementation of measures for a regional system's best possible adaptation to and preparation for exogenous disruptions (normative dimension). The third is concentrated on comparative studies of regions and cities' paths of development, disruptions, and methods of recovery (evolution dimension). All these lines of research are to some extent the consequence of studies from post-positivistic epistemology (Walker et al. 2006) and apply systemic thinking to understand the subject of study as a complex, multidimensional, open regional or urban system.

The list of definitions of resilience or regional and urban resilience emphasise different aspects of the phenomenon. One of the definitions perceives resilience as a reaction to specific extraordinary events (Simme–Martin 2010), while another highlights resilience as the stability of a system against interference (Welter-Enderlin 2006, Lang 2011). There are also approaches that draw attention to system capacity, which allows a system to avoid and manage natural and human-induced hazards (Bosher–Coafee 2008). Generally, in regional science it is assumed that regions and cities are complex adaptive systems of people, economy, and environment, self-organised with a few critical processes creating and maintaining this self-organisation (Hooling 2001) and determining their resilience capacity. This means that regional or urban resilience should be defined in terms of a flexible society and economy that can anticipate, prepare for, respond to, and recover from a disturbance (Bernett 2001, Foster 2007).

Previous and current studies of the resilience concept conclude that a resilient system, such as a region or city, tolerates exogenous disruptions through certain general attributes that determine the disruptions' impact, reducing 'damage and disruption, and allowing the system to respond, recover, and adapt quickly to such disturbances' (Wardekker et al. 2010).

These kinds of attributes, which build and enhance regional or urban resilience, comprise *adaptability*, *diversity*, *efficiency*, *redundancy*, *collaboration,* and *interdependence* (Godschalk 2003, Klein 2003, Walker–Salt 2006, Taşan-Kok–Stead–Lu 2013). According to this approach, a resilient region is one that has the appropriate combination of these attributes to cope with exogenous disturbances within the process of the region's transition. In the context of the diagnosis of the resilience phenomenon, these kinds of attributes, measured for a particular region or regions, seem to be very interesting in examining the assessment of resilience (Drobniak 2014), because they enable a holistic view of a region as a complex system and a decomposition of the region system into traits that may be further decomposed into resilience and vulnerability factors and indicators (Berkas et al. 2003). In an overall assessment of regional resilience, these attributes can be identified within basic regional structures like economic-technological, socio-cultural, environmental-spatial, and institutional-political ones (Drobniak 2014). In this way, economic regional resilience refers to a region's structures that are responsible for creating, manufacturing, distributing, and selling products and services in internal and external markets. Social resilience focuses on a region's demographic and community behaviour patterns, beliefs, and attitudes.

Several conclusions arising from contemporary resilience studies can be applied to the diagnosis and evaluation of regional or urban resilience. For example, Desmet and Rossi-Hansberg (2009) argue that regional economies may be restored after experiencing exogenous disruptions if their firms can introduce new goods or services for export or use new technologies to produce such goods or services relatively quickly. According to Gerst (2009), the path of recovery varied considerably among regions impacted by exogenous disruptions. Some (i.e. those whose economies are based on services) perform better than those dealing predominately with manufacture. Hill's research on resilience in metropolitan areas of the U.S. (Hill et al. 2010) notes that a metropolitan area's industry structure affects the likelihood that the region will experience a downturn, assuming that old economic structures imply a higher probability of downturn. A cyclical demand for durable goods, which are produced by a more traditional economic structure, makes employment in such sectors more vulnerable to exogenous shocks, such as economic crises.

According to Feyrer (2007), the employment and population of regions dominated by traditional industries, like the automotive and steel industry, stopped growing for about two decades after the regions experienced an economic crisis. On the other hand, the economic resilience of metropolitan cores located near traditional industry areas in fact positively impacted (in terms of resilience) by metropolital cores. Contrastingly, Briguglio (2006) stressed that concentration of a nation's export in a few industries inhibits regional economic resilience. Additionally, factors like human capital and the educational attainment or skills of a region's workforce (Gleasier–Saiz 2004), region-specific institutions, behavioural norms, knowledge, and technology (Nunn 2009) comprise the major driving forces of resilience and have a long-lasting impact on regional resilience.

In this paper, the analysis of resilience of the Central European regions was restricted in scope to its diagnosis and evaluation in reference to economic aspects. Economic resilience is about coping with slow and/or radical change in a region's economy that results from the interactions of endogenous and exogenous conditions (Eraydin–Taşan-Kok 2013). Regional economic resilience refers to the ability of the economy to recover or adjust to exogenous economic shocks and benefit from positive changes. Thus, there are two basic types of a region's economy's reaction to changes: 'recover quickly from a shock' and 'withstand the effects of shock' (Briguglio et al. 2008).

In analysing field studies and referring to the attributes of a region's resilience, mentioned above, a set of specific factors determining regional economic resilience can be defined (see Table).

According to Cooke (2008), one strategy for a region's adaptation to changes is to develop a system of innovation to create or attract new technologies and new products that can quickly find demand in the external market. This means that a region is resilient if after an economic shock it can develop new value chains corresponding to the national and/or external global market. The potential to attract new technologies is affected by many other factors determining the competitive advantages of a particular location, place image, capacity of local firms to cooperate, quality of labour force, and tax incentives. Thus, economic resilience applies to regions based on their local knowledge assets and infrastructure, which can 'produce' new knowledge, allowing for further successful diversified specialisation of the economic base. In this process, a region's ability to convert existing industries, their tradition, labour skills, and accumulated knowledge, and then mix them with a creative capacity to cause new sectors to emerge plays a critical role.

Factors enhancing a region's economic resilience

Resilience attributes	Factors of economic resilience (examples)
Adaptability	– high entrepreneurship spirit – high capacity for innovating – significant local knowledge assets (i.e. knowledge base, research infrastructure, and transmission of knowledge)
Connectivity	– networks of economic actors (i.e. clustering in production and distribution chains) – cross-sectoral knowledge linkages (i.e. platforms in innovation, commercialisation chain, and spill-over effects)
Diversity	– diverse specialisation of industries (i.e. industrial mix)
Efficiency	– over-local competitiveness – high value added in production chains (i.e. profitable value chains, as in knowledge intense industries) – recovery quickness
Redundancy	– effective and durable energy sources – redundant ICT application
Interdependency	– economic cooperation patterns – complementarities of local industries (i.e. external and internal, including agglomeration effects)

Source: Cooke (2008), Drobniak (2014), Eraydin and Taşan-Kok (2013), Hess (2013), Lansford et al. (2010).

Summing up, a region's economic resilience can be defined as the ability to successfully foresee technology trends and produce an efficient and effective capitalization of these changes via the regional economic base of national and global markets (Drobniak 2014). The strength of human capital creativity and entrepreneurial skills in a region, a region's networking patterns among business environment players, and the supporting infrastructure impact the level of economic resilience to a vast extent. Thus, the diagnosis and evaluation of a region's economic resilience can be structured in many different ways. In qualitative dimensions, accounting for the attributes and factors of economic resilience mentioned above, this phenomenon may be analysed using tools like focus group interviews (FGI) and individual in-depth interviews (IDI) with business players in a particular region, focusing on networking patterns among small businesses and large companies, creation of production and value chains in the national and global environment, the quality of the business supporting infrastructure, and factors determining individuals' economic activity. In the quantitative approach, regional economic resilience can be measured by long run indicators of GDP level, employment level, value of goods sold in the service and manufacturing sectors, volume of investment, number of enterprises run by individuals, number of patents, level of employment in R&D units, number of spill-overs operating in technological parks, value of export, and inflow of taxes from companies (Drobniak 2012, Eraydin 2016, Hill et al. 2010).

Data and method

Comparatively analysing regional economic resilience has limitations, like any other study. In the current study, the diversity within Central Europe, its area of focus, poses a limitation. The first limitation is connected with the variety of such regions. The diversity manifests in the different potentials of the regions' area, population, economy, history, and institutions. The Central European regions form a wide mosaic of socio-economic structures. Simultaneously, though, they have a common legacy connected with post-socialism experiences, and all of them joined the EU in the first decade or at the beginning of the second decade of twenty-first century. Thus, it is cognitively interesting to analyse their paths of economic development in the face of global changes, which have taken place in recent years.

Another obstacle is the limited possibility of gathering both qualitative and quantitative information about the level of a region's economic resilience. Accounting for the scope of this paper and its aim, the analysis was restricted to the quantitative dimension. This assumption narrows the scope of the study but allows for the preliminary comparative study of such regions in the dimension of economic resilience.

Finally, the analysis of resilience for the Central European regions, in the quantitative dimension, was conducted with the following assumptions:

- All data used in calculations are from the EUROSTAT database. It was assumed that Central European regions (CER) include eight countries of Central Europe (i.e. Bulgaria, the Czech Republic, Croatia, Hungary, Poland, Romania, Slovenia, and Slovakia). Thus, the first selection criterion involves the central location of the mentioned countries and the European regions into which they fall. All these countries, along with their regions, have a strong post-socialism legacy (the second selection criterion), although this legacy is distinguished in various ways. The selected countries also belong to the EU structures (the third selection criterion), which allows them to benefit from EU supporting schemes like structural funds. Finally, this group of countries includes 53 NUTS 2 regions, for which all resilience indicators were calculated.
- Due to the need to capture a broader overall context of interpretation for the resilience phenomenon, resilience indicators were calculated in the following spatial dimensions: (a) for all the EU countries [n=28] with some focus on the Central European countries (n=8) and (b) for the entire Central European region [n=53].
- The analysis period covers the years 2000-2014 and includes the EU pre-accession period and the full EU accession time for the Central European countries. This lifespan includes both positive and negative economic phenomena, like the economic slowdown in 2001-2003 (e.g. in Poland), followed by the favourable economic cycle (2004-2008), the global financial crisis (2008-2010), and the recovery period after this shock (2011-2014). These ex-

ternal changes and disruptions make the surveyed period cognitively interesting for resilience investigations.

– Some of the resilience indicators' calculations were based on Hill's research methodology (Eraydin 2016, Hill et al. 2010) (i.e. dynamic indexes with a fixed baseline were calculated and analysed). However, due to the weaknesses of the fixed baseline indicators used by Hill (i.e. their high dependence on the baseline value), the author's indicators of resilience based on simple descriptive statistics measures were proposed in addition to their combination in the form of portfolios. Resilience investigations for the Central European regions were limited to economic dimensions.
– Economic resilience was measured for all the EU countries and for all the 53 Central European regions with the efficiency attribute of resilience using the following indicators:
  – Economic portfolio no. 1 (named the scale and dynamics of GDP) consists of two indicators: the average value of GDP in the period 2000-2014 (x-variable) and the average dynamics of GDP in the period 2000-2014 (y-variable). Both indicators were standardised to a maximum, with a maximum value of 1.0. Economic portfolio no. 1 was prepared to capture the overall changes in development trends and their scale in the EU countries and Central European regions. These assumptions refer to Figure 1 and Figure 5;
  – Economic portfolio no. 2 (named the changeability and force of changes of GDP) consists of two indicators: the coefficient of GDP variation measured for the period 2000-2014 (x-variable) and the force of GDP change in the period 2000-2014 (y-variable). The first indicator refers to the changeability of GDP level, which shows its dynamics instability (or stability). The second indicator is statistically defined as the GDP dynamics index in 2014 (where 2000=100) multiplied by an average value of GDP in the period 2000-2014. This second indicator compensates for the weaknesses of a fixed base index (i.e. excessive dependence on the baseline value), and it reveals the overall ('value of GDP' x 'its changes') impact of GDP changes (i.e. the scale of an economy along with its changes). In its construction, the force of GDP change index is similar to the momentum used in physics. Both indexes are standardised to a maximum, with a maximum value of 1.0. Economic portfolio no. 2 was prepared to capture the overall changeability of GDP (stability or instability of GDP) and the force of GDP changes. These assumptions refer to Figure 2 and Figure 6;
  – Dynamics of GDP for the period 2000-2014, where GDP was reported at current market prices in millions of euros, and the dynamics indicators assumed the base year to be 2000 (2000=100). Dynamics of GDP indicators were calculated for all 'old' EU countries (Figure 3) and for eight Central

European countries (Figure 4). In the case of the Central European regions, special attention was paid to the economic resilience measured for the ten best and the ten worst regions (the best and the worst-case method, as shown in Figure 7 and Figure 8). Consequently, this approach allowed us to capture the range of differences in the pace of development of Central European regions.

Findings

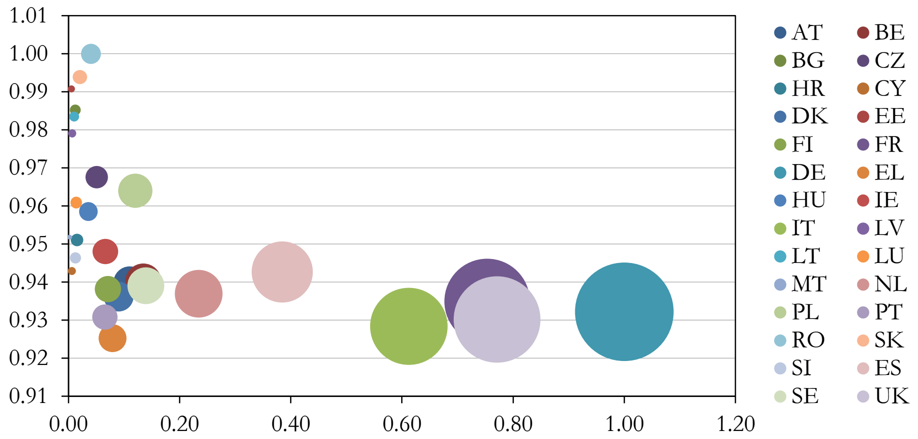
Both in absolute and in standardised terms, there are four 'big' economies among the EU countries. The biggest is Germany (DE) followed by the United Kingdom (UK), France (FR), and Italy (IT) (see Figure 1). However, the economies of these countries are characterised by low growth dynamics. During the period 2000-2014, there are also six 'development leaders' that recorded very high economic development dynamics. The highest development refers to Romania (RO) followed by Slovakia (SK), Estonia (EE), Bulgaria (BG), Latvia (LT), and Lithuania (LV). Their economies, however, measured by the average value of GDP, are relatively small in comparison to the EU 'big' economies.

In addition to these strongly polarised groups of countries, there are a few others. The first consists of the Czech Republic (CZ), Hungary (HU), Luxemburg (LU), Malta (MT), Croatia (HR), Slovenia (SI), and Cyprus (CY), whose economies developed with a good GDP growth pace in the period 2000-2014, but whose overall scale of economies is relatively small. The second includes medium-sized economies with relatively good GDP growth dynamics like Poland (PL), Ireland (IE), Spain (ES), the Netherlands (NL), Austria (AT), Belgium (BE), Finland (FI), Denmark (DE), and Sweden (SE). There is also a third group, including countries like Portugal (PT) and Greece (EL), in which both the size of the economy and the development pace in the period of 2000-2014 are relatively small in relation to other EU countries (see Figure 1).

This kind of huge diversity of economic development is also seen in economic portfolio no. 2, which deals with the stability and instability of GDP growth dynamics and the scale of GDP changes in EU countries in the period 2000-2014 (see Figure 2). Similarly, as in portfolio no. 1, there is a group of four countries (Germany – DE, the United Kingdom – UK, France – FR, and Italy – IT) in which the force of GDP changes (measured by economies volumes and their growth dynamics) dominates that of almost all EU countries. In this case, the force of GDP change is predominately determined by GDP volume, and the changes are relatively very small, as confirmed by the low coefficient of GDP variation. The low coefficient of GDP variation also confirms the small but stable growth dynamics of the mentioned countries, and thus their relatively good resilience.

Figure 1

Economic portfolio no. 1: scale and dynamics of GDP in EU countries (2000-2014) – standardised values

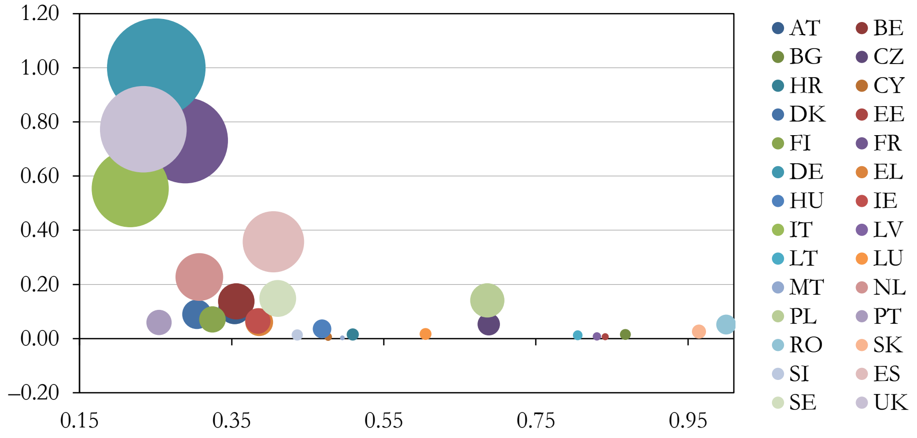


Source: calculation based on EUROSTAT.

Abbreviations: (AT) Austria, (BE) Belgium, (BG) Bulgaria, (CY) Cyprus, (CZ) the Czech Republic, (DE) Germany, (DK) Denmark, (EE) Estonia, (EL) Greece, (ES) Spain, (FI) Finland, (FR) France, (HR) Croatia, (HU) Hungary, (IE) Ireland, (IT) Italy, (LT) Latvia, (LU) Luxemburg, (LV) Lithuania, (MT) Malta, (NL) the Netherlands, (PL) Poland, (PT) Portugal, (RO) Romania, (SE) Sweden, (SI) Slovenia, (SK) Slovakia, and (UK) the United Kingdom.

Figure 2

Economic portfolio no. 2: changeability and force of changes of GDP in EU countries (2000-2014) – standardised values



Source: calculation based on EUROSTAT.

Abbreviations: (AT) Austria, (BE) Belgium, (BG) Bulgaria, (CY) Cyprus, (CZ) the Czech Republic, (DE) Germany, (DK) Denmark, (EE) Estonia, (EL) Greece, (ES) Spain, (FI) Finland, (FR) France, (HR) Croatia, (HU) Hungary, (IE) Ireland, (IT) Italy, (LT) Latvia, (LU) Luxemburg, (LV) Lithuania, (MT) Malta, (NL) the Netherlands, (PL) Poland, (PT) Portugal, (RO) Romania, (SE) Sweden, (SI) Slovenia, (SK) Slovakia, and (UK) the United Kingdom.

Completely different position is reported for the relatively small economies of Romania, Slovakia, Bulgaria, Estonia, Latvia and Lithuania. In turn, those countries are characterised by very high level of GDP dynamics changeability (i.e. high level of coefficient of GDP variation), what proves their high GDP growth dynamics, but also 'a rollercoaster' type of resilience (Drobniak, 2014).

Apart from these two strongly polarised groups of countries, one can distinguish a few others. The first group refers to countries with a medium-sized force of GDP changes and relatively low (but stable) changeability of GDP growth. This group includes the Netherlands (NL), Spain (ES), Belgium (BE), Sweden (SE), and Poland (PL). Poland, however, differs significantly from this group, because of its high level of GDP changeability. The second group consists of countries with a relatively small force of GDP changes and relatively small changeability of GDP growth. This group includes the rest of the EU countries. One exception is the Czech Republic, which, like Poland, represents a relatively higher level of GDP changeability (see Figure 2).

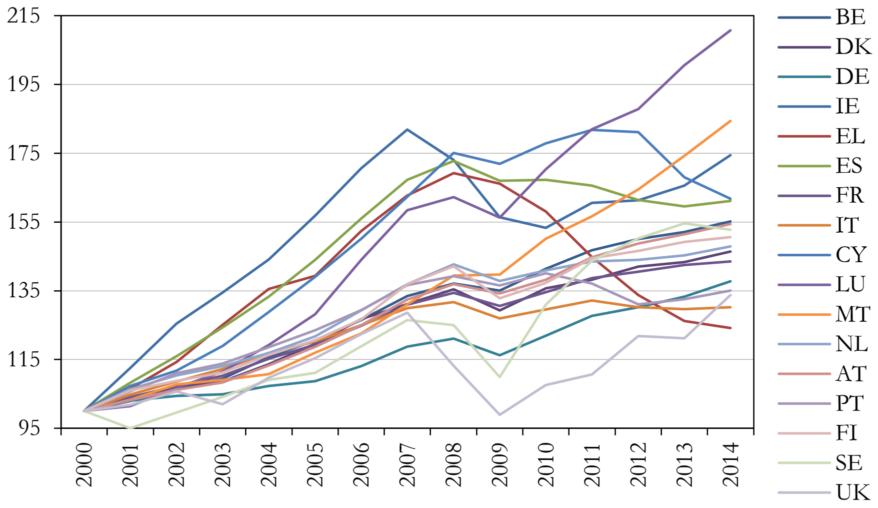
Now, a few words about 'standard' indicators of GDP dynamics for period the 2000-2014. In the case of 'old' EU countries, the value of GDP dynamics indicators varies among countries. The highest growth is reported for Luxemburg (LU), and the lowest for Greece (EL). Almost all 'old' EU countries faced the global financial crisis in 2008. Some of them were hit by the financial crisis very severely, like Cyprus (CY), Spain (ES), Greece (EL), Portugal (PT), and Italy (IT). This confirms their low economic resilience. For other countries, the financial shock of 2008 hit their economies in a gentler way. Countries like Germany (DE), France (FR), Denmark (DE), Ireland (IE), Belgium (BE), Sweden (SE), Austria (AT), and the Netherlands (NL) bounced back to their previous path of development in a year or in a few years. This also confirms their relatively good economic resilience attributes (see Figure 3).

A very interesting case is presented by the United Kingdom (UK) economy. Its GDP growth dynamics collapsed most severely among the 'old' EU countries after 2007, and it recovered only in 2014. This also confirms the UK economic resilience, but the recovery process has taken over seven years.

What was the economic performance of the Central European countries in the period of 2000-2014? All Central European countries recorded very high GDP growth dynamics (see Figure 4), which were much higher than those registered for the 'old' EU countries. The highest (i.e. almost 370% of the GDP value of the year 2000) was reported for Romania (RO), followed by Slovakia (SK) and Bulgaria (BG). These countries increased their economies more than three times (Bulgaria and Slovakia) or even close to four times (Romania). The economies which doubled during 2000-2014 belong to Poland (PL), the Czech Republic (CZ), and Hungary (HU). Slightly lower GDP growth was registered for Croatia (HR) and Slovenia (SI).

Figure 3

Dynamics of GDP in 'old' EU countries (2000-2014, 2000=100)

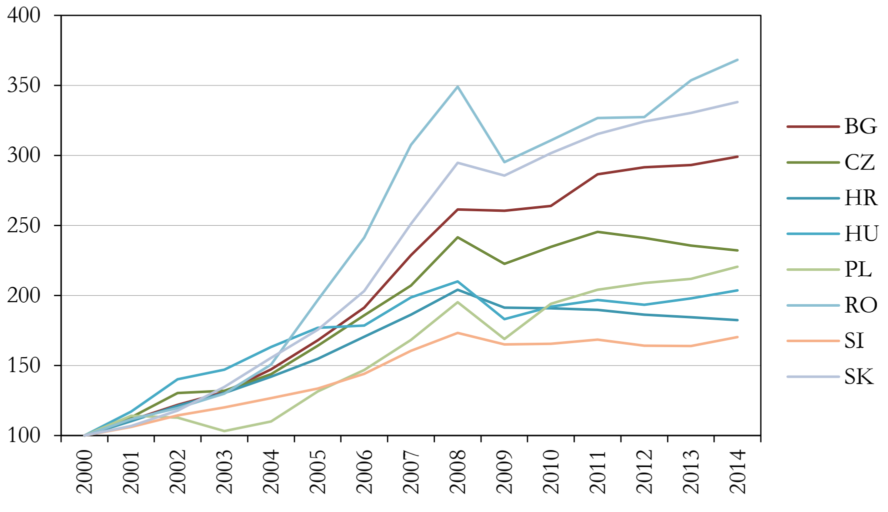


Source: calculation based on EUROSTAT.

Abbreviations: (AT) Austria, (BE) Belgium, (CY) Cyprus, (DE) Germany, (DK) Denmark, (EL) Greece, (ES) Spain, (FI) Finland, (FR) France, (IE) Ireland, (IT) Italy, (LU) Luxemburg, (MT) Malta, (NL) the Netherlands, (PT) Portugal, (SE) Sweden, and (UK) the United Kingdom.

Figure 4

Dynamics of GDP in Central European countries (2000-2014, 2000=100)



Source: calculation based on EUROSTAT.

Abbreviations: (BG) Bulgaria, (CZ) the Czech Republic, (HR) Croatia, (HU) Hungary, (PL) Poland, (RO) Romania, (SI) Slovenia, and (SK) Slovakia.

Like the countries of the 'old' EU, all Central European countries were hit by the global financial crisis in 2008. The crisis has reduced GDP growth dynamics most in Romania (RO). The economic recovery process took five years in this country. In two other countries (i.e. Slovakia (SK) and Poland (PL)) the economic recovery took only two years. In one of the countries, Bulgaria (BG), the GDP dynamics remained 'unshakeable' with respect to the force of the financial crisis. Thus, the economies of Romania, Slovakia, and Poland can be perceived as resilient, and the economy of Bulgaria as even shock-resistant.

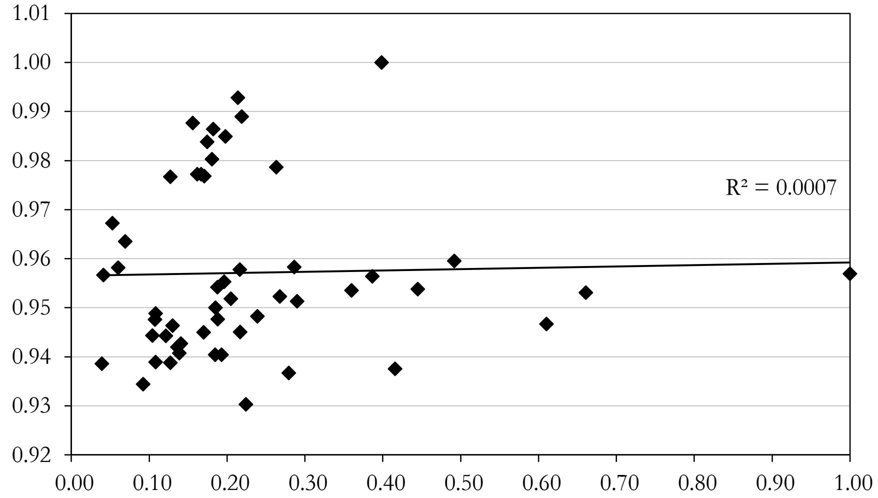
There are other types of Central European countries whose paths of economic growth differ from the patterns described above. The first case is that of Slovenia (SI), whose economic growth after 2008 stopped and which has entered a horizontal trend. The second is that of Croatia (HR), whose economic development dynamics after 2008 are lowering slowly. In the case of Hungary (HU), the economic development path collapsed after 2008; then it began to move upward slowly, but it did not recover completely to the value from before the crisis. The last case is that of the Czech Republic, where growth dynamics recovered three years after the shock of the financial crisis, but dropped again after 2011 (see Figure 4).

The detailed analysis of the Central European regions' level of GDP and its growth dynamics puts broader light on the economic resilience processes taking place at the regional level. In general, there are only two regions with a polarised position in terms of maximisation of GDP and GDP growth dynamics. The first is Mazowieckie (PL12) which has the highest average value of GDP in the period of 2000-2014, but average GDP growth dynamics. The second is Bucuresti - Ilfov (RO32), which recorded the highest GDP growth dynamics, but with an average GDP level (see Figure 5).

For other Central European regions, there are several groups in terms of GDP level and GDP growth dynamics influencing their economic resilience. One includes regions with a relatively small average value of GDP but quite a high GDP growth dynamic. For example: (BG41) Yugozapaden, (RO11) Nord-Vest, (RO12) Centru, (RO21) Nord-Est, (RO22) Sud-Est, (RO31) Sud - Muntenia, (RO41) Sud-Vest Oltenia, (SK01) Bratislavský kraj, (SK02) Západné Slovensko, (SK03) Stredné Slovensko, and (SK04) Východné Slovensko. The economic resilience of these areas can be perceived as high. The other group consists of regions with a relatively good average value of GDP along with a relatively good level of GDP growth dynamics: (HU10) Közép-Magyarország, (PL22) Slaskie, (CZ01) Praha, (PL41) Wielkopolskie, (PL51) Dolnośląskie, and (PL21) Małopolskie. Thus, their economic resilience can be assessed as moderate. The rest of the regions form a mosaic of mixed low or medium sized average values of GDP and relatively low levels of GDP growth, which makes them low in economic resilience (see Figure 5).

Figure 5

Economic portfolio no. 1: the scale and dynamics of GDP in CE regions (2000-2014) – standardised values



Source: calculation based on EUROSTAT.

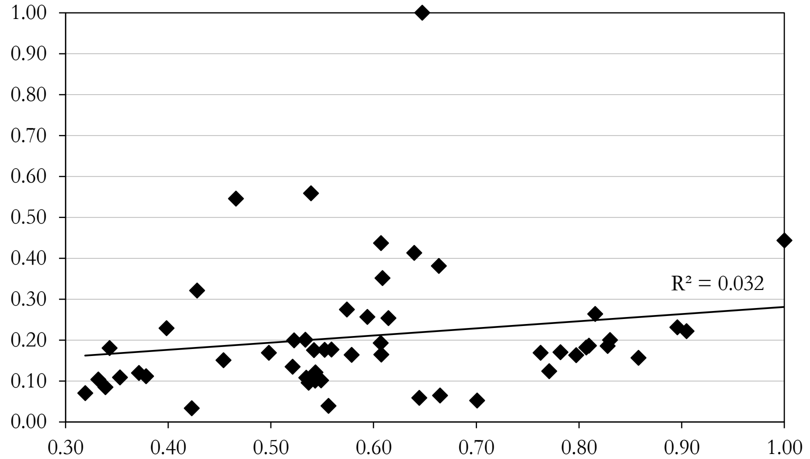
Accounting for the impact of GDP changes expressed by the force of GDP changes along with the 'stability – instability' of GDP growth dynamics (measured by the coefficient of GDP variation) the pictures of economic resilience slightly differ from the one described in terms of GDP average value and GDP average dynamics. There are two polarised regions that have the highest force of GDP change (i.e. PL12: Mazowieckie) and the highest changeability (i.e. RO32: Bucuresti – Ilfov). There is also a group of regions with relatively high GDP growth changeability but very low impact of force of GDP changes (i.e. BG41: Yugozapaden, RO11: Nord-Vest, RO12: Centru, RO21: Nord-Est, RO22: Sud-Est, RO31: Sud - Muntenia, RO41: Sud-Vest Oltenia, RO42: Vest, SK01: Bratislavský kraj, SK02: Západné Slovensko, SK03: Stredné Slovensko, and SK04: Východné Slovensko (see Figure 6).

As in the previous analysis, there is a group of regions with a relatively high force of GDP change, but with medium or even low changeability of GDP change. This group includes (HU10) Közép-Magyarország, (PL22) Slaskie, (PL41) Wielkopolskie, (CZ01) Praha, (PL51) Dolnośląskie, and (PL21) Małopolskie.

The approach that applies the force of GDP changes and GDP changeability allows one to clearly distinguish the group of regions that have medium sized changeability of GDP but a very low level of force of GDP change. The core of this group is comprised of PL34: Podlskie, PL43: Lubuskie, PL52: Opolskie, PL33: Świętokrzyskie, and BG32: Severen tsentralen. All other Central European regions can be classified as economically vulnerable (i.e. as having a small force of GDP change and small changeability of GDP dynamics). Examples include BG31: Severozapaden, HU10: Közép-Magyarország, HU31: Észak-Magyarország, HU32: Észak-Alföld, HU33: Dél-Alföld, and SI01: Vzhodna Slovenija (Figure 6).

Figure 6

Economic portfolio no 2: the changeability and force of changes of GDP in EU countries (2000-2014) – standardized values



Source: calculation based on EUROSTAT.

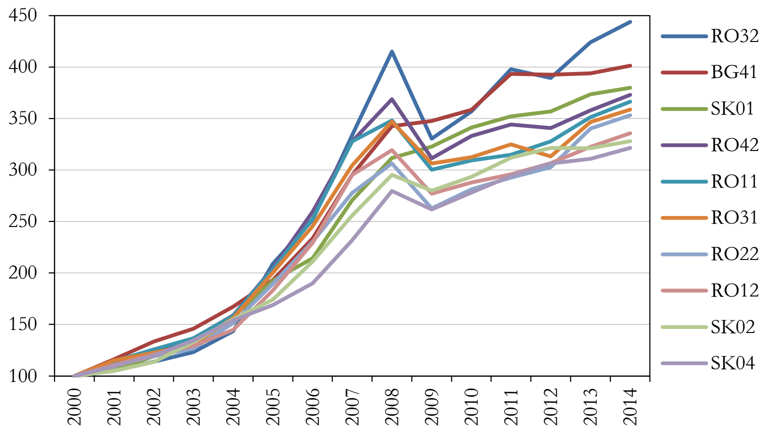
Let us look at the GDP dynamics indicators with a baseline index for the 10 best regions of Central Europe. Within the period of 2000-2014 all of them registered excessive growth of GDP (i.e. their GDP tripled at least). Over four times growth was registered for RO32: Bucuresti – Ilfov, and four times growth of GDP for BG41: Yugozapaden. As shown in Figure 7, almost all analysed regions were impacted by the global financial crisis, which made their path of growth collapse after 2008. Their strong economic resilience, however, has allowed them to bounce back to their previous paths of growth. The region most stricken by the crisis had the highest GDP growth dynamics (i.e. RO32: Bucuresti – Ilfov), but its economy recovered in four years. The most shock-resistant was SK01: Bratislavský kraj, which did not break its growth dynamics after 2008 (see Figure 7).

A completely different level of economic resilience applies to the 10 regions with the poorest performance of GDP dynamics in Central Europe. Almost none of them recovered after the global financial crisis. The exceptions are BG31: Severozapaden and PL42: Zachodniopomorskie, in which the path of GDP growth dynamics fully recovered after the global financial crisis (see Figure 8). The other regions' development paths collapsed after 2008. In some of the regions, GDP growth dynamics have displayed a horizontal trend of stagnation (i.e. HR03: Jadranska Hrvatska, HR04: Kontinentalna Hrvatska, HU23: Dél-Dunántúl, SI01:

Vzhodna Slovenija). Another group has not yet recovered (i.e. HU21: Közép-Dunántúl, HU31: Észak-Magyarország, HU32: Észak-Alföld, and SI02: Zahodna Slovenija; see Figure 8).

Figure 7

Dynamics of GDP in 10 Central European regions (NUTS2) with the best performance in the years 2000-2014 (2000=100)

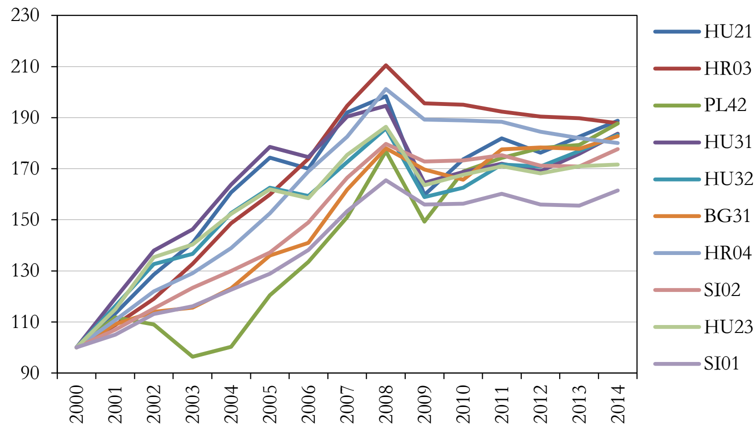


Source: calculation based on EUROSTAT.

Abbreviations: (BG41) Yugozapaden, (RO32) Bucuresti – Ilfov, (RO11) Nord-Vest, (RO12) Centru, (RO22) Nord-Est, (RO31) Sud - Muntenia, (RO42) Vest, (SK01) Bratislavský kraj, (SK02) Západné Slovensko, and (SK04) Východné Slovensko.

Figure 8

Dynamics of GDP in 10 Central European regions (NUTS2) with the poorest performance in the years 2000-2014 (2000=100)



Source: calculation based on EUROSTAT.

Abbreviations: (BG31) Severozapaden, (HR03) Jadranska Hrvatska, (HR04) Kontinentalna Hrvatska, (HU21) Közép-Dunántúl, (HU23) Dél-Dunántúl, (HU31) Észak-Magyarország, (HU32) Észak-Alföld, (PL42) Zachodniopomorskie) (SI01) Vzhodna Slovenija, and (SI02) Zahodna Slovenija.

Discussion and conclusions: from resilience to hybridization of development

This study of the initial identification of resilience at both national and regional levels, with particular attention to the Central European regions, provides some general conclusions. The first concerns the clear variation in the level of resilience among the surveyed territorial units. The second, associated with the first, involves the possibility of identifying several strategic groups among territorial units in relation to the phenomenon of resilience. The third, more general, refers to the hybridization of development which is the consequence of seeking and building an adaptive capacity in the analysed territorial units.

A very high level of variation in resilience is evident mainly in the following portfolios: GDP growth and dynamics and GDP changeability and force of GDP change at both the EU and the Central Europe levels. It is also confirmed by the classical GDP growth indicators (fixed baseline indicators). Among the analysed countries of the EU, they show very large imbalances between their scale of economies (measured by GDP) and corresponding growth patterns (measured by GDP average growth dynamics) in the years 2000 to 2014. In general, the so-called 'old' EU countries, despite their economies' scale, show a lower GDP growth rate (ranging from 124 to 211 GDP value for the year 2000). In the Central European countries the value of growth varies between 170 and 368 GDP values in the year 2000.

In principle, all the EU countries experienced a collapse of GDP growth as a result of the global financial crisis. Some were highly resistant to this economic shock, maintaining their growth rates (i.e. Malta and Bulgaria). Some undertook adjustment processes to recover their growth dynamics (i.e. Austria, Belgium, Denmark, Finland, France, the Netherlands, Ireland, Luxembourg, Germany, Poland, Romania, Slovakia, Sweden, and the United Kingdom). These adjustments, however, took different times (i.e. from two to seven years). The rest of the countries have not recovered their growth dynamics and have fallen into recession or stagnation (i.e. Cyprus, the Czech Republic, Greece, Spain, Croatia, Malta, Portugal, Slovenia, Hungary, and Italy). Even higher levels of GDP growth dynamics variation apply to the Central European regions. The value of growth dynamics ranges from 161 to 444 of the GDP value for the year 2000. Even regions with the highest dynamics of growth have been affected by the global financial crisis of 2008 (the exceptions are BG41: Yugozapaden and SK01: Bratislavský kraj). However, the recovery period has not taken more than two to three years.

The study conducted allows one to identify a few strategic groups, both among the EU countries and the regions of Central Europe, regarding the economic resilience phenomenon, ordered by the scale of GDP (or force of GDP change) and the dynamics of GDP growth (or changeability of GDP). The countries at opposite extremes are those which have a large-scale economy and low growth dynamics, called giant&slow (i.e. Germany, United Kingdom, France, and Italy), and those with small scale economies and high dynamics of growth, called small&fast (i.e. Romania, Slovakia, Estonia, Bulgaria, Lithuania, and Latvia). Interestingly, both groups are characterised by a high level of economic resilience.

Other EU countries have a very diverse position in terms of size and dynamics of economy, and thus resilience. The group of countires with medium-sized economies and average dynamics of GDP growth, called medium&medium, includes the Czech Republic and Poland. The group with medium-sized economies and low GDP growth rates is called medium&slow and includes Austria, Spain, Holland, Belgium, Sweden, Hungary, Denmark, Finland, and Ireland. Both 'medium' groups are resilient, albeit to varying degrees. The last group includes countries with small economies and small GDP growth, called small&slow (i.e. Croatia, Malta, Luxembourg, Cyprus, Greece, and Slovenia). In their case, the level of resilience is very low.

Nearly identical strategic groups can be identified in the Central European regions, in terms of economic size and dynamics of growth. The giant-medium group consists of only one region (i.e. PL12: Mazowieckie). Similarly, the medium-fast group includes only RO32: Bucuresti - Ilfov. There is a large group of small-fast regions, bringing together regions from Romania and Slovakia. The medium-medium group comprises mainly the metropolitan regions of Budapest, Prague, and the most economically strong regions of Poland (Slaskie, Wielkopolskie, Dolnośląskie and Małopolskie). All the indicated groups are characterised by satisfactory resilience. The small-medium group includes, among other things, small Polish and Bulgarian regions with average GDP growth dynamics (e.g. Lubuskie, Opolskie, Swietokrzyskie, Podkaprackie, and Severen tsentralen). The small-slow group, on the other hand, refers mainly to economically small, in absolute terms, Hungarian and Slovenian regions that are de facto characterised by low resilience.

In general, among the Central European regions, a large number of regions have GDP growth defined as 'medium' or 'slow'. This could mean the emergence of the 'middle income trap' problem in their case. The sources of this problem can be found in the specific conditions of their development (i.e. in the post-socialism legacy that makes it difficult to build adaptability towards changes in the global economy).

Other groups (i.e. 'medium-fast' and 'small-fast'), comprise regions with high growth dynamics. Such regions are likely to 'move to a different domain' in a relatively quick way, even after the shock of the global financial crisis. They have apparently invented a new configuration or development path during the surveyed period. Thus, in their case negative hysteresis or the 'remanence' effect (Martin 2012) have not occurred. This means that one-time disturbances (like the mentioned financial crisis) did not permanently affect the development of their economies in a serious way. There remains a question, however, of whether these high rates of GDP growth will be sustained in the long run as a consequence of a new path of development connected with the region's entry into global production chains. However, this requires more detailed research into changes in the economic structure of these regions.

This kind of mosaic of economic behaviour towards tendencies and economic changes (like the good economic situation existing until 2008, the global financial crisis) indicates the development of very diverse paths of growth in the territorial dimension. In this way, building the capacity of regional resilience (and consequently resilience at the country level) leads to a lack of one-way relationships between the size of the economy and the dynamics of its development (this is also confirmed by the low value of R2 indicators for regional analysis), as shown in the above analyses. Such a lack of dependence can be expressed in the context of the hybridization of growth patterns.

The notion of hybridization is present in, among other things, considerations of globalisation, meaning, in the economic sense, the increase of international trade in goods, technology, people, and ideas resulting in a variety of effects. In the territorial dimension, the high level of economic diversification is the basis for Golubchikov to define the assumptions of such hybridization. It explains the different dynamics of the territorial units development based on mutual interactions between the post-socialist legacy and the forces of neoliberal capitalism (Golubchikov et al. 2014, Sýkora–Bouzarovsky 2012). These relationships have a direct impact on the results of the analysis carried out for the Central European regions.

In the territorial dimension, hybrid development is a type of uneven development resulting from the influence of neo-liberal capitalism, for which, in terms of effective capital allocation, only those places are important which provide a satisfactory return on investments. Hybridization of development is simultaneously a result of a post-socialist legacy that has determined a specific accumulation of capital, expressed in the location of a particular type of social and technical infrastructure, economic activity, and human and social capital. In the regional dimension, the post-socialist legacy is perceived by Golubchikov according to the concept of path-dependence and lock-in. Such elements consequently determine the resilience attributes, generating a multidimensional picture of economic effects as a response to changes in the surroundings.

Summing up, the hybridization of regions' development is a consequence of the creation of diverse solutions for enhancing the attributes of economic resilience. As Cooke notes, one strategy for a region's adaptation to changes is to develop a system of economic structures that can create or attract new technologies along with new products that can be quickly sold. This kind of structure requires that regions combine rapidly different resources to obtain new, functionally enhanced products (functional diversity), including greater flexible modification. Thus, the process of building economic resilience of regions is conducive to the emergence of multifaceted effects of different scales and different nonlinear ranges, resulting in a variety of growth dynamics recorded in the spatial dimension.

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Interconnections in public transport as a method for delimiting urban functional areas and the settlement hierarchy in Poland

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The main aim of the article is to clarify the characteristics of the method that determines the functional links and gravity towards cities on the basis of public transport connections. The paper delivers a detailed description of the method and provides examples of its application in empirical research conducted by the authors in the years 2010-2014.

Introduction

Determining the functional and spatial relations between cities and their surroundings is a key area of study in geography and regional science. Nowadays, every piece of geographical space inhabited by humans is under the influence of cities. Amin and Thrift (2002: 1) even conclude that 'the city is everywhere', but the intensity of its presence changes with growth in distance from the centre of the metropolis to the peripheries, which are becoming ever more connected to the central areas. The urban nature of entire areas, and not just individual localities, necessitates addressing urban problems from the perspective of urban regions or functional urban areas (Parr 2005).

Scientific literature and expert studies address a very wide range of problems related to territorial identification of the ties and the areas of influence of cities and towns (see extensive reviews of methods and approaches in Pálóczi et al. 2016 and Śleszyński 2014). Most researchers determine gravitation by measuring the functional links (commuting to work, and less frequently to schools, or travelling to service providers, migration flows), structural indicators illustrating the intensity of selected measures of socio-economic development around an urban locality (e.g. number of businesses per 1000 inhabitants, availability of services), and morphological indicators (e.g. population density). Usually, the latter two groups of indicators, which result from the influence of the core city, play an auxiliary role, but in some studies, in the absence of current data about functional interactions, they have been treated as primary indicators (e.g. ESPON 2007, Smętkowski–Jałowiecki–Gorzelak 2009).

As Sleszynski (2016: 83) indicates a major problem in the delimitations, and generally, in all spatial research on socio-economic development, is obtaining data that reflect the actual intensity of the phenomena and processes. In Poland in particular, between 1991 and 2006, the lack of data on commuting, which is a classic indicator for delimiting the impact zones of cities, forced researchers to develop alternative research methods (see Śleszyński 2013, Siłkowska et al. 2016). One of these includes determining the functional links and gravity towards cities on the basis of public transport connections. The goal of this paper is to describe the characteristics of this method, illustrate its use with examples, and present a discussion.

The paper is organised as follows. The second section provides the detailed characteristics of the method, preceded by a short discussion of the gravity model. The third section provides examples of the application of this method in empirical research conducted by the authors in the years 2010–2014. The next section presents a discussion of the strengths and weaknesses of the method and summarises the main findings.

Public transport links: presentation of the method

Based on the timetables of the companies running the public transport system, each location can essentially be identified as gravitating towards a location situated higher in the hierarchy of settlements using two methods. The first one is to determine which town has the greatest number of incoming connections or most convenient connections in terms of travel times and regularity. The effect of this procedure can be illustrated in a graph. The main drawback of this method is its binary nature, which does not allow the inclusion of gravitational forces to a greater number of localities. The problem is solved by a method based on the gravity and potential models, which not only allows the multidirectional nature of the gravity to be taken into account, but also to be measured and quantified. It should be added that public extra-urban bus transport in Poland is provided almost exclusively by commercial companies. Thus, it can be assumed that the connections (supply in the form of the connections in the timetables) provide a relatively good match with the demand for transport services. The supply side in Poland is very flexible, because carriers are free to launch and discontinue scheduled trips at any time, and are only limited by formal procedures. The presentation of the method used by the authors in a series of regional studies in Poland (see Guzik 2012, Guzik–Kołoś 2015, Guzik et al. 2010, 2016) will be preceded by a brief presentation of the potential model.

Introduction to the potential model

The gravity and potential models are the basic spatial interaction models used in geographical and economic research. They were developed by adapting the concept of the population potential model proposed by Stewart (1941), which quickly became a fundamental model of social physics. A broad overview of the evolution of the models is presented by, among other authors, Chojnicki (1966), Vickerman (1974), Pooler (1987), and Guzik (2003). One interpretation of the value of potential is to consider it as a measure of spatial accessibility. The concept behind the model is as follows: the potential of a phenomenon in a given location is the sum of the partial potentials of all the other places studied that exert their influence on the location. For example, the partial potential exerted by locality j on locality i, i.e. V_{ij}, depends on the mass of locality (M_j) and the distance between the localities d_{ij}. The general formula of the potential model is as follows:

$$V_i = \sum_{j=1}^{n} \frac{M_j^{\,z}}{d_{ij}^{b}}$$

where: Vi – potential at point *i*; Mj – mass of point *j*; dij – distance between points *i* and *j*; b – distance decay exponent; z – locality j mass exponent.

The mass of the locality will represent the phenomenon for which the potential is calculated; for the population potential, it will be the number of people, and for the availability of pharmacies for instance, it will be the number of pharmacies. For human capital, the mass will be the number of people with specific educational attainment. Using the exponents both for the mass (size of locality) and the distance allows the spatial relationships to be determined in a more realistic way and the non-linear increase/decrease in the scale of the spatial interactions between localities i and j to be adopted. The exponents are adjusted to the phenomenon studied. It was assumed that distance decay (d_{ij}) is exponential in nature – the most common solution is to divide the mass by the square of the distance, which was also the case in this study. The measure of distance used in the study is kilometres. The mass exponent (*z* = 1) was waived as it is better suited to transport studies, and the lack of adequate empirical studies does not permit specific values of the parameter to be adopted.

The use of the potential model gives rise to a number of specific problems which need to be addressed. They include:

a. choosing the points for which the potential is to be calculated,

b. the problem of area boundaries,

c. the own potential of localities.

A convenient option is to choose one representative point for each unit (town, municipality /*gmina/*, county /*poviat*/) to which the mass of that locality (phenomenon) will be assigned and from which the distance to the other points will be calculated. The point was placed in the centre of a communal town or in the centre of a *poviat* capital. For rural municipalities /rural *gminas*/ surrounding a city with their headquarters in the city, locating the point for the rural municipality and determining the distances between those municipalities is problematic. In order to calculate the external potentials, it was assumed that both points have the same location, while the distance between them was calculated as two-thirds of the radius of a circle having the summative area of the city and the rural municipality.

As the potential is the sum of the impacts exerted on the municipality, municipalities located on the border of an area will always have a lower potential (no influences from outside of the border). While sometimes this is justifiable for the state border (given their low penetrability), disregarding the mutual interaction for administrative borders inside a country would distort the actual picture of the phenomenon. Therefore, all the potentials calculated in our study (at regional level) take into account the potential exerted by adjacent areas and areas situated at a distance of 25 km from its borders. Including a larger area would be pointless because the potential decreases (exponentially) with increase in distance.

The problem of own potential includes the problem of establishing the distance of the municipality from itself. The most common approach is to assume that $d_{ii} = 1$, i.e., a municipality's own potential equals the size of the phenomenon in the municipality. Such a solution is not always good for assessing accessibility – for example, all doctors or pharmacies in the capital city of a region are assigned to a single point with a very high own potential and accessibility, which, in fact, does not occur anywhere. If the capital city of a region was divided into four units and distances $d_{ii} > 1$ appeared between them, then the sum of the potentials for those four units would be lower than for a single point. Therefore, it can be assumed in potential studies used to assess accessibility that $d_{ii} = ½$ of the radius of the circle representing the area of the unit (municipality), which is the case in the present paper.

The results of the potential model can also be used for comparing the availability of a phenomenon and saturation with the phenomenon by comparing the area of the potential (the potential difference or quotient method). For example, if the share of a municipality in the population potential of a province (*województwo*) is 0.5%, and its share in the potential of the number of doctors is 1%, this means that the availability there is twice the average availability in the whole region. To some extent, the potential quotient method eliminates the boundary problem and completely eliminates the problem of own potential (two potential areas calculated in the same way divided by each other).

Database of connections in public transport

In order to apply the gravity and potential models to determine gravitation in public transport, it was necessary to build a database of connections. The study was based on the timetables of all public and private transport operators. In the example from Pomorskie Province presented in this paper (Guzik 2012, Guzik–Kołoś 2015), a database was created with a record for each city and rural locality in the province (n = 1753) and for 63 towns (municipality seats) in the *poviats* of adjacent provinces bordering on Pomorskie Province. For each of these cities and towns, the following are determined separately for (i) rail connections, (ii) bus links in transport organised by municipalities or their associations (in Poland, this actually means only city transport), and (iii) other bus routes organised by private carriers (on a commercial basis): the number of outgoing trips (separately for three time periods: 4^{01}-6^{00}, 6^{01}-8^{00}, 8^{01}-10^{00} – that include the morning peak traffic), number of trips throughout the day, and the number of trips on Sunday, as well as the travel times to:

a) the capital city of the region (Gdańsk);
b) the *poviat* capital;
c) all the other towns in the *poviat*;
d) other cities and towns in Pomorskie Province subject to the restrictive conditions outlined below; and
e) cities and towns lying outside of Pomorskie Province subject to the restrictive conditions outlined below.

In the case of rural localities for which the links with the cities and towns referred to in points (d) and (e) were determined, only those connections were included that do not cross a city bigger than that with which the connection exists (in line with the principle of indirect possibilities). The above problem concerns rural localities on transit routes crossed by the trips, and small towns situated along such routes. If no restrictive condition was used, their estimated forces of gravity would be well above the actual ones. The complexity and labour intensity of the procedure makes it reasonable for the study to be narrowed down to the morning traffic peak, which allows the actual connections and gravitation to places of work, education, and services to be determined in the best possible way.

Public transport connection indices

The resultant databases consisted of 66,572 public transport connections on weekdays as of the second half of 2014. Using the databases, two key indicators were constructed:

1. A connection index which is the sum of all the connections of a given town weighed by the following multipliers:
   a. Time periods: 4^{01}-6^{00} (number of connections x 2), 6^{01}-8^{00} (number of connections x 3), 8^{01}-10^{00} (number of connections x 1).
   b. Means of transport: rail transport (number of connections x 3), city transport (number of connections x 1.75), bus transport (commercial) (number of connections x 1).
2. Lines operated index: defined as the average number of public transport lines operated on all days of the week (the number of lines operated is the number of cities and towns accessible via direct connections by public transport).

Using the databases of public transport connections in Pomorskie Province, intercity links were also analysed.

The potential model – gravitation in public transport

When using the potential model to identify interactions in public transport, it was assumed that the gravitational forces are proportional to the size of the attracting location (the principle of gravity) and connections (trip number factor), and inversely proportional to the distance as expressed by travel time. Therefore, for any rural locality (in Pomorskie Province – 1,753 localities), the gravitational force from that locality to every city that could be directly reached from that locality were determined based on the timetables and the potential model, and included in the above database. The distance measure adopted (d_{ij}) was the weighted average travel time in minutes for all trips. Instead of the mass exponent, use was made of the gravitational attractiveness multiplier based on the location's position in the settlement hierarchy (*k*): the gravity values to the capital city of the region (Gdańsk) were multiplied by 2; to Gdynia (the second largest city of the region and of the metropolitan Tri-City) by 1.6; to former provincial capitals (Słupsk, Bydgoszcz, Elbląg, Piła) by 1.5; to their own *poviat* town by 1.4; to *poviat* capitals other than their own *poviat* town by 1.2; and gravitation to other towns was assigned the multiplier of 1. In addition, a root of the trip number index (connection number index weighted by the time of day and type of transport) was added to the numerator of the potential model. The authors decided to use it because an increase in the number of trips does not translate into a linear increase in gravity. The index of the radical was chosen arbitrarily (here 1.8) as the square root (that is most often used in literature) would excessively flatten the significance of the number of trips. The resultant potential model formula is as follows:

$$V_i = \sum_{j=1}^{n} \frac{M_j k \sqrt[1,8]{P_{ij}}}{d_{ij}^2}$$

The value of the potential is proportional to the size of the location (large cities strongly attract small towns, with very poor attraction in the opposite direction) and to the number of trips per day, and is inversely proportional to the distance. As the distance grows, the number of spatial interactions declines. The potential was calculated for all the pairs of locations: rural locality-city and city-city (if there was a connection between them by public transport). Calculating the forces of gravity is the most difficult for cities, as it involves the problem of measuring their gravity towards themselves (own potential). It was assumed here that the distance is always 10 minutes, and the strength of the connection was arbitrarily assumed to be 100 trips for towns other than *poviat* towns, 200 for *poviat* towns, and 300 for Gdańsk, Gdynia, and Słupsk. For example, in Bytów, 93% of the population is assigned to the town itself – the high value is attributed to the large distances and poor connections, which cause the potential and gravity to other cities to be very poor. Another extreme example is Żukowo, which is located in the 'shadow' of the potentials of Gdańsk, Gdynia, and Kartuzy, as a result of which only 9% within the town gravitates towards the town itself.

Table 1 shows an example of the calculation for Borzytuchom's potential in the Bytów *poviat*.

Table 1

Calculation of gravity forces for Borzytuchom (the potential model)

Parameters	Cities and towns with direct connections with Borzytuchom (attracting ones)			
	Bytów	Słupsk	Chojnice	Bydgoszcz
1. number of attracting city population	17,537	98,647	41,302	356,177
2. attraction multiplier (administrative attractiveness factor)	1.4	1.5	1.2	1.5
3. root of connection index P_{ij}	33.2	18.8	2.7	2.7
4. square of average time distance d_{ij}	446	7,293	15,374	105,502
5. contribution to the potential (influence)	1,828	381	9	14
6. percentage of total potential	81.9	17.1	0.4	0.6
7. population of Borzytuchom identified as gravitating towards attracting cities and towns	762	159	4	6

Source: Guzik 2012, revised.

The gravitational force of Borzytuchom to Bytów equals the number of inhabitants of Bytów [row 1] multiplied by the attractiveness factor k [row 2], which represents the attracting mass in the gravity model multiplied by the root of the connection index [row 3]. In the next step, the result is divided by the squared average time distance [row 4], which expresses the distance decay. The resultant number is 1828 [row 5], which expresses the power of attraction of Bytów. If we add the rates of attraction of Borzytuchom to all the cities and towns with which it has connections, we will be able to calculate the share for each town, which is 81.9% [row 6] for Bytów. It can be assumed that this percentage of the town's population gravitate towards Bytów, which translates into 762 inhabitants [row 7]. After calculating the above values for all the 9350 interactions, the numbers of population of all the towns that gravitate towards Bytów (or any other town) can be added up to illustrate the size of its hinterland or service strength.

Examples of the use of the method in empirical research

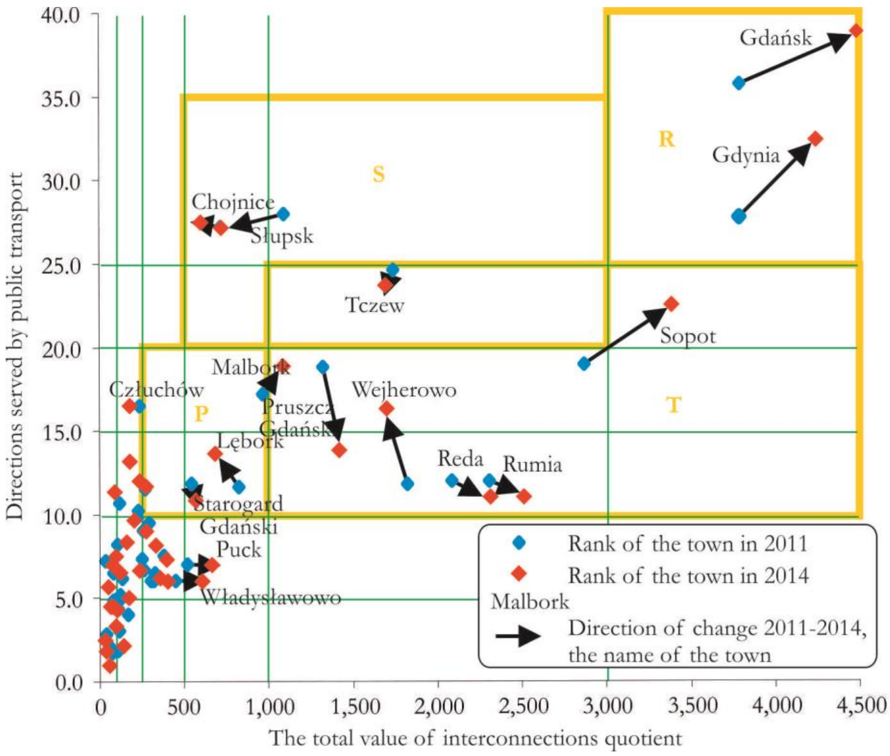
The authors used the method described above to study the rank of towns in the settlement network and delimit functional urban areas in several Polish regions, including the Małopolskie (Guzik et al. 2010), Pomorskie (Guzik 2012, Guzik–Kołoś, 2015), and Warmińsko-Mazurskie Province (Guzik et al. 2016). The use of the method is illustrated below on the basis of the Pomorskie Province example.

Determining the hinterland and service rank of cities and towns in Pomorskie Province – based on gravitational forces in transport

The graph (Figure 1) presents the above-mentioned connection indices (cf r. 2.3) for all the cities and towns of Pomorskie Province in the years 2011–2014. The green lines mark the boundaries of the class intervals, and the orange rectangles indicate the areas within which (as was predicted) the cities and towns should be located – regional and supra-regional cities (marked with the letter 'R'), sub-regional towns ('S'), transit towns ('T'), and *poviat* towns ('P').

In the years 2011–2014, Pomorskie Province shows strong and growing discrepancies in the scale and quality of intercity interactions. The province was clearly divided into the north-eastern part, which was developing (in terms of relations), and the south-western part, where the strength and extent of the intercity links were declining. There is a noticeable increase in the strength and extent of links in the Tri-City (Gdańsk, Gdynia, Sopot) and the other cities of the metropolitan area, especially those lying along the Lębork – Gdynia – Gdańsk – Tczew railway line. The changes in the intercity links are symptomatic of a growing metropolisation of the area, and the growing supra-regional role of Gdańsk and Gdynia. The other cities, including sub-regional ones (Chojnice and Słupsk), saw a decline in at least one of the indices. In only a few *poviat* towns did the strength and extent of their interactions correspond to their rank in the hierarchy.

Figure 1
Number of connections and lines served in the cities and towns of Pomorskie Province

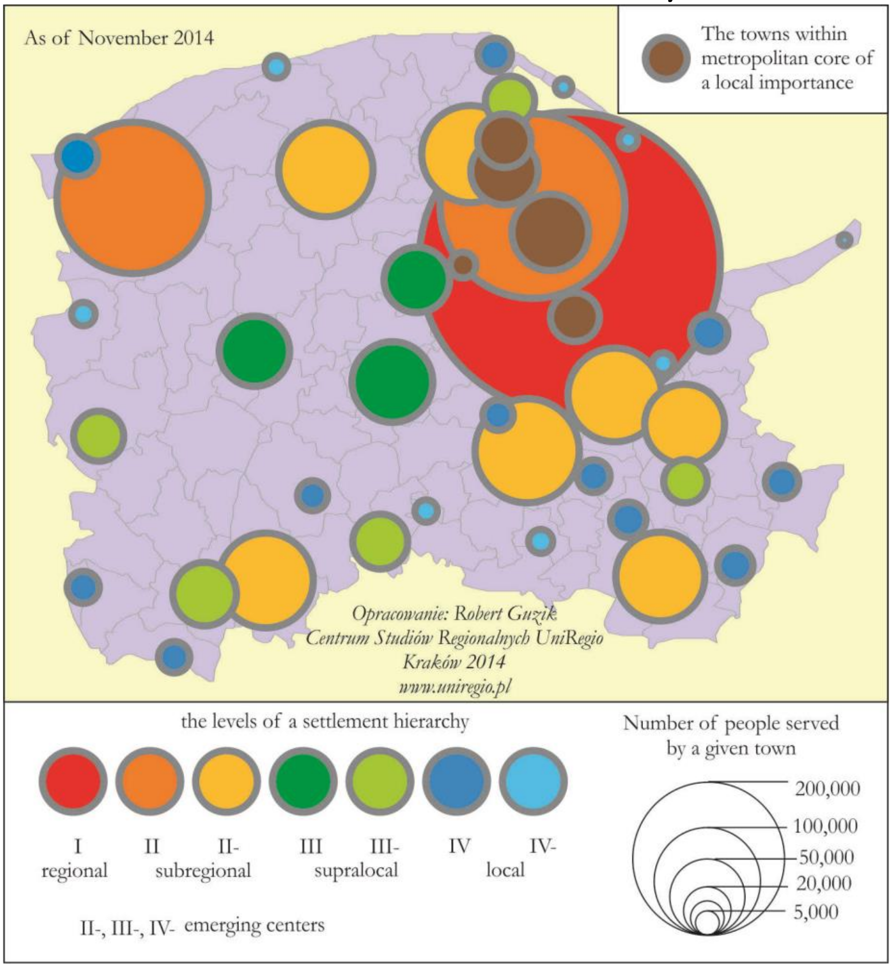


Source: Guzik–Kołoś 2015

Determining the directions and scale of gravitation allows the proportions of each locality's population that gravitate towards the cities where services are provided to be established; then, after adding them up according to the centre of gravity, the size of their hinterland or, in other words, their service potential can be determined. The results for all the cities and towns in Pomorskie Province are presented on a map (Figure 2). It must be pointed out that the method adopted, in which the gravity from a given location is matched to the respective superior units (according to their attraction potential), reflects the actual gravitation more accurately than the greatest flow method, whereby the cumulative gravitation from a given unit is assigned to the unit with the greatest incoming streams.

Figure 2

Hinterland of cities and settlement hierarchy levels



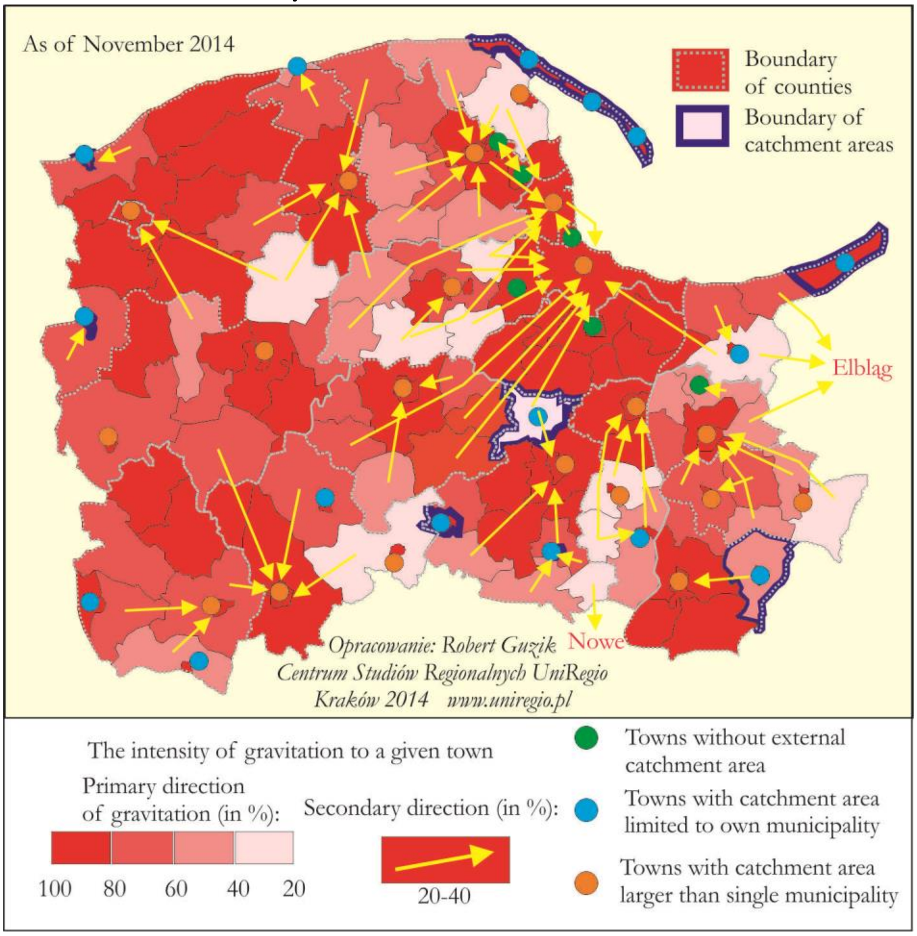
Source: Guzik–Kołoś 2015.

Delimitation of urban regions

The gravity model constructed may also be used for delimiting the areas that serve cities and towns at different levels of the service hierarchy. The areas may also be considered to be urban regions. This study presents an example of such delimitation on the local level (around each city). The catchment areas were delimited at a municipality level (the smallest units of the basic administrative division in Poland). The averaged gravity for municipalities reflects the gravity of the individual localities weighted by their populations. Even though the delimitation was carried out separately (each municipality is assigned to the area of one city only), given the multidirectional nature of the gravity, secondary directions of gravity were also determined.

Figure 3

City service areas at the local level



Source: Guzik–Kołoś 2015.

Delimiting the service areas at a local level (Figure 3) showed that there is a group of towns that have no external service area except for that within their own borders – they act as local service areas for themselves (e.g. the towns of the Hel Peninsula). No service areas were delimited around the strongly integrated cities of the Tri-City, either. In addition, the service area around other small towns includes only the rural part of the municipality to which they belong. Around the other towns, the service areas delimited include at least two municipalities. The largest service areas at the local level were delimited around Słupsk, Bytów, Gdańsk, Starogard Gdański, and Lębork. This results, on the one hand, from strong gravitation and links (Gdańsk, Starogard Gdański), and on the other, from the low density of the urban network and poor connections (e.g. Bytów).

An analysis of the secondary directions of gravitation shows that the localities that perform local functions for a larger number of municipalities (in the map in Figure 3, they are shown as the localities with larger numbers of incoming yellow arrows), concentrate around the key urban locations of the region. The cities identified most often as a secondary gravity direction on a local level are: Gdańsk, Gdynia, Wejherowo, Lębork, Malbork, Chojnice, Starogard Gdański, and Elbląg from the Warmińsko-Mazurskie Province, which has the rank of a sub-regional locality.

The method can also be used to delimit regions at supralocal and regional levels.

Discussion and conclusions

Catchment areas are most often delimited by measuring a variety of functional interactions. In practice, given the types of data available, the most commonly used indicators are those related to commuting to work or school (Gruchociak, 2012, Śleszyński 2014). In Poland, when working on the Polish National Spatial Development Concept 2030, exclusive use was made of the labour market interaction indices available in public statistics and the imperfect indices of migration or structure of the economy (cf. Śleszyński 2012, 2013). According to the authors of the study, attempts to determine the actual gravitation should also include analysing trips to schools, retailers, and service providers, and perhaps also incidental (family and social) ties.

The method presented in this paper is based on the assumption that the public transport network is organised in a commercial manner; thus the supply of public transport corresponds to the actual demand. This allows the gravity to be mapped in a more accurate way than on the basis of commuting to work or school alone. First of all, the method takes into account the links related to broadly defined services. The regional studies conducted by the authors across Poland have shown a high correlation between the measured gravity in the system of public transport, and commuting to work and school. This means that gravity studies in public transport can successfully replace data on actual flows for the regions or time periods for which the latter data are unavailable. In countries or regions with easy access to timetable databases, such studies are much simpler and cheaper than an investigation of commuting to work or school.

The method also has drawbacks. In Poland, public transport only accounts for approximately 27% of pedestrian travel (Centrum Badań i Edukacji Statystycznej GUS 2015). What is more, in the last few years, the structure of the traveller clientele has clearly changed (see Table 2). The number of passengers has dropped considerably, especially among those commuting to work. This is correlated with a large increase in the number of cars. Thus, the gravitation studied does not comprise all trips. In poorly accessible areas, which are forced to use individual transport, establishing the actual interactions by analysing gravity in public transport is likely to generate errors.

Table 2

Changes in the number of passengers on regular bus transport and the motorisation rate in 2010 and 2015

		2010	2015	2010=100.0
Passengers carried by regular (commercial) transport (in thousand passengers)	Total	476,055	347,777	73.1
	With monthly employee tickets	40,975	27,279	66.6
	With monthly student tickets	215,799	168,901	78.3
Motorisation rate (number of cars / 1000 population)		451	539	119.5

Source: authors on the basis of GUS 2011, 2016.

Another problem is the concentration of the public transport network along the main transport routes. Towns located near major roads are characterised by 'excessive' accessibility and vice versa. For example, in the Pomorskie Voivodship, out of the general number of 1753 rural localities (villages) as many as 318 were not served by public transport. Most of them were small villages with an average population of 200, lying outside of the system of national and regional roads.

The multipliers of the connection index may raise some discussion. A connection index is built to reflect a potential accessibility and does not directly take into account the issue of capacity and its utilisation. The authors decided to allocate the highest weight for railway connections followed by city transportation as they are proven in different studies to be more reliable and also cheaper than regional bus connections. What is important about railways is that some real-life connections and relations are deeply rooted in historical accessibility, and one must be aware that buses in some rural areas have been in operation since the 1970s whereas railways have provided accessibility and shaped relations for more than 100 years.

Finally, account must be taken of a problem specific to Poland, namely, the low availability of passenger information: a lack of published timetables, or even an absence of timetables on bus stops, as well as the inaccuracy of the data obtained from the public offices that issue licences to passenger carriers. As a result of the lack of passenger information, obtaining the timetables proved to be the most difficult and labour intensive part of our research.

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Territorial indicators for policy purposes: NUTS regions and beyond

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Regional statistics, along with the NUTS (Nomenclature des Unités Territoriales Statistiques, or Nomenclature of Territorial Units for Statistics) classification, already have a solid tradition. They have developed into a very useful tool for detailed analyses and have become the basis for important decisions in the allocation of EU funding. Gradually, the scope of regional statistics has widened, and regional statistics now play a role in several statistical domains with a wide range of statistical indicators.

The recognition that many of the social and economic issues Europe faces today have urban or rural characteristics has led to an initiative to supplement statistical data on NUTS regions with data on cities and rural areas. These sub-national statistics allow policy makers to better target their policies. For example, in some parts of Europe, poverty and social exclusion are clearly an urban problem, while in other areas they are primarily a rural problem.

A further aspect that has gained considerable importance in territorial policy making – as well as in public awareness – concerns the so-called functional regions, which are selected or constructed from more detailed geographical units according to specific features. The labour market area is one example of this type of functional delineation, which helps to shed light on important territorial characteristics.

The fast-growing use of geographic information and new technical facilities has

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created possibilities for merging statistics and related geographical information into so-called spatial statistics. An example is grid-based population data, which helps to determine the concrete locations of people with access to certain facilities (e.g. public transport, airports) or to identify a population close to the sea. Through the intensive use of map-related functions, the utility of regional and urban statistics can also be enhanced, and different statistics can be combined.

This paper argues that different sub-national statistics offer different but inter-related perspectives. They can be combined in multiple ways to create new possibilities for policy analysis and to illustrate social and economic characteristics at varying levels of geographic detail.

Keywords:
NUTS,
Cohesion Policy,
urban-rural classification,
opulation grid

Meeting the information needs of territorial policies with European statistics

European statistics are the relevant statistics needed to assess the performance of EU activities. The EU places considerable emphasis on regional policy, aiming to bring Europe's regions and cities closer together in economic, social, and environmental terms. European sub-national statistics are important for understanding and quantifying the impact of policies on a specific region or area. Regional and other sub-national statistics available within Europe are thus a helpful tool for understanding territorial diversity. Most of the statistical information need to be met at the EU level comes from the Cohesion Policy.

Cohesion Policy

The Lisbon Treaty specifically introduced the objective of territorial cohesion among the twin goals of economic and social cohesion (Articles 174 to 178 of the Treaty on the Functioning of the European Union; see References). Developing policies for increasing overall cohesion requires recognising the particular characteristics of certain regions, cities, or areas. The EU's Cohesion Policy aims to invest in growth and jobs, and to promote territorial cooperation. Cohesion Policy funding for the 2014–2020 period is foreseen to be almost EUR 352 billion-equivalent to almost one-third of the EU's total budget during that period. Regional statistics are employed to allocate funds and determine geographic eligibility on the basis of regional GDP per inhabitant in purchasing power standards (PPS), averaged over a three-year period. NUTS level 2 regions were ranked and split into three groups:

– less developed regions (where GDP per inhabitant in PPS was less than 75% of the EU average);
– transition regions (where GDP per inhabitant in PPS was between 75% and 90% of the EU average); and
– more developed regions (where GDP per inhabitant in PPS was more than 90% of the EU average).

More than half of the foreseen Cohesion Policy funding is allocated to less developed regions.

The nature of the Cohesion Policy and its objectives have evolved in recent decades. In addition to its focus on reducing economic disparities, the policy has become more closely aligned with the overall strategy of the EU. Accordingly, in the 1990s, funding was extended to environmental and trans-European transport infrastructure. In the 2000s, the Cohesion Policy was directed toward the pursuit of the Lisbon and Gothenburg strategies for growth and sustainable development. Currently, the Cohesion Policy is an integral part of the Europe 2020 strategy, with a strong focus on employment, innovation, sustainability, and reducing poverty and social exclusion. This shift is accompanied by an increased demand for regional statistics on sustainable growth as well as a recognition of the need to move beyond GDP when assessing territorial development.

Regional statistics by NUTS regions: A classic approach that has a future

Regional statistics are based on a harmonised convention in the definition of regions contained in the classification of territorial units for statistics, known by the acronym NUTS (Nomenclature des Unités Territoriales Statistiques, or Nomenclature of Territorial Units for Statistics; see References). This is a regional classification for EU member states that provides a harmonised hierarchy of regions. The NUTS classification subdivides each member state into regions at three different levels, covering NUTS 1, 2, and 3 from larger to smaller areas. If available, administrative structures are used for the different NUTS levels. In Germany, for example, there are 16 NUTS level 1 regions, corresponding to the states (Bundesländer); 38 NUTS level 2 regions, corresponding to government regions (Regierungsbezirke); and more than 400 NUTS level 3 regions, corresponding to districts (Kreise). In those member states where there is no administrative layer corresponding to a particular level, artificial regions are created by aggregating smaller administrative regions. The NUTS classification is defined in Regulation

(EC) No 1059/2003 of the European Parliament and the Council. It defines the minimum and maximum population thresholds for the size of NUTS regions. Regions have also been defined and agreed upon by the European Free Trade Agreement (EFTA) and candidate countries on a bilateral basis.

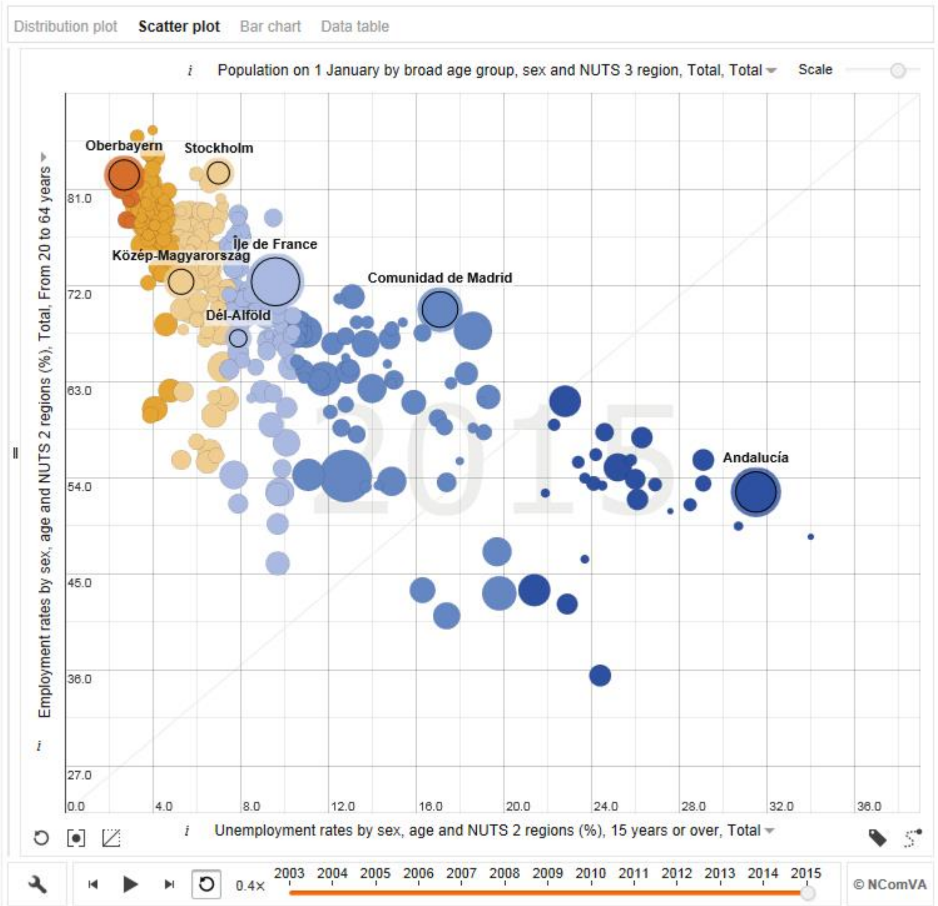
For statistical purposes, the NUTS classification has significant advantages. First, NUTS gives clear preference to established administrative units with identifiable governing structures or aggregations of such units. Second, the administrative nature implies the existence of structures that strongly support the collection of statistics, such as registries or clearly defined competences for the administrative unit. Finally, the NUTS classification achieves a common spatial reference for very different statistical indicators.

Based on NUTS, there is a more than 30-year tradition of EU regional statistics, which has gradually extended to almost all domains of the main social and economic themes. Today, regional statistics cover a broad range of statistical areas: economic accounts, demography, labour market, education, health, agriculture, business, tourism, science and technology, transport, digital economy and society, poverty, crime, social exclusion, etc. It is a field of growing coverage and importance.

An important advantage of regional statistics is the ability to combine different indicators to create new insights. Eurostat offers several interactive applications on its website for visualising regional data. A good example is the Regions and Cities Illustrated tool, which includes a wide range of indicators. There are four standard visualisations: a distribution plot, a scatter plot, a bar chart, and a data table. These provide opportunities to perform deeper analyses of regional data as well as comparisons and rankings of different regions. The scatterplot can be used to explore relationships between different indicators and find regions with similar characteristics. In addition, an animated timeline can be used to explore how indicators for specific regions have developed over time. Figure 1 shows a screenshot of the tool.

Figure 1

Employment and unemployment rates in selected NUTS 2 regions, 2015



Source: Eurostat/Regions and Cities Illustrated.

Reading note: On the chart, each bubble represents a NUTS level 2 region. The size of the bubble reflects the total population of the region. The employment rate among persons aged 20–64 is shown on the vertical axis while the unemployment rate of persons aged 15–74 is shown on the horizontal axis.

The key factor that influences the evolution of regional statistics is the trade-off between the need for more detailed information and the costs (including the burden on respondents) of data collection. For survey-based statistics, it is evident that the lower the regional breakdown, the larger the sample size required for reliable figures. The current trends in statistics toward increasingly relying on open data, big data, and administrative sources, as well as promoting the reuse of existing data across different statistical domains, will in the long run promote the further evolution of regional statistics.

In some key areas, further developments of regional statistics are taking place to strengthen the utility of regional indicators for policy making:

– Regional accounts: Regional accounts data collection now follows the new European System of Accounts 2010 (ESA 2010) methodology. In 2017, Eurostat is expected to release complete tables to users following the new methodology, including back data as from reference year 2000.
– Regional poverty and social exclusion: The Europe 2020 strategy has resulted in increased public discussion about the factors that determine poverty and social exclusion. Currently, the at-risk-of-poverty and social-exclusion rates, and their three sub-components, are not available as data for all EU countries at NUT level 2. For policy development, monitoring, and evaluation in this domain, policy makers have requested regional data for the future. If all the works initiated in this domain deliver the expected results, a majority of countries will be able to deliver NUTS level 2 data with the required precision by 2019.
– Regional population projections: Eurostat released population projections using data for 1 January 2013. The projections result from the application of a set of assumptions about future developments in fertility, mortality, and net migration. They cover population developments from 2013 to 2080.

Urban-rural classifications

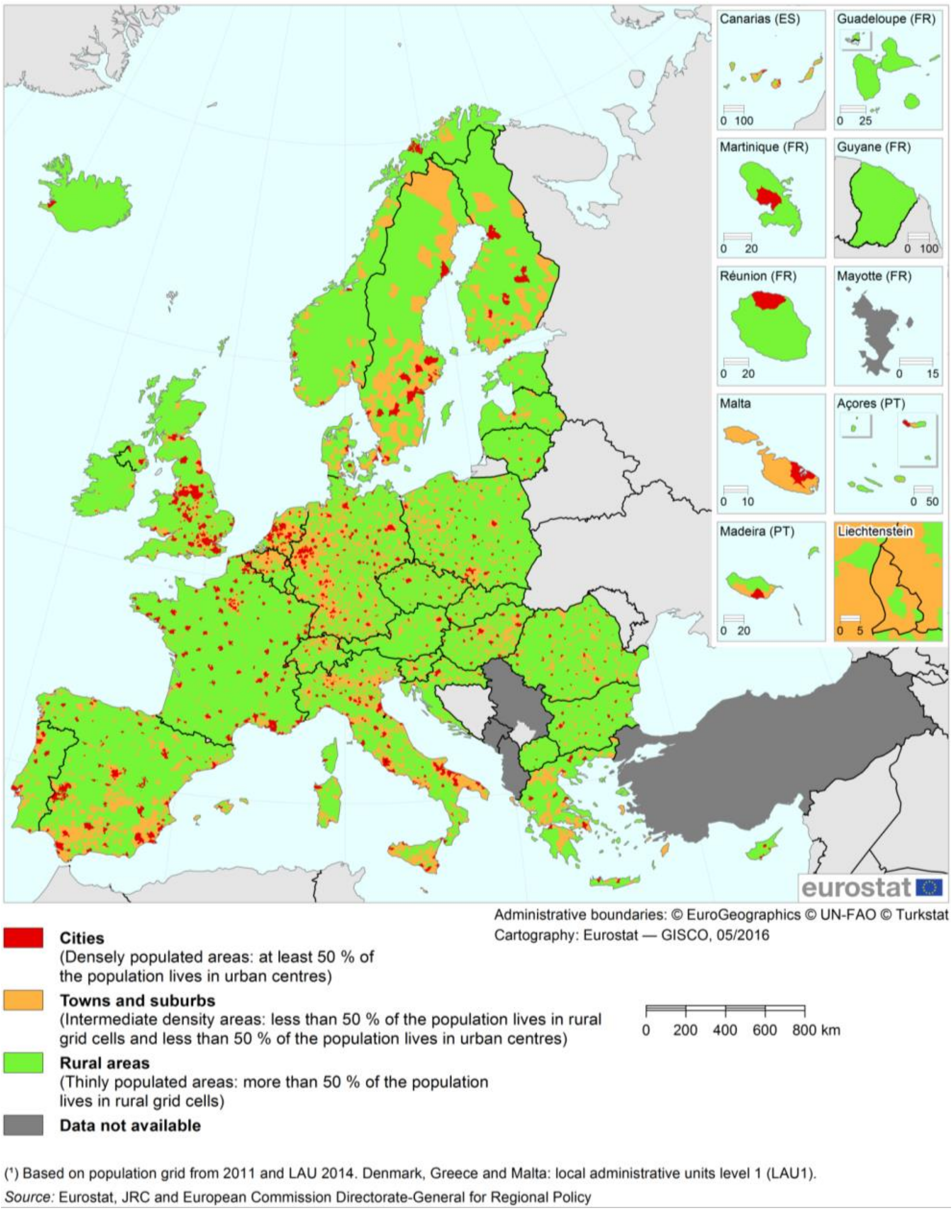
In the past, the NUTS classification has facilitated the collection, compilation, and dissemination of regional-level European statistics. It has ensured stability and comparability for the Cohesion Policy and other territorial policy measures. From the policy side, however, there have been two main relevant developments in recent years. There is a growing need for EU-level policy makers to focus on regions and areas with specific characteristics (urban, rural, coastal, etc.).

The 'Pact of Amsterdam', adopted in 2016, established the Urban Agenda for the EU. The Agenda calls for better regulation, better funding, and better knowledge, including more reliable data for evidence-based policy making. The Cohesion Policy itself has several policy instruments focused directly on cities: sustainable urban development, URBACT, and urban innovative actions. In the post-2020 Cohesion Policy, cities will most probably play again a key role.

On the other hand, the recent reform of the EU's Common Agricultural Policy (CAP) shifted its focus toward a land-based policy. A number of CAP indicators describe the situation of rural areas, in line with the policy objective of balanced territorial development. These indicators are also essential for the programming, implementation, monitoring, and evaluation of rural development policy. For policy makers, it is particularly important to obtain these indicators by urban-rural typology. This is a precondition for the comparison of social and economic living conditions between rural, intermediate, and urban areas.

Figure 2

Degree of urbanisation for local administrative units level 2



Source: Eurostat/Territorial typologies.

To address these policy needs, the European Commission established harmonised typologies and sub-NUTS classifications, because comparability can only be achieved through European-level harmonisation. These tools have been used for analytical purposes. The European Commission introduced territorial typologies based on population size, geographic location, and population density to monitor situations and trends in specific regions and areas. Eurostat disseminates statistical aggregates using the following urban-rural classifications (Eurostat/Territorial typologies; see References):

- Urban-rural typology classifies the NUTS level 3 regions of the EU into three different categories: predominantly urban, intermediate, and predominantly rural. It is a geographical typology based on the definition of urban versus rural grid cells of 1 km² each. The type of region depends on the share of the regional population living in rural grid cells.
- Degree of urbanisation classifies local administrative units (LAUs) based on the share of the local population living in urban clusters and urban centres into cities, towns and suburbs, and rural areas.

Eurostat's Statistical Atlas is an interactive viewer that allows users to study these different layers of classification, as well as statistical data, in combination with layers of geographical information (e.g. statistical regions, cities, roads, or rivers).

Eurostat's database with statistics by degree of urbanisation contains a range of population and social indicators covering the following: education and training, living conditions and welfare, the labour market, tourism, and the information society.

Functional geographies

Further challenges for regional statistics derive from the recognition that certain economic, social, and environmental phenomena do not strictly follow administrative boundaries; thus, a more flexible statistical geography is needed. Different parts of a region may have very different social conditions, or the lives of citizens are strongly influenced by the distances they have to travel to work. Mountainous and coastal areas have very different conditions that determine access to education or the job market. In administrative terms, these areas are usually combined with areas of different characteristics. With a focus based purely on administrative boundaries, the specific issues of the area in question are not as apparent as policy requirements would necessitate. Thus, the varied facets of policy actions require a picture at a different level of territorial focus – namely, a functional view.

Functional geography captures the spatial extent of a policy issue (e.g. managing a river basin or labour market area). Using functional geography can enhance the efficiency of public policies, even though it often calls for more coordination across administrative or political boundaries. To obtain a better understanding of the functional geography dimension, the European Commission developed a number of new harmonised territorial definitions and continues to work on new ones. Together with the OECD, it has created a new harmonised definition of a city and its commuting area which shows that the latter, especially in large cities, often cross NUTS region boundaries and even national borders. Another prominent example is the labour market area (LMA): a geographic area defined for the purposes of compiling, reporting, and evaluating employment, unemployment, workforce availability, and related topics. Commuting patterns are the primary consideration in defining and delineating LMAs. LMAs are potentially the most appropriate spatial units thus far for examining spatial phenomena such as labour mobility and labour market development, as well as the spatial relationships of neighbouring municipalities in terms of the EU's free labour market.

Merging statistics and geographical information: New possibilities for statistical analysis

In contrast to regional or urban statistics, the area analysed in 'Spatial Statistics' is not fixed from the start but flexibly determined based on topological, geometric, geographic, or statistical properties. Starting from the spatial location of the phenomena being studied, the analysis is applied precisely to the area considered most appropriate for understanding the phenomena in question. For example, for analysing certain health-related issues, the different locations of individuals, their residences, their workplaces, or their routes to work can be used in flexible ways and combined with user-defined areas most suitable for the characteristics to be studied.

Spatial statistics originates from technological progress as well as from a growing awareness of possibilities following the introduction of some widely popular applications based on spatial information. The technological basis for geographic information systems (GIS) has changed radically in recent years, creating new possibilities, although the concept and technology are by no means new in principle. Spatial datasets are often very large, amounting to gigabytes of data that need to be not only stored but also manipulated in flexible and efficient ways. Progress in data storage, database technology, and IT processing speed moved the field of GIS from data centres to desktop computers, while at the same time specialised GIS software became more mature and easier to use.

The use of maps and spatial information is far from new. Each city has a cadastral office, and maps in general were always used for planning purposes. However, the ease of access and processing of such data in modern IT systems has introduced spatial data into many new application areas.

Evident uses of spatial statistics are local, such as planning by communal administrations, planning streets to minimise environmental impact, or planning bus stops to optimise their utility for citizens. Maps and spatial analysis are also indispensable for disasters, such as flooding or large-scale fires, in order to show the impact in detail without losing the larger perspective.

Spatial statistics and analysis are also useful for subjects requiring a large-scale perspective to explore the characteristics of regions that were not initially identified in the same way. For example, a geocoded survey originally intended for administrative regions may allow for studying differences between rural and urban regions.

The grid-based perspective

The grid-based perspective is particularly useful for statistical purposes because it allows, on the one hand, the application of a very detailed geographical perspective. On the other hand, it preserves statistical confidentiality by not disclosing the characteristics of individual statistical units. Statistical grid data are statistics geographically referenced to a system of (usually squared) grid cells in a grid net with Cartesian coordinates. Traditionally, official statistics are reported in accordance with a hierarchical system of administrative units. In the EU, NUTS is the most important example of such an output system. While this is excellent for many purposes – like reporting to the respective authority administering the territory – it is not suitable for studying the causes and effects of many socioeconomic and environmental phenomena, such as flooding, commuting, etc.

Population density is one subject that can be well displayed in terms of grids. Reliable population density grids allow for a flexible delineation of areas of interest. Consequently, it becomes much easier for researchers and analysts to combine statistical data with scientific data. In addition, such a system will provide for temporal stability in the statistical reference system. Potential users range from local to national authorities, the EU, businesses, and researchers. In particular, all statistics related to individuals will profit from the availability of high-resolution population data.

Conclusions

Since 2010, the quantity and quality of regional and other sub-national data from official statistics have significantly improved due to the efforts of the National Statistical Institutes and Eurostat. The domain has also benefited from data from other sources, such as the Joint Research Centre, Copernicus, the European Space Agency, the European Environmental Agency, and the Directorate-General for Regional and Urban Policy, among others. This has led to better data on a wide range of issues, including poverty, well-being, health, air quality, innovation, access to public transport, and the structure of settlements. However, more remains to be done to complete the picture and provide more detail. With technological progress in geocoding units of the economy, society, and environment, the availability of information at the lowest level of geographical resolution is increasing, creating new opportunities for regional and sub-national statistics. Big data can also help to better fulfil the mandate of providing timely and coherent statistics for decision making, research, and public debate in the future.

EU policy making increasingly focuses on sub-national aspects based on the understanding that sub-national analyses play an important role in achieving an integrated economic and social space. Deeper analyses of social and economic conditions (e.g. those required for focused cohesion projects) need to look to functionally defined regions to complement the administrative perspective of administrative regions.

Statistics and geographic information are naturally related. Statistics are intrinsically geo-referenced information since they refer to specific geographic entities such as states, regions, and cities. The explicit link with more detailed and fine-grained geographic information is, therefore, a rather natural extension of statistics.

The different forms of sub-national statistics presented should not be seen as isolated and distinct types of statistical or geographic information. They are in many ways integrated and complementary.

Disclaimer

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Examining the Factors of Endogenous Development in Hungarian Rural Areas by Means of PLS Path Analysis

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forms of capital,
dependencies,
rural areas

The study analyses the development of Hungarian rural sub-regions. After the delimiting of the countryside, we focus on the academic literature of endogenous regional development. There are many approaches to the theory and, thus, there are differences and similarities between the key factors of the theory. We synthesize these forms of capital to create a conceptual framework that can serve as a basis for quantitative analyses. We propose our own measuring system and a model to reveal the relations among endogenous capital factors in the framework of a descriptive analysis, relying on the theory of endogenous development. Furthermore, we propose a model that explains development, and includes latent variables symbolising the forms of capital. We then examine the model using a partial least squares path analysis. The results show that the various forms of capital thought to be relevant in the literature are not all included in the regression model. This shows and helps us to understand the connections between forms of capital, although the model is only valid in a rural context. Furthermore, we find that the relations between the forms of capital vary considerably over time.

Introduction

Despite the fact that rural areas in East-Central Europe struggle with many difficulties, in a wider context of the countryside, we can discuss numerous changes. In the past few decades, the theory of endogenous development has come to the fore in spatial development and regional policy, and has gained relevance in a rural context. However, in the case of the countryside, the emphases are slightly different.

Nevertheless, empirical analyses of the popular theory of endogenous development, including probably the most popular concept of territorial capital, place cities or territorial units on a particular hierarchical level. These analyses either neglect the countryside, or place minimal focus on them.

Today, endogenous development is a highly valued branch of development theory. Concerning the notion itself, Lengyel states that "*…endogenous, in economics, means the factors which are not inherited ("not born of God") but created consciously by economic activities. In regional science the bottom-up organised public actions and initiatives, which are based on consciously created local facilities are regarded as endogenous*" (Lengyel 2012, p. 145).

The utilization of local facilities is sometimes ambiguous, which can cause significant disadvantages. The appreciation of undercover facilities mentioned above highlights the real problem with the devalued Hungarian countryside.

Capello et al. (2009) believe that at least two conditions are essential. The first is local production and the appropriate utilization of knowledge. The second is territorial capital, which respects the specialities of a given region.

Our aim is to analyse the interaction among forms of capital in terms of endogenous development. We focus on the rural sub-regions of Hungary, which we investigate using partial least squares (PLS) path analysis. However, we first clarify the term 'rural' and its relevant data.

Countryside and delimitation

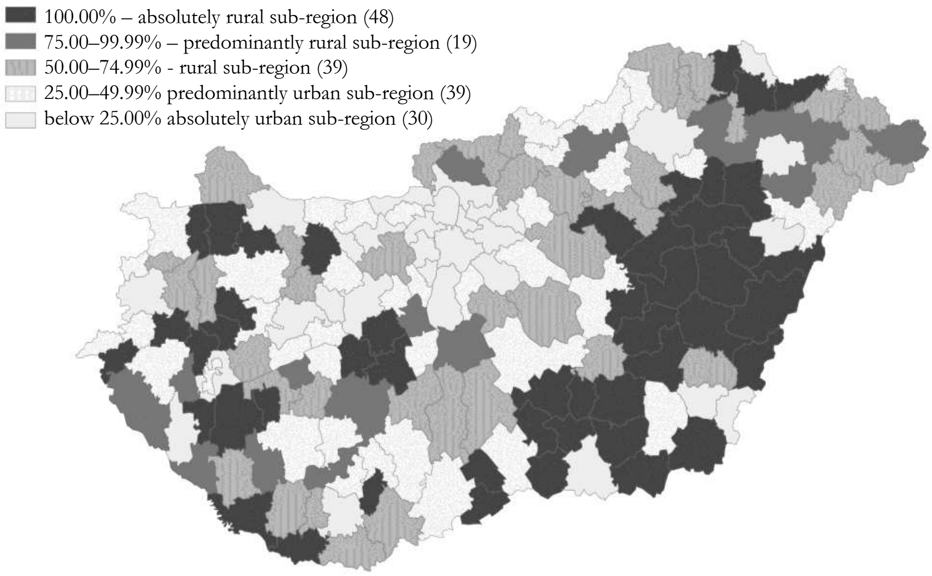
The countryside is a unique territory that differs from urban settlements, and has special characteristics that are determined by the settlements, economy, and society surrounding it. Rural areas have an irreplaceable economic, social, cultural and ecological importance (Perlín–Simciková 2008). That the functions of rural territories do not only serve trade in the suburbs, agriculture, and tourism was first mentioned in a regional development document (EC 1999) more than a decade and a half ago. This statement is even more relevant today, because most of the cultural and biological diversity of the European Union can be attributed to such territories.

In order to define rural territories, we base our analysis on the Hungarian system of sub-regions, and use the recommendations of Csatári (2001). As such, we can categorize Hungarian minor territorial units using the urban/rural index; that is, we determine the ratio of residents in territories with a density below and above 120 people/km^2.

The urban/rural index considers 106 territorial units to be rural, although the features of these areas do vary. However, this is a widely accepted method, note that each rural area includes one or more cities.

Figure 1

Rural and urban micro regions in Hungary



Source: Own creation.

Theory of endogenous development

Next, we determine the relevant forms of capital in the context of endogenous development. However, we first briefly describe the theory of endogenous development, which is based on the notion of development.

"The concept of development, according to its most general interpretation, means the process which leads from a lower standard to a higher one" (Szentes 2011, p. 13). Szentes (2011) highlights that the theory of development has had diverse interpretations over time, and particularly in the recent past, depending on the branch of social science in which it is applied. The definitional problem is also mentioned by Todaro and Smith (2009), who claim that without a certain level of agreement, we cannot carry out quantitative analyses or determine the development within a country. The authors add that the strict economic definition of development refers to long-term income per capita growth that enables a faster output than the population growth of a nation.

According to Benko (1997), endogenous development appeared in the late 1980s, although the author refers only to industrial and urban regions in his study. Stimson et al. (2011) claim that the past few decades have seen a shift from exogenous to endogenous facilities. Supporting this finding, Lengyel (2012/a) states that endogenous factors have recently come to the fore in regional development.

Then, Capello's (2007, 2011) view is that endogenous development depends on a regions' constitution, which is a socio-economic and cultural system defining the success of local economy via the elements of entrepreneurial skills, local factors of production (labour and capital), and contact management of local actors, which increasingly contribute to the creation of knowledge.

These conditions are important, because several statistically significant territorial differences should not be attributed to the inefficient use of the classic factors of production, such as capital and labour, but rather are the result of more deeply rooted regional problems, such as local geographical facilities, openness, creativity, and entrepreneurial milieu (Capello et al. 2009). Capello and Nijkamp (2011) mention social opportunities, a healthy environment, and high-quality education as factors determining the regional aspect of economic development.

In order to determined the importance of each form of capital, we consider a wide selection, from which we choose those that are the most appropriate (see Table 1).

Table 1

Forms of capital in models of endogenous development

	fixed capital asset	human capital	social capital	natural capital	cultural capital	relational capital	infrastructural capital	institutional capital	physical capital	creative capital	symbolical capital	structural capital	cognitive capital	settlement capital	entrepreneurial capital	built capital	political capital	activities and business firms	markets, external relations	image/perception
AEIDL (1999)	x	x	x		x				x	x								x	x	x
Capello (2007)	x	x				x		x		x					x					
ETC (2007)	x	x	x	x	x				x											
Vermeire et al. (2008)	x	x	x	x					x											
Camagni (2008)	x	x	x	x	x	x	x	x												
Braithwaite (2009)	x	x	x	x	x											x	x			
Affuso–Camagni (2010)			x		x	x	x						x							
Milone et al. (2010)	x	x	x	x	x			x			x									
Stimson et al. (2011)	x	x	x	x						x										
Brasili et al. (2012)	x	x	x	x		x	x						x	x						
Lengyel–Szakáné Kanó (2012)	x	x	x			x	x	x	x											
Atkinson (2013)	x	x	x	x	x		x	x								x				
Dinya (2013)	x	x	x	x	x	x	x	x	x											
Tóth (2013)	x		x	x	x	x					x	x								
Rechnitzer (2016)	x	x	x		x	x		x		x			x							

Source: Own creation; based on Tóth (2013, p. 44.)

The most frequent and important forms of capital, which we attempt to include in our model, are the following: fixed capital, human capital, social capital, natural capital, cultural capital, relational capital, and infrastructural capital[1].

It is a common attribute of the forms of capital that they are all highly relevant in the rural context, where they appear in a special form. The role of the classic form of capital is unambiguous, and the importance of natural capital to rural areas is self-evident.

The table shows that the same elements are mentioned in several endogenous models as key factors. For example, fixed capital stock appears in many theories, and human capital is important as well. Social capital, natural capital, built capital, and cultural and relational capital are also important. Thus, we treat these as the fundamentals of our quantitative analysis.

Note that we partly agree with Jóna (2013), who adapts Camagni's conception into seven elements. While we interpret the forms of capital in Table 1, we also include natural capital, because the cell in the bottom, left corner of the table can be understood as a natural resource in Camagni's (2008) system.

See Table 2 for a brief summary of these elements.

Table 2

Forms of capital

Form of Capital	Definition	Examples of indicators	Source
Private fixed capital (wealth) Entrepreneurial milieu (fixed capital no. 2)	Private fixed capital is a derived element, and it has been created as a factor of production. It is determined by a high level of materiality and rivalry in Camagni's (2008) model (as well).	Financial characteristics of inhabitants and enterprises, local structure of economy, standard of services, indicators of multinational companies, labour productivity, industrial indicators	Brasili et al. (2012) Camagni et al. (2011) Jóna (2013) Tóth (2013)
Infrastructural capital	'Infrastructural capital is usually referred to as a support system created by people to carry out economic activities in the best possible conditions, in terms of both time and savings. Hence, infrastructural capital is composed of the set of communication means (roads, airports, railways) that expedite and facilitate the exchange of people, goods and services' Brasili et al. (2012, p. 13).	Indicators belonging to public utilities, indicators of natural environment, settlement structure	Affuso–Camagni (2010) Brasili et al. (2012) Jóna (2013) Tóth (2013)

(Table continues on the next page.)

[1] Indicators of each capitals can be seen in Annex I.

(Continued.)

Form of Capital	Definition	Examples of indicators	Source
Natural capital	As Buday-Sántha (2006, p. 352) describes, natural capital is '…those kind of stock of natural resources and environmental assets which can supply precious goods for mankind nowadays and in the future'.	Indicators belonging to tourism, pollution, environmental protection expenditures, green areas, sustainable agriculture, running water service, built-up density	Affuso–Camagni (2010) Brasili et al. (2012) Tóth (2013)
Social capital	Social capital refers to '...features of social life-networks, norms, and trust that enable participants to act together more effectively to pursue shared objectives' (Putnam 1996, p. 66).	Indicators of unemployment, crime, tourism; social indicators; participation in public life; volunteering; donations	Affuso–Camagni (2010) Brasili et al. (2012) Jóna (2013) Tóth (2013)
Human capital	'Human capital refers to the set of skills, competencies, abilities owned by the individuals' (Camagni et al. 2011, p. 6).	Data belonging to education, tertiary education, research and development, culture	Brasili et al. (2012) Camagni et al. (2011) Jóna (2013) Tóth (2013)
Cultural capital	'Bourdieu (…) developed the concept of "cultural capital" to explain the ability of elite managers and professionals to transmit their privileged status to their children, a process he referred to as "social and cultural reproduction" (DiMaggio 2004, p. 167).	Data belonging to culture	Jóna (2013)
Relational capital	Relational capital is described by Sik (2006, p. 77.), based on two conditions, who states '…it is capable to co-create goods and services meanwhile it does not transform itself; moreover to produce relational capital it is necessary to make sacrifices in the hope of future success (which can be failure, so it is a hazardous investment)'.	Turnout in elections, exporting ability, level of openness, amount of active spin-off companies, minorities, figures of telecommunication, non-profit organizations, data belonging to clubs for senior citizens	Affuso–Camagni (2010)[2] Brasili et al. (2012) Jóna (2013) Tóth (2013)

Source: Own creation

[2] Affuso and Camagni (2010) handle social and relational capital as a single form.

Note that we regard to Table 2, the quantitative approach of fixed capital assets was not clear, despite our studying the literature. Thus, we decided to create two separated forms: private fixed capital, which expresses individual wealth, an entrepreneurial milieu, which reflects the wealth of companies.

PLS path analysis – original model

In this section, we attempt to determine the importance of each selected form of capital using a PLS path analysis. Moreover, we investigate the interactions among the forms of capital and their effect on development. It is important that we do so in order to allow for temporal and spatial changes. With the help of a PLS path analysis, we run a factor and a regression analysis simultaneously, enabling us to analyse the direct and indirect effects among the latent variables (Henseler 2010, Kazár 2014). The advantage of the PLS method is that it can be used in the case of small samples and nonnormal distributed variables (Hair et al. 2012). To analyse the relations between latent factors, we used a PLS path analysis with SmartPLS 3. We use a regression model based on the created latent variables. The results show the weight and importance of each factor in the Hungarian countryside. Then, we investigate the effects of the abovementioned elements on a simplified concept of well-being, interpreted as private fixed capital[3].

Note that our model has an aim of confirmation. As Münnich and Hidegkuti (2012) describe we supervise the relevancy of used data because the links between them are hypothetical.

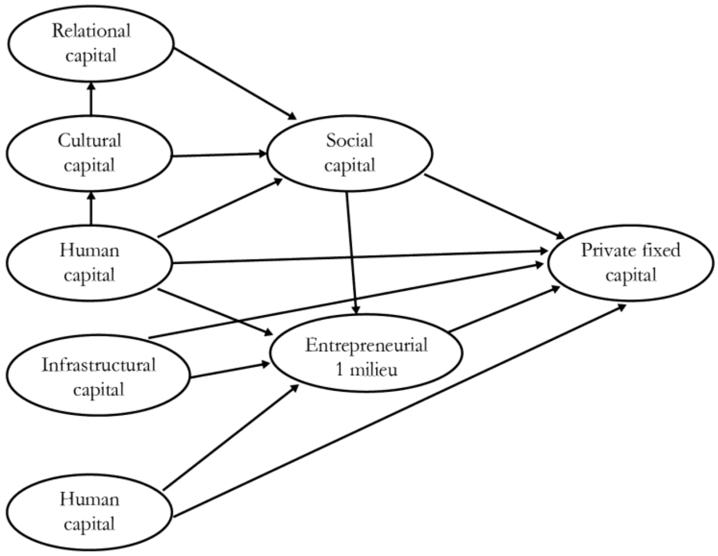
The PLS path model has an inner and outer part. The inner model can be understood as a collective of the latent variables, and the interactions among them. The outer model contains the elements (indicators) of each factor. The variables towards the top of the inner model (Figure 2) are non-material elements, and those towards the bottom denote material elements.

For all three years, we construct an original model of dependencies (Figure 2). We assume that cultural, human, and relational capital shape social capital directly. Furthermore, we assume that social capital has the same effects on private fixed capital and the entrepreneurial milieu, and that relational capital is shaped by cultural capital. Moreover, we hypothesize that infrastructural capital has a direct and significant effect on private fixed capital and the entrepreneurial milieu. Natural capital also forms part of the entrepreneurial milieu.

[3] The concept of well-being is understood as a synonym of private fixed capital, which is an exaggerated simplification, but helps with the interpretation of our aims.

Figure 2

Dependencies of elements describing private fixed capital – original model



Source: Own creation.

Table 3

Attributes of forms of capital

Factor	Cronbachs Alpha			Composite Reliability			Average Variance Extracted (AVE)		
	2009	2011	2013	2009	2011	2013	2009	2011	2013
Human capital	0.793	0.783	0.764	0.838	0.834	0.820	0.515	0.509	0.485*
Infrastructural capital	0.762	0.733	0.767	0.841	0.822	0.843	0.518	0.484*	0.518
Relational capital	0.803	0.682	0.760	0.866	0.754	0.791	0.645	0.531	0.556
Cultural capital	0.785	0.764	0.762	0.857	0.841	0.841	0.544	0.515	0.505
Private fixed capital	0.811	0.820	0.843	0.874	0.873	0.894	0.557	0.540	0.591
Natural capital	0.743	0.743	0.722	0.798	0.838	0.829	0.573	0.634	0.619
Social capital	0.852	0.836	0.853	0.894	0.885	0.897	0.630	0.614	0.638
Entrepreneurial milieu	0.781	0.820	0.841	0.843	0.875	0.893	0.510	0.564	0.593

*: Lower than required result.
Source: Own creation.

In order to describe the latent constructions, we first examine the internal consistency, which can be measured by Cronbach's alpha. A value of 0.6 or higher can be accepted. When the PLS algorithm is applied, Cronbach's alpha often underestimates the level of internal consistency, because it assumes the equality of loadings. In order to solve this problem, the composite reliability indicator is applied, which considers the differences among the loadings. In this case a value of 0.7 or higher can be accepted (Kovács–Bodnár 2016). In our examination, these conditions were satisfied (see Table 3).

Table 4

Values of the HTMT correlation ratio

Pairs of latent variables	HTMT P Values		
	2009	2011	2013
Infrastructural capital – Human capital	0.733	0.697	0.703
Relational capital – Human capital	–0.062	–0.052	–0.066
Relational capital – Infrastructural capital	0.514	0.558	0.573
Cultural capital – Human capital	0.062	0.063	0.147
Cultural capital – Infrastructural capital	0.586	0.638	0.600
Cultural capital – Relational capital	0.587	0.392	0.321
Private fixed capital – Human capital	0.579	0.539	0.587
Private fixed capital – Infrastructural capital	0.994*	0.881	0.813
Private fixed capital – Relational capital	0.204	0.214	0.198
Private fixed capital – Cultural capital	0.387	0.348	0.360
Natural capital – Human capital	–0.073	–0.071	–0.112
Natural capital – Infrastructural capital	0.164	0.179	0.042
Natural capital – Relational capital	0.145	0.161	0.139
Natural capital – Cultural capital	0.453	0.404	0.314
Natural capital – Private fixed capital	0.132	0.111	0.082
Social capital – Human capital	–0.513	–0.570	–0.597
Social capital – Infrastructural capital	–0.761	–0.889	–0.809
Social capital – Relational capital	–0.094	–0.179	–0.154
Social capital – Cultural capital	–0.484	–0.498	–0.596
Social capital – Private fixed capital	–0.880	–0.844	–0.874
Social capital – Natural capital	0.023	0.009	–0.068
Entrepreneurial milieu – Human capital	0.692	0.638	0.634
Entrepreneurial milieu – Infrastructural capital	0.743	0.626	0.665
Entrepreneurial milieu – Relational capital	0.120	0.116	0.102
Entrepreneurial milieu – Cultural capital	0.211	0.150	0.268
Entrepreneurial milieu – Private fixed capital	0.614	0.576	0.547
Entrepreneurial milieu – Natural capital	0.039	0.042	0.013
Entrepreneurial milieu – Social capital	–0.462	–0.473	–0.471

* Over the required results.
Source: Own creation.

Convergent and discriminant validity were used to examine the validity of the latent constructions. Convergent validity, which is a measure of the extent to which the variables in a set can be considered representatives of the same latent variable, can be measured by the average variance extracted (AVE). Here, a value of 0.5 or higher can be accepted (Henseler et al. 2009). Most previous studies evaluate discriminant validity using the Fornell–Larcker criteria, and than examining the cross-loadings. However, Henseler et al. (2015) provide examples, based on Monte-Carlo simulations, of when these results are false. They suggest an alternate approach, namely, heterotrait-monotrait (HTMT) correlation ratio (Table 4).

We find that all of the investigated factors have satisfactory test values, except for two of the AVE values. However, although these two AVE values do not reach the expected limit (0.5), but the gap is negligible. Furthermore, the lowest AVE value represents a correlation over 0.69 and, thus, it fits. Composite reliability and HTMT each have one test value under the required level, but these do not cause any problems. Therefore, we include them in our model.

PLS path analysis – the final model

After testing the latent variables, we focus on the direct relations of the model in order to determine their significance levels. In using the PLS method, we cannot investigate the significance levels of path coefficients directly. Therefore, we use bootstrapping with a high number (5000) of subsamples (see Table 5). *Note that the special indicators of social capital indicate that greater values express higher under-development.*

Table 5

P-values of the original model, 2009

Path	Path Coefficients	T Value	P Value
Human capital → Cultural capital	0.123	1.573	0.116
Human capital → Private fixed capital	–0.023	0.312	0.755
Human capital → Social capital	–0.485	8.171	< 0.001
Human capital → Entrepreneurial milieu	0.511	6.168	< 0.001
Infrastructural capital → Private fixed capital	0.525	6.232	< 0.001
Infrastructural capital → Entrepreneurial milieu	0.247	1.990	0.047
Relational capital → Social capital	–0.068	0.624	0.532
Relational capital → Entrepreneurial milieu	0.070	0.642	0.521
Cultural capital → Relational capital	0.482	2.726	0.006
Cultural capital → Social capital	–0.307	3.460	0.001
Cultural capital → Entrepreneurial milieu	0.048	0.586	0.558
Natural capital → Private fixed capital	0.024	0.395	0.693
Natural capital → Entrepreneurial milieu	0.009	0.142	0.887
Social capital → Private fixed capital	–0.403	6.876	< 0.001
Social capital → Entrepreneurial milieu	–0.030	0.372	0.710
Entrepreneurial milieu → Private fixed capital	0.087	1.173	0.241

Note: Significant correlation, with $p<0.05$.
Source: Own creation.

Note that we had to run many tests before the final model was complete. This was necessary because a path indicated as not significant in a given model can be significant in a different model if the paths are changed. The opposite may be true as well. Table 5 shows the significant path between infrastructural capital and private fixed capital, but this is not included in the model for 2009 (Table 6). The p-values for 2011 and 2013 are shown in Annex II.

Table 6

P-values of the final model, 2009

Path	Path Coefficients	T Value	P Value
Human capital → Social capital	–0.488	8.820	< 0.001
Human capital → Entrepreneurial milieu	0.454	6.445	< 0.001
Infrastructural capital → Entrepreneurial milieu	0.372	4.242	< 0.001
Cultural capital → Relational capital	0.507	3.560	< 0.001
Cultural capital → Social capital	–0.344	4.839	< 0.001
Social capital → Private fixed capital	–0.611	9.288	< 0.001
Entrepreneurial milieu → Private fixed capital	0.326	4.326	< 0.001

Note: Significant correlation, with $p<0.05$.
Source: Own creation.

After rejecting non significant direct paths, private fixed capital is described by six forms of capital, either directly or indirectly, in the final model and in all three years: two material forms of capital (*entrepreneurial milieu, infrastructural capital*), and four non-material forms of capital (*cultural capital, human capital, social capital, relational capital*). It is interesting that natural capital, which had satisfactory test results, has no significant connections to other forms of capital. Nevertheless, the factor is included in the model because this separation can be found as a scientific result.

Similar to the renewed pyramidal model of regional competitiveness (Lengyel 2015, Lengyel–Szakálné Kanó 2012), we identify the success determinants, main factors, and the target in our model (Figure 3). Cultural, relational, human, and infrastructural capital are success determinants, whereas social capital and the entrepreneurial milieu can be defined as the main factors of the model. The target is embodied by private fixed capital, of course.

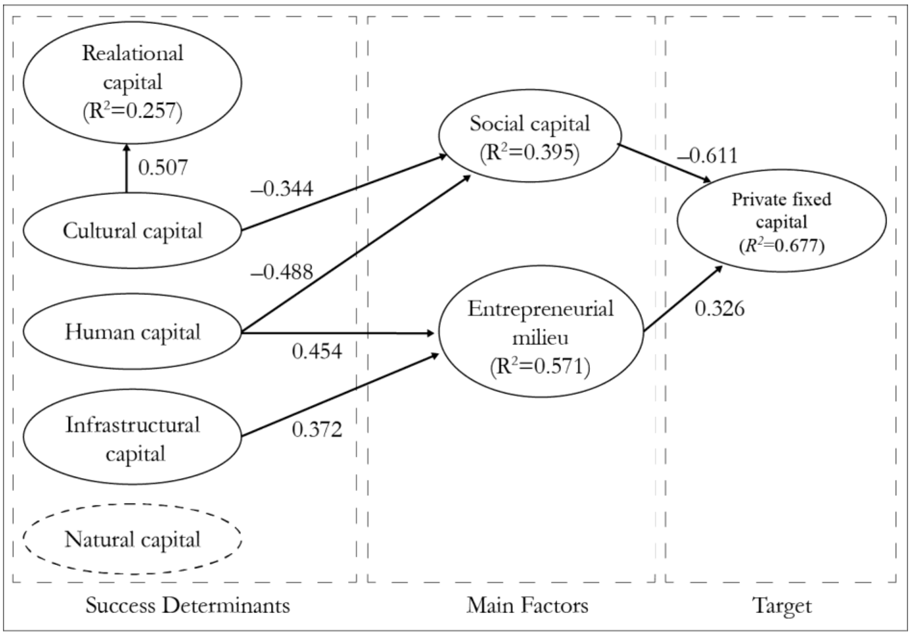
In 2009 (Figure 3), we find that cultural capital and human capital have an effect on social capital. The cultural factor has a weak impact, while the human element has a moderate influence. In addition, the human capital has a direct effect ($R = 0.454$) on entrepreneurial milieu. Moreover, this element moderately shapes private fixed capital, indirectly, through social capital and the entrepreneurial milieu ($(-0.488) \times (-0.611) + 0.454 \times 0.326 = 0.446$).

Infrastructural capital forms the entrepreneurial milieu directly, with a moderate effect (0.372), as well as private fixed capital. However, the latter indirect effect is rather weak (0.372 × 0.326 = 0.121).

Relational capital has a unique role in the model, because it has no effect on the other forms of capital. Cultural capital has a moderate effect on relational capital (0.507).

Figure 3

Interactions of forms of capital explaining private fixed capital, 2009



Source: Own creation.

Social capital has a greater impact (–0.611) on private fixed capital, while the effect of the entrepreneurial milieu is much lower (0.326). More than two-thirds of the variance in social capital can be explained by the model, with the remainder (approx. 32%) determined by factors outside the model.

It is important to present the values of correlation. In analysing the data, we find there are moderate links between forms of capital. The connection between human and relational capital, and that between human and cultural capital are exceptions. In those cases, we refer to a lack of connection. Otherwise, there is a strong relation between private fixed capital and infrastructural capital (0.811). However, note that infrastructural capital has only an indirect effect on private fixed capital.

We have mentioned the specific nature of indicators of social capital. Thus, the positive correlation between the forms of capital is unambiguous (Table 7).

Table 7

Correlations between the forms of capital, 2009

	Human Capital	Infrastructural Capital	Relational Capital	Cultural Capital	Private Fixed Capital	Social Capital	Entrepreneurial Milieu
Human Capital	1.000						
Infrastructural Capital	0.672	1.000					
Relational Capital	0.060	0.503	1.000				
Cultural Capital	0.115	0.473	0.507	1.000			
Private Fixed Capital	0.602	0.811	0.271	0.337	1.000		
Social Capital	–0.528	–0.645	–0.190	–0.400	–0.773	1.000	
Entrepreneurial Milieu	0.704	0.677	0.222	0.269	0.629	–0.497	1.000

Source: Own creation.

Table 8

Values of total effect, 2009

	Relational Capital	Private Fixed Capital	Social Capital	Entrepreneurial Milieu
Human Capital		0.446	–0.488	0.454
Infrastructural Capital		0.121		0.372
Relational Capital	1.000			
Cultural Capital	0.507	0.210	–0.344	
Private Fixed Capital		1.000		
Social Capital		–0.611	1.000	
Entrepreneurial Milieu		0.326		1.000

Source: Own creation.

We use the same method as that of Hetesi and Révész (2013) in order to determine the degree of the direct and indirect affects of the latent variables on private fixed capital. Here, we find that the direct effects are equal to the path coefficients (Figure 3), and that the direct and indirect effects are explained by the total effects (Table 8).

In addition to the direct effects of social capital and the entrepreneurial milieu on private fixed capital, the target variable is shaped indirectly by cultural (0.21) and infrastructural capital (0.121).

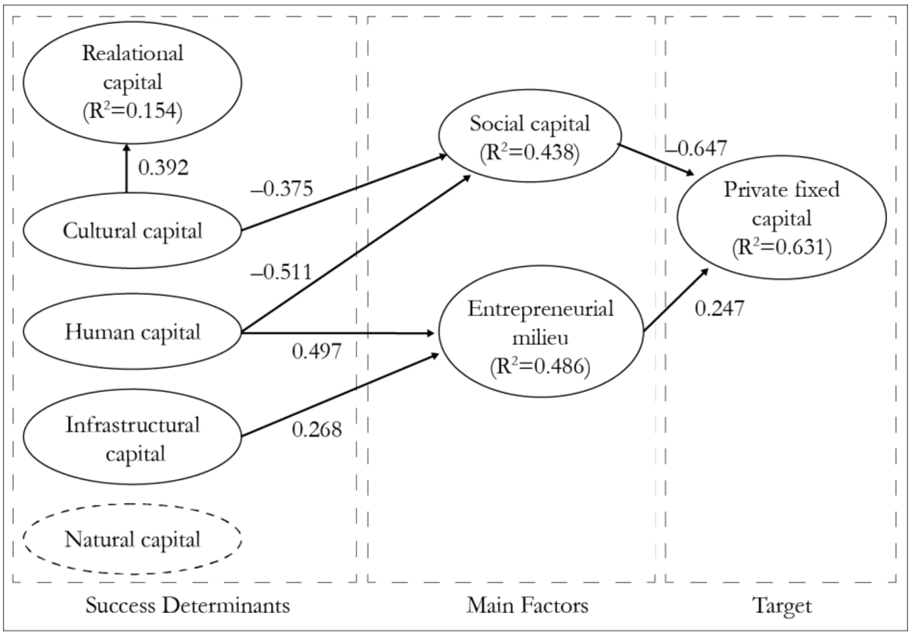
In 2011[4], we find the same interactions in our model. A comparison with 2009 shows that, the same paths have roughly the same weights. Natural capital has no significant connection to the other forms of capital, and relational capital is in the same position (Figure 4).

[4] Test values for 2011 and 2013 are provided in Annex II.

We find that four paths strengthened between the two years, but that these changes were negligible. The effect of human capital on social capital and on the entrepreneurial milieu has changed slightly, as has the effect of cultural on social capital. Three paths have weakened (e. g. the link between entrepreneurial milieu and private fixed capital), but again, the changes are not important. In conclusion, in 2011, the variance of private fixed capital decreased slightly, but the change was not important.

Figure 4

Interactions of forms of capital explaining private fixed capital, 2011

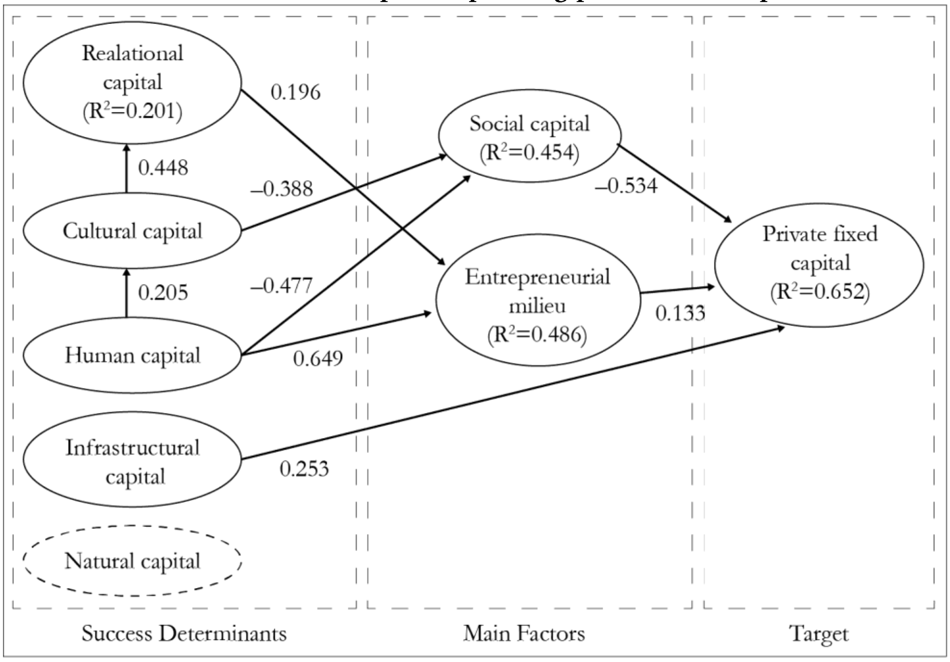


Source: Own creation.

In 2013, we find a different picture (Figure 5), with changes among the paths. The connection between infrastructural capital and the entrepreneurial milieu is no longer significant. Another notable change is that the capital of enterprise performance is formed by relational capital (0.196). The direct effect of infrastructural capital on private fixed capital (0.253) appears as a new path as well. In addition, human capital has an influence on cultural capital (0.205). Thus, the linkages of 2013 are the most similar to the theoretical dependencies of our original model (Figure 2).

Figure 5

Interactions of forms of capital explaining private fixed capital, 2013



Source: Own creation.

There are smaller changes among the significant paths identified earlier. For example, the effects of cultural capital on relational and social capital are negligible.

There is a weakening of the path between human and social capital. Moreover, both social capital and the entrepreneurial milieu shape the target variable with less of an effect. However, in 2013, the variance of private fixed capital has decreased (0.652). Private fixed capital being formed by social capital (–0.534) is the strongest effect, human capital (0.387) has the most robust indirect effect on private fixed capital.

The roles of the forms of capital in the model are clear because every element has a positive effect on private fixed capital. (As mentioned earlier, human capital includes specific indicators, which is why we find a negative sign.)

Future research should investigate the interaction, or the change of the interaction between endogenous forms of capital in a different context. Our model applies to the countryside, and is able to express rural characteristics well. We ran tests to adapt the model to an urban system[5], but were unsuccessful owing to poor test values.

[5] The focus areas of the tests are shown in Figure 1, excluding Budapest.

Table 9

Attributes of forms of capital in urban context, 2013

Faktor	Cronbachs Alpha	Composite Reliability	Average Variance Extracted (AVE)
Human capital	0.826	0.861	0.559
Infrastructural capital	0.702	0.806	0.464*
Relational capital	0.690	0.806	0.584
Cultural capital	0.776	0.795	0.450*
Private fixed capital	0.762	0.836	0.482*
Natural capital	0.362*	0.675*	0.485*
Social capital	0.709	0.787	0.524
Entrepreneurial milieu	0.736	0.840	0.549

* Lower than required result.
Source: Own creation.

Natural capital has extremely low test results, but it is self-evident in a metropolitan context. Three other forms of capital have poor AVE-values (see Table 9), while additional bias is also evident. Thus, we emphasize that using the model in an urban milieu can lead to improper conclusions.

We consider it helpful to compare our results to those of other studies. However, this comparison is limited owing to the lack of rural-centric analyses. Jóna (2013) analysed territorial capital, a more specific aspect of endogenous development, and examined the entire sub-region system of Hungary, while Tóth (2013) focused on the measurement of territorial capital in medium-sized Hungarian cities.

Jóna's (2013) work is based on a multivariate regression analysis, and he describes the effects of the forms of capital on territorial capital. He finds that infrastructural and social capital had almost no effect on territorial capital between 2004 and 2010. In the same period, relational and cultural capital had the most remarkable impact.

Note that, in our assessment, social capital has the most important role in forming the dependent variable.

In his work, Tóth (2013) highlights the capital accumulation in Hungarian cities. His analysis is based on constructed material and non-material factors, and he focuses on the correlation coefficients.

Simplifying his statement slightly, there is a strong link between infrastructural and human-cultural capital. If we investigate the correlations between these forms of capital, we find a moderate-to-strong connection between infrastructural and human capital (2009: 0.672; 2011: 0.63; 2013: 0.642), and a moderate connection between infrastructural and cultural capital. However, we find no causal links between the forms of capital, or that they are questionable.

Our findings, as well as those of Tóth (2013), and Jóna (2013), show that the use of different territorial approaches may lead to different outcomes, even within similar frameworks.

Conclusions

In our paper, we attempted to measure the role of endogenous forms of capital in a rural context. The PLS path analysis approach is a novel tool within territorial research, especially if we focus on rural differences. With the help of the method, we showed the interactions between the various forms of capital, as well as their changes over time.

In our model, cultural, relational, human and infrastructural capital are defined as success determinants. The main factors are social capital and the entrepreneurial milieu, while the target variable is private fixed capital.

Investigating the potential of natural capital is left for possible future research. However, being able to determine the appropriate territorial context and level is significant. In our study, we developed a regression model applicable to rural areas, and used it to analyse the interactions between various forms of endogenous capital. Our findings will help to reveal data on the nature of the Hungarian countryside.

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ANNEX I.

Indicators of each capitals, 2013

Forms of Capital	Indicator
	Material capital
Private fixed capital	Licensed traditional small-scale producing income (Ft) per capita
	Total domestic income (Ft) per capita
	Total income of full-time jobs (Ft) per capita
	Number of built properties per 1,000 inhabitants
	Total floor area (m^2) of built properties in the same year per 1,000 inhabitants
	Total number of taxpayers per 1,000 inhabitants
	Number of passenger cars by residence of operator per 1,000 inhabitants
Entrepreneurial milieu	Gross value added (1,000 Ft) per registered entrepreneurship
	Balance sheet total (total assets) (1,000 Ft) per registered entrepreneurship
	Number of registered limited partnerships per 1,000 inhabitants
	Number of registered limited companies per 1,000 inhabitants
	Number of registered agricultural cooperatives per 1,000 inhabitants
	Number of registered limited liability companies per 1,000 inhabitants
	Number of registered joint venture per 1,000 inhabitants - GFO'11
Infrastructural capital	Amount of electricity (1,000 kWh) of households per 1,000 inhabitants
	Length of electricity network only for public lighting per 1,000 inhabitants (km)
	Amount of sewage disposal in public collecting system per 1,000 inhabitants (1,000 m3)
	Number of broadband subscriptions at the end of the year per 1,000 inhabitants
	Number of telephone lines (including ISDN lines) per 1,000 inhabitants
Natural capital	Areas of other parts (forest, ha) per 1,000 inhabitants
	Forest area (ha) per 1,000 inhabitants
	Green area (ha) per 1,000 inhabitants
	Non-material capital
Social capital	Total number of registered long-term (180 days) job-seekers per 1,000 inhabitants
	Number of constant replacement migration per 1,000 inhabitants
	Number of full-time pedagogues in primary education per 1,000 inhabitants (including specific education)
	Number of juvenile offenders (year 14-17) within registered offenders per 1,000 inhabitants
	Number of registered offenders (by location) per 1,000 inhabitants

(Table continues on the next page.)

(Continued.)

Forms of Capital	Indicator
Human capital	Number of full-time students in tertiary education per 1,000 inhabitants (by location)
	Number of lecturers in tertiary education per 1,000 inhabitants (by location)
	Number of high-tech processing industry (pc.) per 1,000 inhabitants
	Number of medium high-tech processing industry (pc.) per 1,000 inhabitants
	Number of knowledge-intensive services (pc.) per 1,000 inhabitants
Cultural capital	Number of creative cultural collectivities per 1,000 inhabitants
	Number of members of creative cultural collectivities per 1,000 inhabitants
	Number of cultural events per 1,000 inhabitants
	Number of participants of cultural events per 1,000 inhabitants
	Number of visitors of museums per 1,000 inhabitants
	Number of participants of regular forms of culture per 1,000 inhabitants
Relational capital	Number of nights spent at rural tourist accommodation establishments per 1,000 inhabitants (by non-residents)
	Length of fastest path to Budapest by time optimization (from the centre of sub-region)
	Number of nights spent at tourist accommodation establishments per 1,000 inhabitants (by non-residents)
	Number of total guests at tourist accommodation establishments per 1,000 inhabitants
	Number of nights spent at tourist accommodation establishments per 1,000 inhabitants

Note: Some indicators have different names in 2009 and in 2011. These negligible differences have no influence on the dynamic analysis.

Source: Own creation.

ANNEX II.

Test values of PLS Path Analysis

Values of the year 2011

P Values of the original model, 2011

Path	Path Coefficients	T Value	P Value
Human capital → Cultural capital	0.104	1.227	0.220
Human capital → Private fixed capital	0.025	0.287	0.774
Human capital → Social capital	–0.492	8.831	< 0.001
Human capital → Entrepreneurial milieu	0.579	6.823	< 0.001
Infrastructural capital → Private fixed capital	0.287	2.863	0.004
Infrastructural capital → Entrepreneurial milieu	0.073	0.471	0.638
Relational capital → Social capital	–0.151	2.195	0.028
Relational capital → Entrepreneurial milieu	0.171	1.726	0.084
Cultural capital→ Relational capital	0.387	3.224	0.001
Cultural capital→ Social capital	–0.311	4.944	< 0.001
Cultural capital→ Entrepreneurial milieu	0.050	0.678	0.498
Natural capital → Private fixed capital	0.082	1.288	0.198
Natural capital → Entrepreneurial milieu	0.017	0.291	0.771
Social capital → Private fixed capital	–0.461	6.269	< 0.001
Social capital → Entrepreneurial milieu	–0.023	0.246	0.806
Entrepreneurial milieu → Private fixed capital	0.148	1.504	0.133

Note: Significant correlation, with $p<0.05$.
Source: Own creation.

P Values of the final model, 2011

Path	Path Coefficients	T Value	P Value
Human capital → Social capital	–0.511	9.475	< 0.001
Human capital → Entrepreneurial milieu	0.497	6.843	< 0.001
Infrastructural capital → Entrepreneurial milieu	0.268	2.263	0.024
Cultural capital→ Relational capital	0.392	3.646	< 0.001
Cultural capital→ Social capital	–0.375	6.189	< 0.001
Social capital → Private fixed capital	–0.647	9.973	< 0.001
Entrepreneurial milieu → Private fixed capital	0.247	2.776	0.006

Note: Significant correlation, with $p<0.05$.
Source: Own creation.

Correlation between the capitals, 2011

	Human capital	Infra-structural capital	Relational capital	Cultural capital	Private fixed capital	Social capital	Entrepre-neurial milieu
Human capital	1.000						
Infrastructural capital	0.630	1.000					
Relational capital	0.075	0.503	1.000				
Cultural capital	0.096	0.508	0.392	1.000			
Private fixed capital	0.555	0.740	0.278	0.340	1.000		
Social capital	–0.547	–0.741	–0.275	–0.424	–0.764	1.000	
Entrepreneurial milieu	0.666	0.581	0.232	0.223	0.554	–0.474	1.000

Note: Significant correlation, with $p<0.05$.
Source: Own creation.

Values of Total Effect, 2011

	Relational capital	Private fixed capital	Social capital	Entrepreneurial milieu
Human capital		0.453	–0.511	0.497
Infrastructural capital		0.066		0.268
Relational capital	1.000			
Cultural capital	0.392	0.243	–0.375	
Private fixed capital		1.000		
Social capital		–0.647	1.000	
Entrepreneurial milieu		0.247		1.000

Note: Significant correlation, with $p<0.05$.
Source: Own creation.

Values of the year 2013

P Values of the original model, 2013

Path	Path Coefficients	T Value	P Value
Human capital → Cultural capital	0.201	2.309	0.021
Human capital → Private fixed capital	0.061	0.598	0.550
Human capital → Social capital	–0.471	8.123	0.000
Human capital → Entrepreneurial milieu	0.577	5.463	0.000
Infrastructural capital → Private fixed capital	0.232	2.149	0.032
Infrastructural capital → Entrepreneurial milieu	0.095	0.526	0.599
Relational capital → Social capital	–0.110	1.585	0.113
Relational capital → Entrepreneurial milieu	0.128	0.962	0.336
Cultural capital→ Relational capital	0.452	2.701	0.007
Cultural capital→ Social capital	–0.341	4.557	0.000
Cultural capital→ Entrepreneurial milieu	0.080	1.000	0.317
Natural capital → Private fixed capital	0.040	0.515	0.606
Natural capital → Entrepreneurial milieu	0.034	0.547	0.584
Social capital → Private fixed capital	–0.522	6.889	0.000
Social capital → Entrepreneurial milieu	0.008	0.090	0.928
Entrepreneurial milieu → Private fixed capital	0.108	1.262	0.207

Note: Significant correlation, with p<0.05.
Source: Own creation.

P Values of the final model, 2013

Path	Path Coefficients	T Value	P Value
Human capital → Cultural capital	0.205	2.265	0.024
Human capital → Social capital	–0.477	8.532	0.000
Human capital → Entrepreneurial milieu	0.649	14.457	0.000
Infrastructural capital → Private fixed capital	0.253	2.575	0.010
Relational capital → Entrepreneurial milieu	0.196	2.167	0.030
Cultural capital→ Relational capital	0.448	2.948	0.003
Cultural capital→ Social capital	–0.388	5.727	0.000
Social capital → Private fixed capital	–0.534	7.297	0.000
Entrepreneurial milieu → Private fixed capital	0.133	1.954	0.051*

Note I: Significant correlation, with p<0.05.
Note II:* – it is involved to the analysis by our decision.
Source: Own creation.

Correlation between the forms of capital, 2013

	Human capital	Infra-structural capital	Relational capital	Cultural capital	Private fixed capital	Social capital	Entrepre-neurial milieu
Human capital	1.000						
Infrastructural capital	0.642	1.000					
Relational capital	0.103	0.571	1.000				
Cultural capital	0.205	0.489	0.448	1.000			
Private fixed capital	0.570	0.688	0.332	0.322	1.000		
Social capital	–0.557	–0.672	–0.306	–0.486	–0.765	1.000	
Entrepreneurial milieu	0.670	0.567	0.262	0.300	0.521	–0.456	1.000

Source: Own creation.

Values of Total Effect, 2013

	Relational capital	Cultural capital	Private fixed capital	Social capital	Entrepreneurial milieu
Human capital	0.092	0.205	0.387	–0.557	0.667
Infrastructural capital			0.253		
Relational capital	1.000		0.026		0.196
Cultural capital	0.448	1.000	0.219	–0.388	0.088
Private fixed capital			1.000		
Social capital			–0.534	1.000	
Entrepreneurial milieu			0.133		1.000

Source: Own creation.

Population Ageing in Eastern Europe: Toward a Coupled Micro-Macro Framework

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Population ageing has been a major demographic trend in Europe. The post-socialist countries are still younger than the European average, but their age transitions are well underway. These transitions are particularly challenging in the rural areas of the region. These areas often do not have enough resources or sufficient community capacity to address the challenges of ageing in place. Although there is considerable variation in the way that ageing influences rural municipalities, it is important to consider an overall framework to investigate this variation. This paper presents an interlinked approach that aims to connect the macro-level and micro-level perspectives on population ageing through the example of Eastern Europe and a detailed study of Bulgaria and Lithuania. Using the unique challenges faced by rural communities in post-socialist countries, we propose a framework for such research in Eastern Europe.

Introduction

Population change is inextricably linked with other aspects of social and economic development at the national, regional, and local levels. Changes in population size generally attract the most attention, but changes in population structure, particularly age structure, are important (Brown–Eloundou-Enyegue 2017). Population changes influence, and are influenced by, macro-level factors, such as economic transformations, regime transitions in governance, and entry into multi-national political and economic arrangements. There is virtually no aspect of a country's social and economic structure not linked to at least one demographic trend.

The process of modernization and capitalist development during the 20th century is associated with numerous well-known demographic processes, among which global declining birth rates is one of the most significant. Accompanying this trend, life expectancy at birth has increased in many countries because chronic diseases have replaced contagious diseases as the major causes of mortality and advancements in public health have reduced infant mortality rates. Increased life expectancy is usually considered a positive indicator of socioeconomic development; however, the corresponding ageing of populations has often evoked alarmist commentaries because countries struggle with the challenges of providing care and support of their increasing numbers of retired workers, who are comprising growing shares of total populations (Brown–Eloundou-Enyegue 2017). Ironically, only a few decades after the alarmist concerns about apparent uncontrollable population growth (Ehrlich 1968), ageing, not "overpopulation," was tagged as the next global demographic challenge, particularly in countries with large post-World War II birth cohorts entering retirement age (Kinsella–Phillips 2005, Pool 2005).

According to the latest revision of World Population Prospects, about 12 per cent of the world's population, accounting for more than 900 million people, were aged 60 or older in 2015. This number is projected to reach 1.4 billion, or 16.5% of all people, by 2030 (UN, 2015). This is the fastest growing segment of the global population, although regional dynamics show considerable variation. For example, European countries are ageing more rapidly than other regions, mainly due to persistently low fertility. Europe's median age in 2015 was about 42 years, which the global population is not projected to reach until 2100 (UN 2015).

In Europe, the former socialist countries of the Eastern periphery have experienced rapid population ageing along with the rest of the continent. By 2000, fertility had fallen below replacement in all of the former socialist nations, except Albania and the Muslim-majority successor states of the Soviet Union. In addition, many of these countries lost young adults to labour emigration. The combination of these two trends radically changed Eastern Europe's age structures within two generations. However, one aspect changed only moderately, namely, lower life expectancy at birth and, particularly, at older ages, persisted in Eastern Europe compared to the West. Although it remains younger than the rest of Europe, Eastern Europe has significantly aged.

A demographic analysis of global or regional ageing could provide valuable background for public policymaking at the national or regional level by providing the necessary historical context for understanding and projecting long-term socioeconomic changes. However, because demographic change is mediated by variation in social structures, demography can only take scholarly inquiry on the implications of population ageing so far. Because population dynamics have considerable social and economic inertia, their actual influences might be overlooked.

This study focused on the effects of population ageing on communities as a specific framework for demographic analysis. Demographic scholarship during recent decades has moved towards combining contextual and historical knowledge with qualitative and quantitative case studies (Thiede et al. 2017). This is an important development because the policy tools at the national level, where most of the data are collected and analysed, might not suitably address community-level situations.

Concurrently, developed locality-specific solutions to problems might not be accessible by other communities struggling with similar challenges.

The link between macro-level (national or large regional) and micro-level (community) fits the broad approach of incorporating history and culture into demography. This is a challenging process given the inherently quantitative nature of population studies and the qualitative (including ethnographic) traditions of scholarship on history, culture, and micro-level social organization (Bachrach 2014). It would be relatively easy to incorporate contextualized or community studies in this process (which is one way to understand micro-perspectives), but we suggest linking the macro-level to the micro-level analysis, which begins with the individual as the unit of analysis.

This study employs an interlinked approach that aims to connect the macro-level and micro-level perspectives on population ageing using the example of Eastern Europe. We start by discussing the long-term ageing trends of the post-socialist region, and, then, we explore the special case of rural ageing. We focus on rural areas because they often have the fewest resources with which to address these challenges. Although there is significant variation among rural areas, even to the extent that the urban and rural dichotomy is under increasing scholarly scrutiny (Brown–Shucksmith 2017f), rural communities share many similarities. Thus, demographic trends, such as population ageing, might create similar challenges for rural communities around the world, and international comparative work on these topics potentially identifies solutions and ideas otherwise unavailable to the relevant stakeholders. This line of research builds on the two basic themes proposed by Glasgow and Berry (2013) in their seminal study on rural ageing: (1) what makes ageing different in rural areas compared to urban areas and (2) how does ageing change the nature of rural places. Our study examines these themes in the context of Eastern Europe.

Ageing in Eastern Europe

Population ageing is largely a function of declining birth rates. Improving life expectancy is also a factor, but contrary to the intuitive opinion, increasing proportions of older adults (those aged 65 or older) are not driven simply by more people surviving to and during old age. A third basic component of population change is migration, which can play a crucial part in ageing, depending on its age selectivity. Because migration is generally selective of younger cohorts, negative net migration removes younger persons from a population. Exacerbating the problem, this is the age group with the highest reproductive capacity; therefore, losing young adults through emigration doubles the impact on population ageing because they take their children and future reproductive potential with them.

As stated above, ageing in Europe is considered a major challenge, which has energized many scholars and policymakers to address its issues and potential solutions. In a recent report, the European Commission took a broad and standard approach to pensions, the labour market, and the human capital implications of population ageing (EC 2014). Interestingly, the challenges to rural areas were not among the identified problems, although copious research has identified rural ageing as a particular challenge (see the special issue of *Journal of Rural Studies* focusing on rural ageing, (i.e., Milbourne 2012). In fact, the word "rural" is not even mentioned in the 76-page report.

Population ageing in Eastern Europe also has been a focus of academic discourse for some time. The aptly named World Bank report 'From Red to Grey' argued a decade ago that the age transition in the post-socialist countries will be faster and exert a stronger impact than in Western Europe (World Bank 2007). The somewhat optimistic position of the report was that the effects of ageing could partially be offset by increasing the labour force participation rates of the existing workforce, which works if that potential is not eroded by large-scale outmigration.

Outmigration, already a serious problem for several post-socialist countries, contributes to overall population decline as well as population ageing. Of the 27 countries in the afore-mentioned World Bank report, 20 were projected to lose population in the near future. In the geographic periphery of Europe, only Albania and Macedonia are expected to grow; the other former socialist countries with projected population increases are in Central Asia. For several countries, such as Hungary, Bulgaria, and Romania, combined ageing and population loss has been a familiar trend since the 1980s. For example, in Bulgaria, 30 years of population growth was lost in just the first ten years after its political transition, and some observers have characterized the country's current demographic trend as a 'national catastrophe' (Vassilev 2005). Thus, in contrast to countries in the global north, post-socialist nations are not only becoming older; the trend is occurring simultaneously with a dramatically shrinking population base. Smaller sizes and older populations are framed as a 'social problem' associated with insufficient labour to maintain economic growth and with rising age dependency and its associated increases in social welfare.

As shown in Table 1, Europe's median age increased from 28.9 to 41.7 between 1950 and 2015 (UN 2015). The corresponding change in Eastern Europe was from 25.9 to 39.6. Eastern Europe is slightly younger, but the gap between it and the continental average has shrunk from three to two years, indicating that the post-socialist periphery is *ageing faster* than its Western counterpart. It is projected that the difference by 2040 will be just one year.

Table 1

Aging in Eastern Europe in the European context[1]

	Median age		Percent 65+	
	Europe	Eastern Europe	Europe	Eastern Europe
1950	28.9	25.9	8.0	5.9
1960	30.3	28.0	8.8	6.6
1970	31.7	30.9	10.5	8.5
1980	32.6	31.5	12.4	10.8
1990	34.7	33.6	12.7	10.8
2000	37.7	36.6	14.7	12.9
2010	40.4	38.6	16.4	14.1
2015	**41.7**	**39.6**	**17.6**	**14.7**
2020	42.7	40.8	19.3	16.7
2030	45.1	43.8	23.1	20.1
2040	46.7	45.8	25.7	21.4

Source: UN: World Population Prospects: The 2015 Revision.

However, the proportions of the 65 or older (65+) segments present the opposite trend. In 1950, the difference was about 2% in favour of Eastern Europe. By 2015, the difference had grown to 3%. In other words, whereas the change in median age means that Eastern Europe is catching up to the continental average, in terms of the growth of the 65+ segment of the population, a convergence has not materialized. One reason for this seeming inconsistency is that, although the shape of the population pyramid (age structure) is becoming 'rectangular' in Western and Eastern Europe, life expectancy in Eastern Europe lags behind the European average, meaning that many people do not live long enough to enter the 65+ age group. On average, European men and women currently live to 73 and 81 years, respectively (UN 2015). The corresponding life expectancies of Eastern European men and women are 67 and 77 years, respectively. The gap between the two geographic regions is larger regarding life expectancy at age 65. In contrast, the convergence in median age is caused by a declining youth and young adult share of the population because of chronically low fertility across Europe and the net outmigration of workers in Eastern Europe.

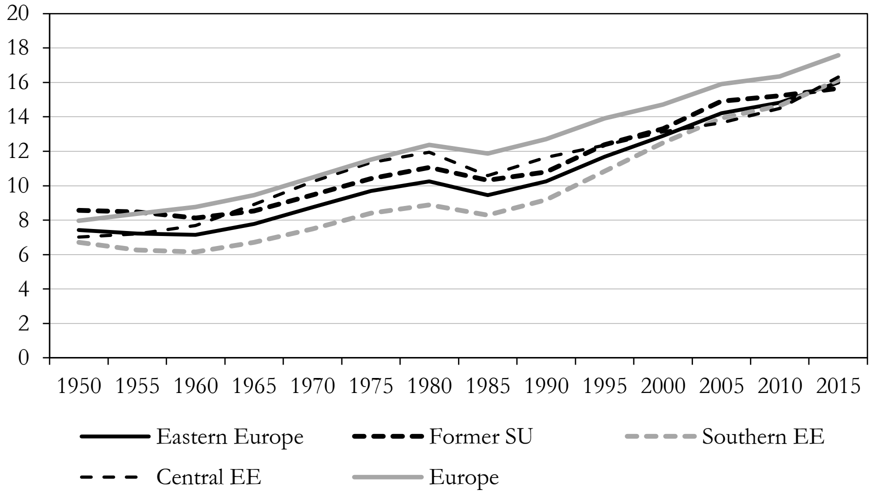
These changes mean that single indicators might not provide accurate assessments of population ageing for the region. The interaction of various demographic trends is the force that produces the outcomes and challenges, and, in Eastern Europe's case, ageing has been influenced by morbidity and mortality more than antic-

[1] This designation of Eastern Europe follows the United Nations classification, and includes the following countries: Belarus, Bulgaria, Czech Republic, Hungary, Poland, Republic of Moldova, Romania, Russia, Slovakia, and Ukraine.

ipated. The Eastern European mortality crisis, which is inadvertently maintaining a younger population, has been well documented (Compton 1985, Meslé 2004, Cunningham 2009). It stems from the failure of healthcare systems to provide the institutional capacity necessary to treat chronic diseases following the epidemiological transition. This failure is coupled with culturally specific public health behaviours, such as a high prevalence of smoking, excessive alcohol consumption, and low levels of physical exercise, particularly among males. It has been pointed out that the mortality pattern creates difficulties for projecting the sizes and compositions of these countries' 65+ populations (Gavrilova–Gavrilov 2009).

Figure 1

Percent 65+ in Eastern Europe and its subregions



Source: UN: World Population Prospects: The 2015 Revision.

Figure 1 shows the per cent of the 65+ populations of Europe, Eastern Europe as a region (20 countries), and three unique sub-regions.[2] Ageing increased until the mid-1970s, when the echo of the post-war baby boom temporarily changed the age composition. However, this change was temporary, and, by the 1990s, the shares of the 65+ segments were rapidly increasing again. This happened because of declining fertility caused by the uncertainty of the post-communist political and economic changes that were hitting the region at an unfortunately crucial time due to cohort dynamics. The echo boomers, born in the 1970s, faced adverse economic conditions during their traditional years of family formation, which lowered their completed fertility below the expected rate. Furthermore, they were disproportionately among

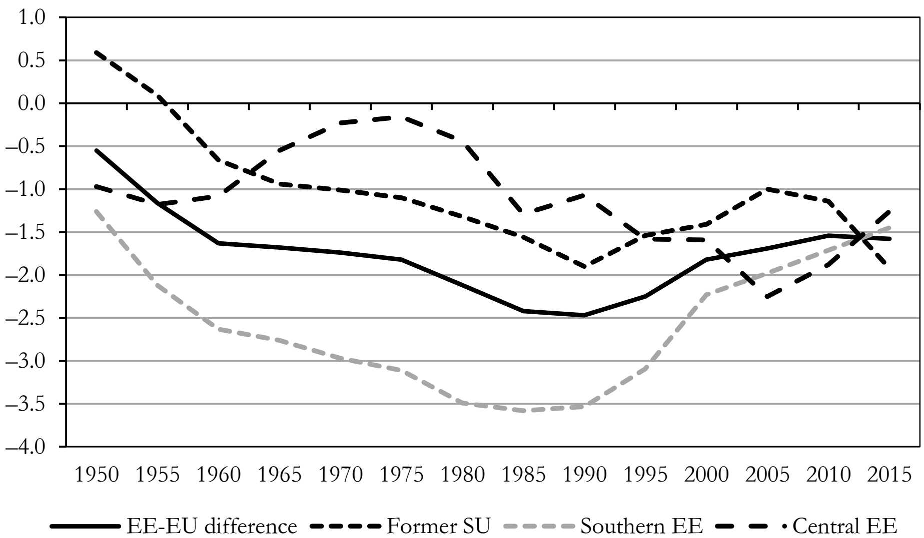
[2] The three sub-regions are the former Soviet Union (Belarus, Estonia, Lithuania, Latvia, Moldova, Russia, and Ukraine), the southern countries (Romania, Bulgaria, Serbia, Croatia, Slovenia, Bosnia-Herzegovina, Macedonia, Montenegro, and Albania), and Central Europe (Poland, Czech Republic, Hungary, and Slovakia).

those who emigrated. Therefore, by 2015, the shares of the 65+ segments of the populations of most of those countries had reached about 16%. Figure 1 also shows a conversion effect, which indicates that the historical differences among the former socialist countries have slowly been disappearing. However, in every year, the three Eastern European sub-regions had lower 65+ proportions than the continental average. Hence, although Eastern Europe has aged with the rest of the global North, it still lags behind the rest of Europe, at least with respect to conventional measures, such as median age and the proportional share of the 65+ segment of the population.

The data in Figure 2 show the differences in the proportions of the 65+ segments of the populations among the EU and Eastern Europe's three distinct sub-regions. The average of the 20 countries (labelled 'EE–EU difference') indicates that ageing in Eastern Europe was slower than the continental average until about 1990, when the gap began to close, and this convergence is observed throughout the post-1990 period. However, the reason for this convergence differed across Eastern Europe. High fertility and lower life expectancy kept the former Soviet Union and the Southern European countries younger relative to the age progression in the EU. In Central Europe, rapidly declining fertility (partly due to easily available induced abortions) kept the proportions of the 65+ segments closer to the continental average until the 1970s, when the echo of the baby boom caused the age composition to be younger. By 2015, the sub-regional differences in Eastern Europe had disappeared; however, previous inter-regional differences will influence these populations into the future.

Figure 2

Difference in the percent 65+ population between Europe and Eastern Europe



Source: UN: World Population Prospects: The 2015 Revision.

A relatively young population is not necessarily indicative of fewer population-related challenges at the local level. Because the Eastern European mortality patterns stem from detrimental lifestyle-related health behaviours, the quality of life after retirement must also be considered. It is obvious that older adults in the region typically have relatively more difficulties, which is a problem for public policy to address. However, aggregating individual experiences at the community level also means that places with higher than average proportions of older adults must provide more extensive healthcare and social services to their less healthy populations at the same time when their workforce is shrinking. Rural communities in Eastern Europe are prime examples of the problem of increasing dependency.

Ageing in rural areas

It is well established that the proportional increase of older adults in a population creates a labour shortage when other demographic and economic conditions, such as migration, labour force participation, and enhanced labour productivity, are unchanged. In the absence of specific policies, such as large-scale immigration or guest worker programs and initiatives to either intensify production with technological advancements or to keep older adults in the workforce, economic production at the national level is jeopardized.

This challenge is exacerbated at small geographical scales, particularly in rural areas. In most cases, the issue is triggered before the age transition is apparent at the national level. This process is remarkably similar between rural areas in Western and ex-socialist countries. The development of urban industries and amenities has had the same impact on rural areas on both sides of the Iron Curtain. Population displacement, whether through the mechanization or the collectivization of agriculture, has created a large-scale rural to urban migration flow. Once traditionally high rural birth rates have declined, these areas no longer can counterbalance migration loss, and rural communities start to experience population decline and ageing in place. This typically occurred in the 1970s, although the fertility echo of the post-war baby boom kept it hidden for some time. In addition, governments and international organizations were focusing on the problems of rapid urbanization and the services and housing deficiencies of cities (Timberlake–Kentor 1983), hardly considering rural areas more than as labour reserve pools. However, by the 1980s, rural depopulation and ageing were occurring around the globe.

The 2015 EU Demographic Report indicated that, between 2004 and 2014, the proportion of the 65+ segments increased by 4% in the European Union, reaching 18.5% (European Union 2015). A cursory look at the report confirms our argument of the previous section that Eastern Europe is still slightly younger than the EU average. However, reliable data for vertical (urban-rural) and horizontal (across regions/countries) classifications are difficult to obtain, making detailed comparisons impossible for most European countries. Most EU reporting uses the NUTS-3 level to aggregate population dynamics below the national level. However, this level is largely useless for urban-rural comparisons. In addition, rurality is based on the OECD typology of predominantly rural, intermediate, and predominantly urban categories. This typology is based on the percentage of the population living in rural communities, except when an area includes an urban core of a certain size, which automatically categorizes the *entire region* as non-rural.

The latest available report using this general typology across the member states was published in 2010 (Goll 2010). It used change in population composition, including the 65+ segment of the population, by country and employed the tripartite rural typology. Although based on data reported at the NUTS-3 level, it allowed for some general observations about rural-urban population dynamics. In the EU-27, growth of the 65+ segment of the population between 2001 and 2006 was exactly 1%. This rate was the same in the predominantly urban and the predominantly rural regions, although rural regions had a slightly (0.3%) higher proportion of older adults in 2001. Focusing on the former socialist countries, it is clear that these countries cannot be treated as an undifferentiated demographic region and generalized (Table 2).

Table 2

Percent of 65+ population in predominantly rural and urban regions in selected Eastern European countries

Country	NUTS-3 region	2001	2006	Change
EU-27	Predominantly rural	16.2	17.2	1.0
	Predominantly urban	15.8	16.9	1.1
Bulgaria	Predominantly rural	17.9	19.1	1.2
	Predominantly urban	14.6	14.8	0.2
Czech Republic	Predominantly rural	13.8	14.4	0.6
	Predominantly urban	16.3	15.6	–0.7
Estonia	Predominantly rural	15.5	16.4	0.9
	Predominantly urban	16.0	18.2	2.2
Latvia	Predominantly rural	16.0	16.9	0.9
	Predominantly urban	12.9	14.2	1.3
Hungary	Predominantly rural	15.1	15.9	0.8
	Predominantly urban	17.8	18.1	0.3
Poland	Predominantly rural	11.8	12.5	0.7
	Predominantly urban	13.4	14.9	1.5
Romania	Predominantly rural	14.2	15.5	1.3
	Predominantly urban	13.8	14.5	0.7
Slovakia	Predominantly rural	12.3	12.7	0.4
	Predominantly urban	12.0	12.2	0.2

Source: Goll 2010.

In the Czech Republic, Estonia, Hungary, Poland, and Estonia, the proportion of the 65+ segment of the population was larger in urban than in rural regions in 2001 and in 2006. On the other hand, Bulgaria, Romania, Latvia, and Slovakia had proportionally larger elderly populations in rural areas. This heterogeneity suggests that some national and sub-national trends have significant roles along the urban-rural continuum for causing age composition outcomes.

To explore these differences more deeply, we selected two countries, Lithuania and Bulgaria, for further analysis. We aimed to compare countries that are culturally and historically different and located in different sub-regions of Eastern Europe. Another consideration was that both countries experienced significant population loss during the study period that exacerbated the age transition at the national levels, thus making rural-urban differences more obvious. Data were obtained from the Official Statistics Portal of Lithuania (http://osp.stat.gov.lt/en/home) and the National Statistical Institute's website in Bulgaria (http://www.nsi.bg/en).

We selected two data points, 2002 and 2015, for the analysis. Five-year age groups were created for both years, separately for urban and rural areas. The urban and rural designations followed the official statistical typologies of the respective countries. No attempt was made to harmonize those designations with each other or with a typology developed by the OECD or the EU. We considered 'rural' a socially constructed category, and we took the position that each country has a unique understanding and designation of 'rural' and that their designations are more valid than an administratively generated unified typology.

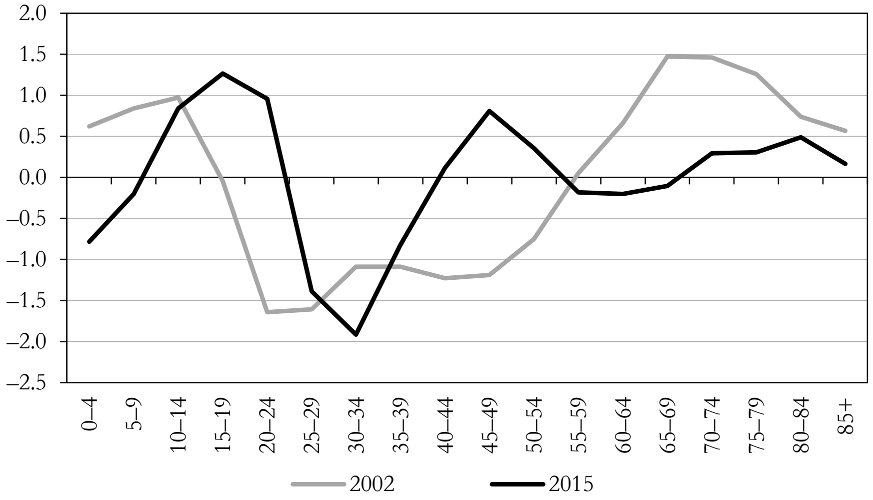
To compare change between the two points in the two countries, we standardized the age composition in four analytical categories in 2002 and 2015 (Lithuanian rural, Lithuanian urban, Bulgarian rural, Bulgarian urban), creating eight analytical categories. In other words, age distribution in rural Bulgaria in 2002 used the base of all rural Bulgarian residents in 2002, and so on.

The data in Figure 3 show the standardized age composition differences between the urban and rural areas of Lithuania for 2002 and 2015. Where the line is above zero, there is a higher proportion of rural population in the given age category, and, where the line is below zero, there is a higher proportion of urbanites. Again, these figures are relative to the total rural and urban populations. For example, because most of Lithuania's population is urban, unstandardized numbers would have yielded significant urban excess in every age category. One way to think about this is as the deviation of the urban and rural age structures from the combined age structure of the entire country.

In 2002, there was a positive urban deviation in Lithuania by the traditional working ages (20–59) and a negative deviation by children and older adults. This age distribution is typical of cities where fertility is relatively low and ageing in place is less prevalent. By 2015, however, this structure had changed. Negative numbers in the two youngest age categories indicate an increase in young urban children. Then, until the mid-20s, there is a positive rural deviation, showing that those who were young children in 2002 did not necessarily immigrate to cities upon reaching young adulthood, at least not immediately after secondary school. There is a small rural peak in the 40- to 50-year-old age group, which had not previously existed, but was large enough to mitigate the positive deviation of rural old people, which became less pronounced.

Figure 3

Standardized differences in age composition between urban and rural areas in Lithuania (%)



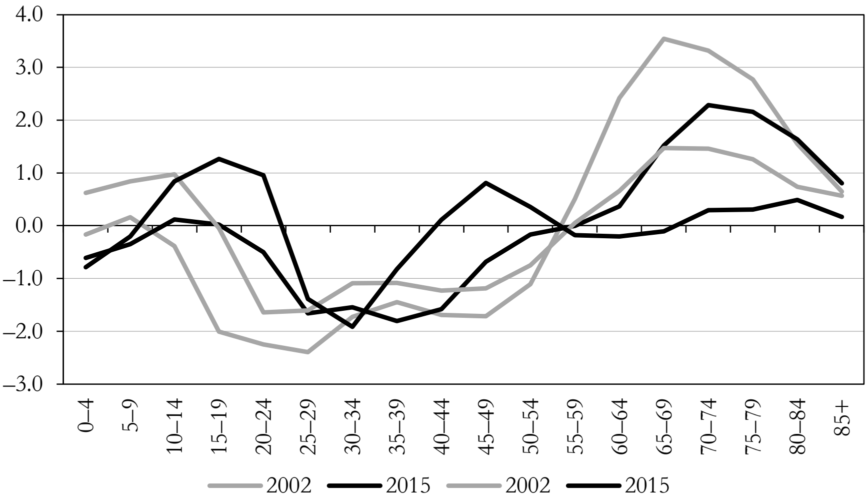
Source: Authors' computations based on OSP and NSI data, respectively.

Numerically, about 20,000 fewer older adults lived in rural Lithuania in 2015 than in 2002. This is a 10% decline, which is less than the 15% overall population decline of the country and less than the 17% decline of the rural areas between 2002 and 2015. Thus, proportionately, because the rural elderly population declined less rapidly than its urban counterpart, the Lithuanian countryside was still ageing, despite the fact that fewer people, including older adults were living there than had been a decade ago.

In Figure 4, the same indicators are shown for Bulgaria. In 2002, Bulgaria already had a distorted age structure, in which urban areas had positive deviations for ages 10 through 55, whereas rural areas had positive deviations for older adults. There was virtually no difference in the younger adult age groups, but a significant rural surplus in the 60+ segment of the population is observable. This pattern changed little between 2002 and 2015. The notable fact regarding change in this case is the significant, albeit less pronounced, rural positive deviation of older adults. However, we must remember that these differences are compared to changes of the country's overall age composition. Thus, an overall ageing trend coupled with the emigration of young adults (and their families), dynamics that Bulgaria definitely experiences, might generally suppress urban-rural differences in particular age groups.

Figure 4

Standardized differences in age composition between urban and rural areas in Bulgaria (%)



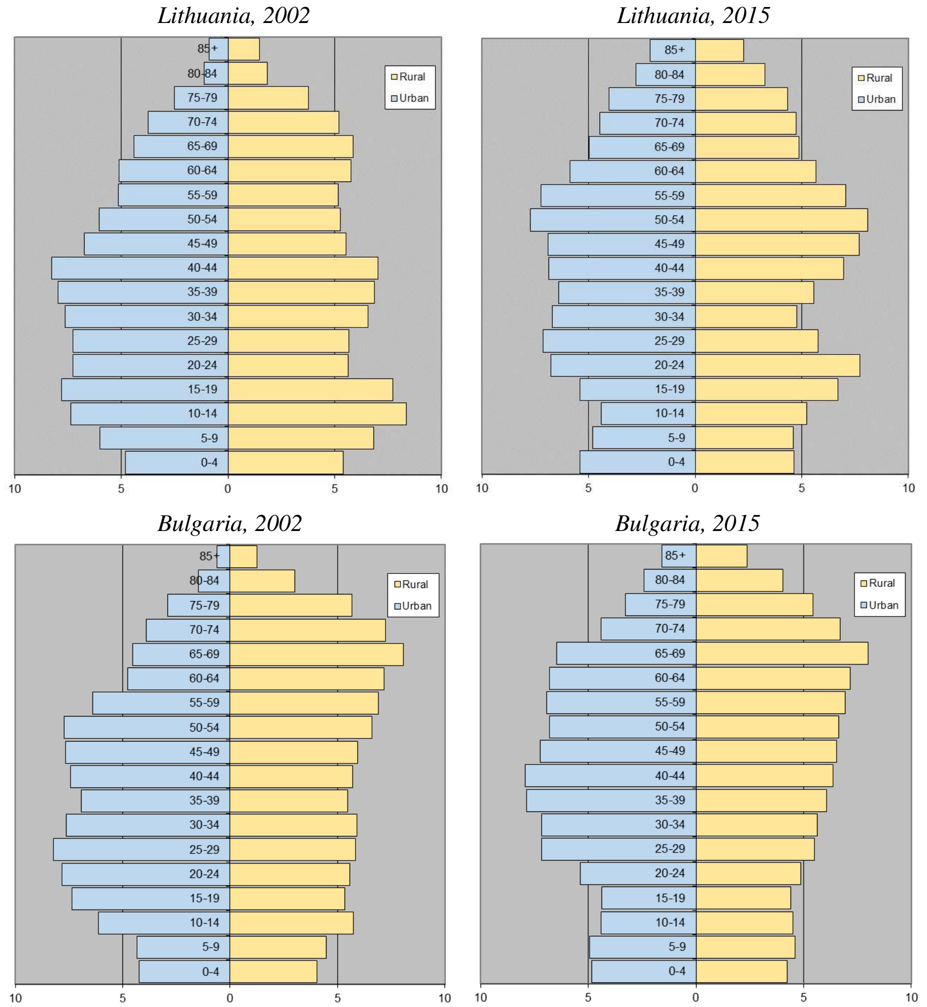
Source: Authors' computations based on OSP and NSI data, respectively.

Bulgaria's overall population decline was 9% between 2002 and 2015, but its rural area lost 19% of its population. Similar to Lithuania, the per cent decline in the rural elderly population was smaller, at 15%; thus, the same ageing in place can be observed in Bulgaria as was found for Lithuania. During the same period, Bulgaria lost 90,000 older adults in rural areas, which is another reason for the smaller age-specific bulge in 2015.

Differences between Lithuania and Bulgaria are more evident when the shapes of their population pyramids are compared (Figure 5). For Lithuania, the wider bars of the upper age categories (rural as well as urban) in 2015 indicate overall population ageing. The relatively large 10–19-year-old age cohort in 2002 had entered its childbearing years by 2015, which is observable in the widening lower bars of the pyramid. Although that is a straightforward cohort effect and not a fundamental change in ageing trends, it gave a long-needed boost to fertility. The most important comparison between Lithuania's urban and rural areas is that this fertility effect also is observed on the rural side of the pyramid, at least for those in their early 20s. The typical young adult rural dent in the pyramid is not observed until the 25–29 age group.

Figure 5

Standardized urban/rural population pyramids for Lithuania and Bulgaria



Source: Authors' computations based on OSP and NSI data, respectively.

The Bulgarian story is somewhat different. Rural Bulgaria already had a top-heavy age pyramid in 2002 with a deficit in the numbers of people in the working-age cohorts. This was even more pronounced by 2015. Bulgaria also evidenced a cohort effect of young adults entering their childbearing years, but that only occurred in urban places, and, even there, it provided only mild relief. On the other hand, instead of the rural young adult dent, we observe a continuous lengthening of the age bars starting at ages 15–19, which shows the progressive ageing in the countryside.

Ageing in Bulgaria's rural areas offers implications somewhat different from its urban ageing for two reasons. First, rural areas have smaller population sizes and lower population densities. Second, and closely related to population size and density, the institutional capacities of most rural places are far more limited in the provision of necessary services for the elderly. In other words, rural areas often have small and shrinking economic bases and revenue streams, limited local revenue, and under-resourced governments and related institutions. This limited capacity in human, organizational, and financial resources is coupled with greater challenges to the availability of affordable services because of low population density, sparse populations, and the resulting low economies of scale and higher per unit costs of services. Geographically small and remote areas typically cannot benefit from economies of scale, even when there is concentration of the target population, which, in our case, are older adults, creating a demand for the services. The rural challenges identified by Glasgow and Berry (2013) of geographic isolation, small populations, relatively few businesses and services, and relatively low financial capacity definitely apply to the rural areas of Eastern Europe. Furthermore, using the example of Hungary, Szilágyi and Gerse (2015) demonstrated the differences in some socioeconomic conditions and demographic trends based on a community's position in the central place hierarchy.

Further integrating the micro-level and macro-level perspectives

Studies on ageing from a micro-level perspective typically examine individual experiences with a focus on the biological aspects of change. However, it is important to acknowledge that such change always occurs in a community context, and individual experiences are strongly influenced by the characteristics of the places where people live. Rural places are good examples of this interrelationship, and, as pointed out in the previous section, rural areas' unique challenges make a good case for both scholarly inquiry and policy intervention.

It is generally accepted that rural communities have vulnerabilities specific to their unique demographic trends and interrelated development pathways. For example, in the cases of Canada and New Zealand, Joseph and Cloutier-Fisher (2005) used the term 'double jeopardy', arguing that a community is more than the aggregate of its citizens because it has particular conditions that may exacerbate disadvantages. They stated that ageing is a 'situated experience' (Joseph–Cloutier-Fisher 2005:146), particularly for those older adults who are less healthy and mobile over time. For those elders, their 'place', which is their community, neighbourhood, and, perhaps, eventually their homes, becomes an increasingly large part of their experience as they age in place. From an individual perspective, the shrinking geographic horizon of service availability carries with it far greater challenges to service provision for rural communities than for cities. In cities, the lower proportion of elders does not mean numerically fewer of them than in rural areas, which allows economies of scale to emerge on a relatively strong revenue basis. Moreover, urban elders generally have relatively better access to a variety of transportation modes, which potentially alleviates possible social isolation and alienation from services.

Joseph and Cloutier-Fisher (2005) further proposed that, to understand vulnerability (or, arguably, any particular condition), one must look at both the personal experience and the space or place where they occur. This perspective is a crucial component of our proposed framework, and it is consistent with environmental psychologists Lawton and Nahemow's (1973) 'person-environment fit'. A previous application of this perspective was a study on rural ageing in Romania and Bulgaria conducted by Kulcsár and Bradatan (2014). That study added a third layer to the investigation of rural ageing, namely, the overall context of the post-socialist transition, which situated the ageing experience at the community level in the specific context of the transforming Eastern European periphery. These case studies found that the market transition was just one component of the difficulties being faced by rural areas in Eastern Europe. Changing cultural norms about long-term care and family obligations played an equally important part in determining the quality of life of older residents and contributed to a radical change in rural life.

International scholarship provides examples that more positively frame ageing. Rural places with numerous amenities fare quite well, and they successfully transition from places of production to places of consumption (see, for example, Silva–Figueiredo, 2013). Many Eastern European rural areas have actively branded themselves as authentic rural experiences to compete for Western tourists (Hall 2004). Rural retirement migration, often based on rural areas' natural amenities, is a development strategy in the US, Spain, Italy, and other places in Europe. Research has found that older in-migration had strong positive multiplier effects that resounded throughout a community's economy (Stallman et al. 1999); while other studies have shown that destination communities place a high value on the abundant volunteer services provided by older in-migrants (Brown–Glasgow 2008). Of course, these studies assume that older in-migrants will eventually leave to live closer to their children when they experience declining health and/or other negative life course events in later old age (Litwak–Longino 1987). However, it is a risky bet because many in-migrants will age in place; then, their contributions to the community will fall below the costs of maintaining their quality of life and many of those costs will be shouldered by the locality. In addition, the presence of natural amenities is not necessarily sufficient for turning around rural affairs, and infrastructural development, which requires resources and investment before gains can be realized, is necessary to capitalize on those amenities (Brown et al. 2011).

The importance of population ageing at the local level for Eastern Europe can be examined through a coupled micro-macro framework. The micro level addresses existing and potential community capacities to provide a variety of services to older adults and to facilitate their continual social engagement. This situated approach is an enhanced perspective compared to the traditional understanding of micro-level approaches that focus solely on individuals or households. As we argued, an individual's experiences should be understood in the context of the opportunities and constraints of that individual's community. These opportunities and constraints constitute community capacity, which is influenced by the macro-level transitions occurring in Eastern Europe. The question to focus on concerns the type(s) of community forces that shape individual experiences of ageing.

Table 3

Framework for a coupled micro-macro approach

Themes at the micro level	Orienting items
Institutions and legacies	Organization of municipal government and institutions; history of municipal structures (pre- and post-transition); local governance; capacity for collaboration and/or grant writing.
Health care and long term care	Access to hospitals and specialty care; availability of nursing homes and long term care facilities; financing of health care and long term care; the most common unmet needs in these areas.
Transportation	Availability and affordability of public transportation (buses and trains); mapping the geographic distribution of important services and transportation linkages; driving as a potential substitute.
Businesses, services, and community assistance	Availability and affordability of services provided by both private business and local / mid-level government; non-profit community assistance; business transitions and consolidations, human resources.
Formal and informal social relations	Local cultural norms; reciprocal services, volunteerism; participation in local decision making; family transition; social isolation and exclusion; intergenerational relations.
Themes at the macro level	
Institutional structure and capacity	Political transformation; national institutional structure; social security and pension systems; demographic dynamics; public administration systems.
Economic environment and resources	Opportunities for businesses; subsidies and development options for service provision in remote / underserved areas; regional economic conditions (particularly since the post-socialist transition).
Social and community norms	Societal attitudes toward aging; meaning of retirement; the concept of successful aging in a post-socialist context; traditions of elder care (family vs. institutional).

From a broad list, we propose five micro-level community capacity themes: (1) institutions and legacies; (2) healthcare and long-term care; (3) transportation; (4) businesses, services, and community assistance; and (5) formal and informal social relations. These micro-level community capacity themes are embedded in a set of macro-level domains specific to Eastern Europe and its transition, with a particular focus on rural areas: (1) institutional structure and capacity, (2) economic environment and resources, and (3) social and community norms. Table 3 shows this framework with a few typical items on each topic.

The micro-level themes address community capacities as they pertain to the everyday lives of older adults as individuals and as community residents. The organization of institutions and services as well as the opportunities for businesses provide the general context in which the services for are planned and delivered. In our experience, two domains, healthcare and transportation, are particularly important to facilitate the well-being of rural older persons. Rural communities tend to struggle with those domains when municipalities have insufficient revenues and private businesses do not fulfil those needs because of limited returns on investment or insufficient subsidies from higher levels of government. These conditions are typical of Eastern European rural communities. On the other hand, formal and informal social relations have a much larger role in the region because of traditional norms and reciprocal relationships in villages (Brown–Kulcsar 2001). These micro-level forces are embedded in the broad context of Eastern European nations' movements on trajectories with respect to political institutions, economies, and social and cultural norms.

Conclusions

Rural populations in Europe are ageing. By the middle of this century, one-fourth or more of most of them will be 65 years of age or older. We found that Eastern Europe, although somewhat younger than Western Europe, is significantly ageing. In fact, the data we presented indicate that the *rate* of population ageing in rural Eastern Europe exceeds that of its Western European counterparts. Hence, the extent of population ageing is converging across the European continent. As other scholars have observed, ageing is particularly challenging to rural areas because of their small size, low density-dispersed populations, and relatively modest fiscal capacities (Glasgow–Berry 2013). How will rural communities respond to their older populations? Although continuing population ageing is quite certain for most rural areas, communities' responses to this fundamental demographic change is not easy to predict, and it will undoubtedly vary dramatically across communities, depending on their current resources, historical legacies, and institutional peculiarities.

Although demographic change, which, in this case, is population ageing, influences older adults' wellbeing and the well-being of their communities, demography is not destiny (Brown–Argent 2016). Rather, the impacts of population ageing on a community's organization are mediated by its social structure and institutions, which, in turn, are embedded in a national-level policy environment that constrains and/or facilitates the community's responses to its growing elderly population. Communities that experience relatively similar population changes, such as declining size and an increased share of older persons, could experience distinctly different outcomes, depending on their economic resources, the perceived salience of population-related problems (such as the cost of pensions), the need for elder care housing, and the extents of leaders' willingness to spend political capital on services for older populations. This is particularly important in regions, such as Eastern Europe, where there are distinct differences in resources among countries and between rural and urban areas (Brown et al. 2007).

As Phillipson and Scharf (2005) observed, it is important to examine the ways in which the lives of older people in rural areas are either advantaged or disadvantaged by prevailing socio-political and economic structures at the national and community levels. Some countries consider population ageing a 'social problem', but others are less negative. Ironically, defining ageing as a problem is more likely in countries with strong social welfare systems. In these cases, in which the social contract provides generous support for retirees, growing elderly populations tend to be perceived as a 'care and pensions issue' draining community resources. In contrast, some countries, particularly those that are similar to the US, with relatively weaker social welfare systems, less public responsibility for elder care and support, and strong market economies, do not necessarily consider an ageing population as a drain on the public purse because maintaining elders' standard of living is considered an individual (and/or family) responsibility.

Studies of ageing populations tend to take an exclusively macro-level or exclusively micro-level approach. These studies are important for investigating dynamics, but we suggest that there is an inherent value to examining ageing from a combined micro-macro perspective. Research in the US has found that the individual expectations and experiences of ageing services are strongly influenced by community capacity and social norms that are functions of social organization and governance structures. The study of individual experiences should, if possible, include community and national factors, and research on macro-level indicators of ageing could be more valuable if the residents' actual experiences were included. That approach would comprise individuals' personal experiences, their communities' characteristics, and the national policies and economic frameworks in which ageing occurs.

Finally, it is important to note that the relationship between ageing experiences at the micro level and the constraints and opportunities present at the macro level is not a unidirectional relationship. Demographic processes occur in contexts of structural changes with strong influences on population dynamics that, in turn, create changing demographics (in our case, the age structure) that continuously influence community capacity as well as individual experience. In other words, this causal interrelationship always presents the possibility of downward or upward cycles of socioeconomic change at the local level. Unfortunately, rural communities experience downward cycles much more often than upward ones and can enter a self-reinforcing underdevelopment trajectory relatively easily. This is not a new phenomenon to those who follow the discourse on rural development in the studied region, but rural ageing strains community development long before its effects are evident in urban areas or at the national level. Thus, it is important to investigate the interrelationships between micro-level and macro-level factors with respect to ageing communities to proactively address ageing-related challenges wherever and whenever they appear.

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A socio-economic analysis of Airbnb in New York City

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In recent years, the so-called sharing economy has spread all over the world and, through the proliferation of online peer-to-peer platforms, provides a marketplace that matches sellers who want to sell/share their underutilised assets with buyers who need them. One of the well-known and heavily debated manifestations of the sharing economy is an accommodation provider platform called Airbnb. Airbnb is experiencing astonishing growth provoking several intense debates, regulatory challenges, and political battles due to its wide-spread effects on rental and real-estate markets. Thus, it is important to analyse the uneven spatial effects of the phenomenon. This paper aims to map Airbnb's presence in New York City but, going beyond visual inspection, it analyses the socio-economic factors influencing the spatiality of Airbnb in the American metropolis. After collecting data from various data sources, we performed a statistical analysis (correlation, regression analysis) to determine the socio-economic conditions of areas and revealed those factors that may affect the spatial distribution of Airbnb listings in the city. Results highlight that (1) Airbnb supply concentrates in those parts of New York City with a young population, (2) there is a significant number of housing units, and (3) the number of points of interest is high.

Introduction

In recent years, the development and diffusion of ICT worldwide alongside the growth of Web 2.0 have facilitated the proliferation of online peer-to-peer (P2P) marketplaces (Einav et al. 2016, Hamari et al. 2016, Ke 2017, Meleo et al. 2016). These platforms are by-products of a larger economic-technological phenomenon called the sharing economy (Hamari et al. 2016, Malhotra–Alstyne 2014, Pizam 2014) also known as collaborative consumption (Botsman–Rogers 2010, Gutiérrez et al. 2016). The phenomenon itself is not new, but the Internet is accelerating its implementation into everyday life as it empowers users to share and make use of underutilised assets and services (Quattrone et al. 2016, Sundararajan 2016) by enabling a match between sellers, who are willing to share their idle capacities and services, and buyers who need them (Azevedo–Weyl 2016, Ke 2017). Services covered by the sharing economy range from transportation (Uber, Lyft, BlaBlaCar) to finance (Kickstarter, Prosper) to accommodation (Airbnb, Couchsurfing, HomeAway); however, P2P marketplaces associated with the sharing economy operate particularly within the field of travel and tourism (Ert et al. 2016). The primary example of this type of marketplace is Airbnb, the best-documented case in P2P accommodation (Oskam–Boswijk 2016). Airbnb describes itself as a 'trusted community marketplace for people to list, discover, and book unique accommodations around the world – online or from a mobile phone or tablet' (Airbnb 2017). In other words, it connects people who have a spare room to rent with guests who need a place to stay (Ke 2017, Quattrone et al. 2016). The company was founded in 2008; since then it has grown exponentially, and now is present in more than 34,000 cities and 191 countries, has more than two million global listings (Airbnb 2017), and surpasses the major hotel chains in accommodation offered and market valuation (Guttentag 2015, Oskam 2016, Oskam–Boswijk 2016, Samaan 2015, Slee 2016). However, the explosive growth of Airbnb has encountered several intense debates, regulatory challenges, and political battles around the world. Advocates of Airbnb argue that it brings many benefits for its users, including extra income, and better resource allocation and utilisation as it enables hosts to become small business owners and reduce their rental burden. Moreover, it also provides new economic activities for cities and municipalities as it fosters tourism because it involves new areas in tourism and deconcentrates the accommodation supply within the city. On the other hand, opponents argue that its negative impacts on cities and residents far outpace its benefits. Detractors state that Airbnb has lost its original objective to be a spare-room sharing platform and highlight the belief that economic self-interest became the main motive rather than sharing (Ke 2017, Quattrone et al. 2016). The critics also argue that these short-term rentals operate mostly in illegal ways in many cities (Guttentag 2015, Schneiderman 2014, Streitfeld 2014), as hosts may fail to fulfil their tax obligations.

Despite the heavy debates around the sharing economy and Airbnb, the phenomenon itself is still too recent for academic literature to have analysed it thoroughly. Papers studying Airbnb and its impacts focus on some key issues such as trust or the reliability of online reviews (Ert et al. 2016, Ikkala–Lampinen 2014, Guttentag 2015, Zervas et al. 2015), quantify the impact of Airbnb on the hotel industry and the local accommodation sector (Choi et al. 2015, Schneiderman 2014, Zervas et al. 2016), or address legal issues surrounding Airbnb (Guttentag 2015, Kaplan–Nadler 2015, McNamara 2015). Moreover, there is a rising interest in the spatial distribution of Airbnb listings in major cities (Dudás et al. 2017, Gutiérrez et al. 2016, Quattrone et al. 2016, Schneiderman 2014) and the socio-economic factors influencing it (Quattrone et al. 2016) to locate those parts of the city that have seen the greatest pressure from Airbnb.

In recent days, Airbnb listings have become globally distributed and reach a fairly heterogeneous coverage; however, focusing on the country level, the main markets are in the US, France, Italy, Spain, and the United Kingdom (Ke 2017). Overall, the US has the most listings and the cities located in the country are considered the main revenue-generating cities of Airbnb with New York City being the most important city of all (Inside Airbnb 2017b).

However, the rapid rise of P2P accommodation rental platforms like Airbnb have profoundly expanded the use of traditional apartments as temporary hotel rooms all over the world, generating public debate about disruptive technologies and their real-world consequences (Schneiderman 2014). The site has run into problem with legislators in several markets, including Amsterdam, Barcelona, Berlin, Los Angeles, etc., although the most important battle that received considerable media attention was in New York between the Attorney General of New York and Airbnb (Slee 2016). As the number of short-term rentals is growing at a staggering pace in New York City, this expansion creates many challenges for communities and legislators throughout the city facing three important issues: violation of New York City and state laws, significant commercial use, and impact of Airbnb on housing supply and rental prices (Delgado-Medrano–Lyon 2016) as entire homes listed on Airbnb may disappear from the local housing market and drive the rents up (Ke 2017). Several studies were conducted to address these issues and similar ones (Cox–Slee 2016; Delgado-Medrano–Lyon 2016, Samaan 2015, Schneiderman 2014, Waters–Bach 2016) by highlighting the impact of Airbnb on the short-term rental market of New York City. The most frequent question asked by travellers, legislators, and municipalities is where the Airbnb listings are located. Therefore, legislators, planners, and researchers want to reveal the spatial pattern of Airbnb listings and understand the underlying processes affecting the spatial spread of Airbnb more deeply. Thus, the aim of our study is to map Airbnb presence in New York City because there are an abundant number of Airbnb listings in the city, the phenomenon is receiving considerable media attention, and it is in a crossfire of sharing economy criticisms. However, we want to go beyond visual inspection and seek to determine the socio-economic factors influencing the spatiality of Airbnb in the American metropolis. Furthermore, we want to reveal what the main socio-economic characteristics of areas with Airbnb listings are and where Airbnb customers go.

First, we developed a database that included a large number of Airbnb listings and socio-economic indicators characterising the Neighbourhood Tabulation Areas (NTAs) of New York City, and presented the applied statistical methods. In the second half of the study, the collected data are analysed using correlation matrix and regression analysis, and finally, the key findings are summarised.

Data and methodology

In order to answer the research question proposed in the previous sections and to conduct a statistical analysis, we needed to collect data from various data sources. On the one hand, we needed detailed data on Airbnb properties, while on the other hand, socio-economic data about the neighbourhoods of New York City.

Airbnb data

Based on previous studies (Gutiérrez et al. 2016, Inside Airbnb 2017b) we collected a comprehensive set of geolocated Airbnb data from the Inside Airbnb website: http://insideairbnb.com/. Inside Airbnb is an independent initiative and offers Airbnb data for more than 30 major cities around the world. The data represented on the website are publicly available, however, Inside Airbnb states that 'the site is not associated or endorsed by Airbnb or any of Airbnb's competitors' (Inside Airbnb 2017a). The dataset contains information not only about the location (latitude and longitude coordinate) of all Airbnb listings in New York City but also data about the host name and ID, room type, price, minimum nights, number of reviews, listings per host, and availability. The data utilised in this study refer to December 3, 2016, and our dataset contains detailed information about 33,533 distinct hosts and 40,156 listings (Table 1).

Table 1

Descriptive statistics on listings offered by Airbnb in New York City

		Price	Availability	Listings per host	Number of reviews	Minimum nights
Entire home/apt (*19906*)	Mean	207.95	143.33	1.36	15.66	4.26
	SD	234.075	145.048	1.615	26.594	16.367
	Min.	10	0	1	0	1
	Max.	9,999	365	28	321	1,250

(Table continues on the next page.)

(Continued.)

		Price	Availability	Listings per host	Number of reviews	Minimum nights
Private room (*18876*)	Mean	89.14	164.57	2.13	15.08	3.20
	SD	151.616	151.132	1.890	29.062	7.045
	Min.	10	0	1	0	1
	Max.	9,999	365	33	380	500
Shared room (*1374*)	Mean	74.33	209.14	4.33	12.13	2.85
	SD	280.587	149.445	5.171	22.366	7.646
	Min.	17	0	1	0	1
	Max.	9,900	365	20	284	150
Total listings (*40156*)	Mean	147.53	155.57	1.71	15.27	3.71
	SD	210.364	148.794	2.157	27.661	12.586
	Min.	10	0	1	0	1
	Max.	9,999	365	33	380	1,250

Source: edited by the authors.

Socio-economic data

To collect the necessary data for the statistical analysis we utilised multiple data sources. Previous studies stated that participation in the sharing economy highly depends on the age of the participants (Eurobarometer 2016, Smith 2016), their ethnic background (Edelman et al. 2016, Schor et al. 2016), level of education (ING 2015, Smith 2016), social status (employment, income) (Schor 2017), and urbanity (Eurobarometer 2016, Smith 2016). Therefore, we took these factors into consideration and our collected data included calculations of demographic information about population density, the number of young and educated people, the percentage of black and non US-born populations, as well as the score for ethnic diversity. The data source was provided by the American Community Survey (ACS) and contained detailed information about the demographic, social, economic, and housing characteristics of New York City (ACS 2017). The ACS is a five-year estimate (2010–2014) aggregated at three geographical levels: boroughs (5), community districts (59), and NTA (195). From this dataset, we queried the necessary data at the NTA level, however, we also collected housing and economic indicators, including indicators of median household income, employment, median gross rent, total housing units, the number of owner-occupied housing units, and housing units with a mortgage. We also gathered points of interest (POI) data to determine the attractiveness of the places. Under this indicator, we can understand hundreds of POI of a varying nature from hospitals to restaurants and hotels. From this database, we selected the relevant categories that may attract the people who use the services offered by Airbnb; thus, we considered POI that fall under one of the following categories: 'eating and drinking', 'attractions', 'retail', and 'sports and entertainment'. The data source for this indicator was the website www.geofabrik.de from which OpenStreetMap data was collected, including 12,999 POI in New York City. Table 2 lists all the indicators utilised in the statistical analysis.

Table 2

Description of variables applied in statistical analysis

Variables	Description	Source
abnb_listing	Number of Airbnb listings per km^2	Inside Airbnb
abnb_price	Average price of Airbnb listings	Inside Airbnb
abnb_rev	Number of Airbnb reviews per km^2	Inside Airbnb
young_p	Number of people aged between 20-34 years per km^2	American Community Survey
pop_density	Population density of an NTA	American Community Survey
ethnic_d	Score for ethnical diversity	American Community Survey
black_p	Percentage of black population	American Community Survey
nonUS	Percentage of non-US born residents	American Community Survey
education	Percentage of bachelor's degree or higher	American Community Survey
employee	Ratio of the number of employees over the area's population	American Community Survey
income	Median household income	American Community Survey
housing	Total housing units per km2	American Community Survey
house_own	Percentage of owner-occupied housing units	American Community Survey
house_mortg	Percentage of housing units with a mortgage (owner-occupied)	American Community Survey
rent	Median gross rent (occupied units paying rent)	American Community Survey
POI	Number of attractions and entertainment places	OpenStreetMap

Source: edited by the authors.

Statistical analysis

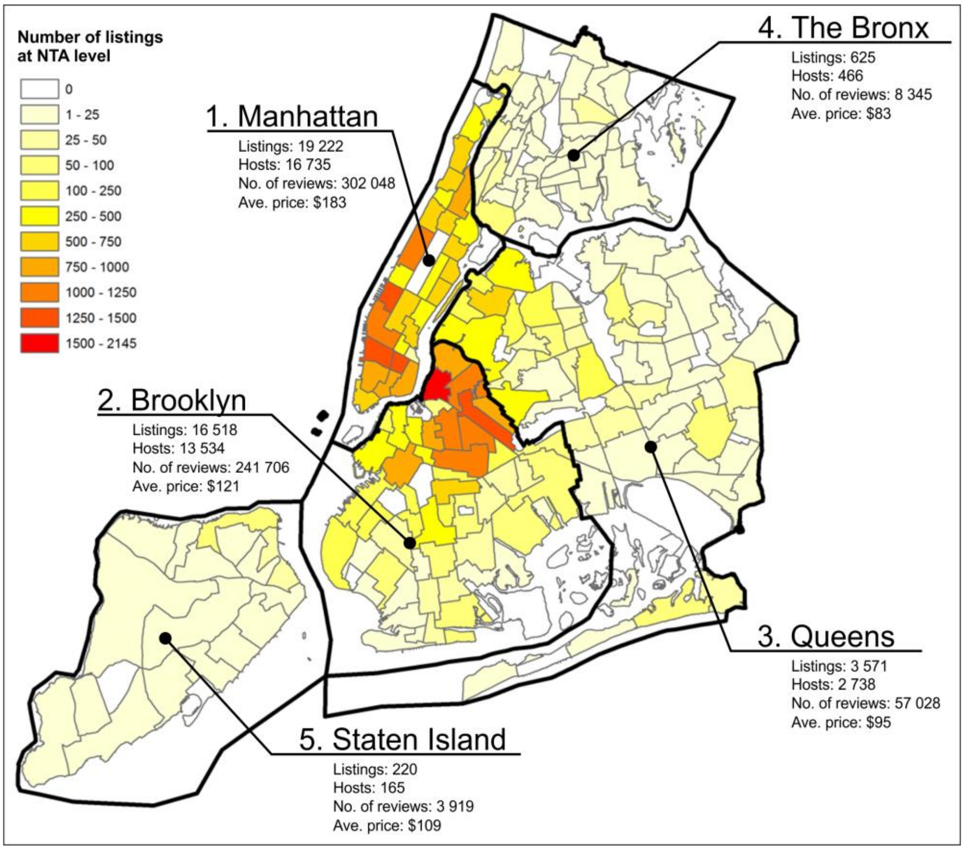
In our study, we applied basic mathematical and statistical methods to answer the research questions raised in the introductory section. As the aim of the study was to measure which socio-economic factors influence the spatial spread of Airbnb, we initially analysed which of these factors associated with the New York City NTAs were correlated with Airbnb indicators. Nevertheless, at first, we eliminated those NTAs from our database where there were no housing units or the data was incomplete, such as parks or the vicinity of airports. Thus, our test sample size was reduced from 195 to 189 NTAs. In order to signal the nexuses between the selected indicators, we created a Pearson cross-correlation matrix using SPSS 23 statistical software and utilising the data indicated in Table 2. In addition to the correlation of specific indicators, it is practical to filter the partial effects as well. Thus, we applied a multivariate linear regression model to reveal the relations between Airbnb supply and demand, and socio-economic indicators. Using our aggregated database, we compiled specific indicators that were utilised as input variables in our multivariate regression model. In the analysis, we strove to observe strict statistical rules (Dusek–Kotosz 2016, Kovács 2008); therefore, only those regression results were taken into consideration where there was a significant relationship between the dependent and independent variables and the explanatory power of the regression was greater than 0.5. In addition, we also sought to filter multicollinearity between the input variables; thus, where the VIF value was above 5, the results were not taken into account.

Findings and analysis

By analysing Airbnb listings and the socio-economic features of the population in NTAs in New York City, the study presents a snapshot of the short-term accommodation sector of New York City and the factors affecting it. However, before analysing the spatiality and characteristics of the Airbnb units in New York City we have to differentiate three different types of rooms in Airbnb listings (entire home/apt, private room, shared room). As their name suggests, an entire home means that the host is not present in the unit during the guest's stay. A private room is a space within a host home and the host is present during the stay, but the guest has some private space (e.g. bedroom) and shares common space with others. The third type is when the guest and the host share the same living space, which represents the original model emphasised by the founders (Ke 2017, Samaan 2015). In all the major markets, where the short-term rental site is present, entire homes dominate Airbnb listings. In the US, according to the research of Ke (2017), 65.8 per cent of the listings are entire homes; however, our results highlight that in the case of New York City the share of these units shows lower values, as only 50 per cent of the listings are entire homes, 47 per cent is the share of private rooms, and shared rooms make up an almost negligible 3 per cent share of the market (Table 1). The descriptive statistics of Airbnb listings reflect quite similar values of entire homes and private rooms with the exception of price. Entire homes on the platform of Airbnb in New York City cost on average of twice as much as private rooms; however, the difference between the price of a private room and a shared room is not as significant at approximately $15. The average availability of the listings is approximately 143 days for an entire home, while it is approximately 164 days for a private room. The numbers also suggest that in regard to entire homes, one host manages 1.36 listings, while in the case of private rooms the number is 2.13; however, there are several multiple-lister hosts operating more than two listings. Nevertheless, these numbers should be put into context, as according to Schneiderman (2014) multiple hosts represent only 6 per cent of Airbnb hosts, but they dominate the platform and generate 37 per cent of all host revenues, receiving $168 million. In addition, considering the entire home market, multiple-lister hosts earn 41 per cent of revenues (Cox–Slee 2016). These facts encourage critics to claim that a disproportionate amount of revenue is gained by 'commercial' hosts; incidentally, the vast majority of these listings are operated illegally by violating the MDL of New York City,[1] disrupting neighbours, and displacing long-term residents.

Figure 1

Basic data on listings offered by Airbnb in New York City at borough and NTA level



Source: based on http://insideairbnb.com/ data, edited by the authors.

The geographical distribution of Airbnb indicates the fact that the vast majority of the listings (89%) are concentrated in a few neighbourhoods of Brooklyn and Manhattan (Figure 1), primarily in the southern part of Manhattan and northern

[1] 'The New York State Multiple Dwelling Law (the 'MDL') prohibits rentals of less than 30 days in 'Class A' multiple dwelling unless a permanent resident is present during the rental period' (Schneiderman 2014, p 18).

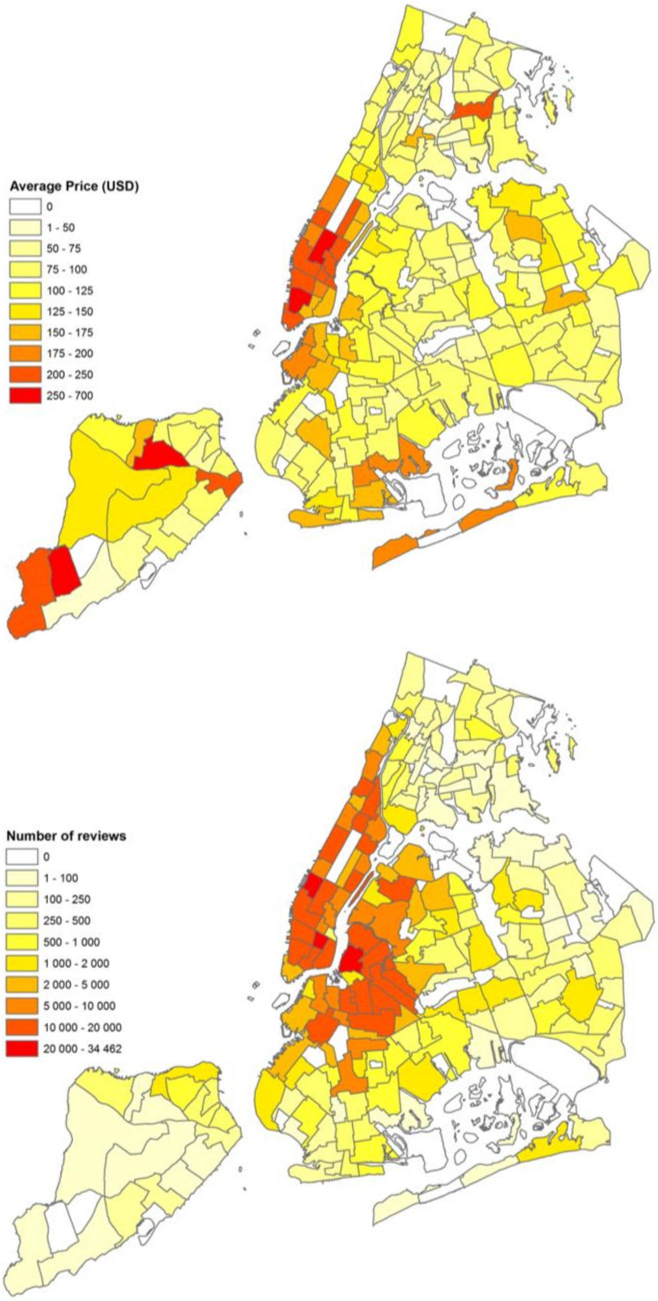
Brooklyn. These neighbourhoods are attractive to tourists and New York City residents as well because of the favourable access to public transport and jobs in Manhattan. Moreover, the study in Inside Airbnb (2017b) revealed that Airbnb activity overlaps with gentrification as the most popular Airbnb neighbourhoods are gentrifying or are already gentrified (e.g. Chelsea, Greenwich Village, Williamsburg, Greenpoint, Lower East Side, etc.). According to our dataset, from the 40,156 unique units about 16,000 hosts offered over 19,000 listings (47.8%) in Manhattan and about 13,000 hosts offered more than 16,000 listings (41.1%) in Brooklyn. These two boroughs account for most of the revenues generated by short-term rentals according to the New York General Attorneys' report (Schneiderman 2014). In Manhattan, the total host revenue between 2010 and 2014 exceeded $338 million, while in Brooklyn it was $100 million. By contrast, the other three boroughs yielded only $12.2 million.

The number and spatial distribution of Airbnb listings and the revenues generated do not fully reflect the number of hosting events. However, to answer the research question raised in the introductory section and highlight where Airbnb customers actually go (Airbnb demand), we utilised the number of user reviews as a proxy. We applied this proxy as Fradkin et al. (2015) in their study had indicated that the number of reviews can be a good proxy for demand because the completion rate for reviews over the number of stays in an Airbnb accommodation is more than 70 per cent (Quattrone et al. 2016). Nevertheless, we also displayed the average Airbnb accommodation price in the New York NTAs, assuming that budget-conscious tourists may use cheaper Airbnb units (Figure 2).

The average Airbnb accommodation prices are more expensive in Manhattan and Brooklyn, while within these areas, the most expensive Airbnb units are located in the southern part of Manhattan (Midtown-Midtown South, SoHo-TriBeCa-Civic Center-Little Italy; West Village) and the north-western part of Brooklyn (Madison; Carroll Gardens-Columbia Street-Red Hook). In addition, the spatiality of the reviews indicates that use of Airbnb accommodations is less concentrated in a few neighbourhoods than in Airbnb listings. Although the vast majority of the reviews are given in the proximity of Manhattan and Brooklyn, the diffusion within these boroughs is more balanced. This signals that Airbnb users not only prefer the centrally located higher-priced accommodation but book in lower-priced neighbourhoods as well.

Figure 2

The price and the number of Airbnb reviews in New York City at NTA level



Source: based on http://insideairbnb.com/ data, edited by the authors.

In order to go beyond visual representation and descriptive statistics on Airbnb listings, we correlated our socio-economic indicators with Airbnb listings and compiled a correlation matrix (Figure 3). The results reflect that the number of Airbnb listings and reviews that concentrate in those areas have a population who are young, a significant number of housing units, and a notable POI supply. By contrast, the majority of the variables show moderate or weak positive covariance, while weak negative correlations are revealed between the Airbnb sector and the variables describing the ethnic structure, as well as the ownership structure of the housing market of the given areas. Regarding the third Airbnb indicator (price), it is apparent that price moderately correlates with education, household income, and the POI supply, while the other indicators show weak or negative values. Moreover, the matrix shows further covariance between the social and economic variables. These are strong positive correlations between high education, employment, and incomes, from which we could draw conclusions about the general development characteristics of the areas. In addition, these results may also reflect the partial distortion effects and their nexuses. Thus, to reveal the cause-effect relations and go into the details, we performed a multivariate linear regression analysis based on the number of Airbnb listings, reviews, and price.

Figure 3

Pearson cross-correlation matrix based on the independent variables of Table 2 with significance levels

	abnb_listing	aibnb_price	abnb_rev	pop_density	young_p	ethnic_d	black_p	nonUS	education	employee	income	housing	house_own	house_mortg	rent	POI
abnb_listing		0.309**	0.984**	0.530**	0.678**	0.064	–0.092	–0.256**	0.531**	0.540**	0.235**	0.540**	0.654**	–0.112	0.328**	0.727**
aibnb_price	0.309**		0.285**	0.064	0.143	–0.076	–0.240**	–0.336**	0.500**	0.355**	0.484**	0.237**	0.142	–0.054	0.350**	0.439**
abnb_rev	0.984**	0.285**		0.489**	0.624**	0.069	0.073	–0.234**	0.467**	0.485**	0.186*	0.603**	–0.320**	–0.110	0.272**	0.679**
pop_density	0.530**	0.064	0.489**		0.942**	–0.064	–0.030	0.040	0.210**	0.168*	–0.108	0.918**	–0.662**	–0.266**	0.085	0.433**
young_p	0.678**	0.143	0.624**	0.942**		–0.018	–0.084	–0.053	0.348**	0.355**	0.019	0.916**	–0.627**	–0.217**	0.235**	0.565**
ethnic_d	0.064	–0.076	0.069	–0.064	–0.018		–0.247**	0.154*	0.024	0.036	–0.137	–0.083	–0.158*	–0.041	–0.054	–0.014
black_p	–0.092	–0.240**	–0.073	–0.030	–0.084	–0.247**		–0.032	–0.395**	–0.294**	–0.314**	–0.105	–0.106	0.490**	–0.363**	–0.209**
nonUS	–0.256**	–0.336**	–0.234**	0.040	–0.053	–0.154*	–0.032		–0.293**	–0.070	–0.330**	–0.114	–0.112	–0.212**	–0.107	–0.258**
education	0.531**	0.500**	0.467**	0.210**	0.348**	0.024	–0.395**	–0.293**		0.815**	0.808**	0.501**	0.166*	0.271**	0.801**	0.688**
employee	0.540**	0.355**	0.485**	0.168*	0.355**	0.036	–0.294**	–0.070	0.815**		0.754**	0.412**	0.161*	–0.150*	0.843**	0.626**
income	0.235**	0.484**	0.186*	–0.108	0.019	–0.137	–0.314**	–0.330**	0.808**	0.754**		0.180*	0.583**	–0.036	0.854**	0.486**
housing	0.654**	0.237**	0.603**	0.918**	0.916**	–0.083	–0.105	–0.114	0.501**	0.412**	0.180*		–0.507**	–0.293**	0.323**	0.631**
house_own	–0.338**	0.142	–0.320**	–0.662**	–0.627**	–0.158*	–0.106	–0.112	–166*	0.161*	0.583**	–0.507**		0.117	0.331**	–0.236**
house_mortg	–0.112	–0.054	–0.110	–0.266**	–0.217**	–0.041	0.490**	–0.212**	–0.271**	–0.150*	–0.036	–0.293**	0.117		–0.145*	–0.195**
rent	0.328**	0.350**	0.272**	0.085	0.235**	–0.054	–0.363**	–0.107	0.801**	0.843**	0.854**	0.323**	0.331**	–0.145*		0.545**
POI	0.727**	0.439**	0.679**	0.433**	0.565**	–0.014	–0.209**	–0.258**	0.688**	0.626**	0.486**	0.631**	–0.236**	–0.195**	0.545**	

** correlation significant at 0.01 level; * correlation significant at 0.05 level.
Source: edited by the authors.

The multivariate linear regression analysis of Airbnb listings signals that the analysed indicators have almost a 70 per cent explanatory power of Airbnb supply (Table 3). The explanatory variables highlight that the proportion of young people, the employment rate, and the concentration of the POI supply positively affect the number of Airbnb listings, while the number of foreign-born residents and the rent negatively affect the supply. These results may indicate two phenomena. On the one hand, the model demonstrates that the spatial distribution of Airbnb supply is strongly related to the nearby attractions (POI supply) because within a given destination the accessibility of touristic attractions is essential. On the other hand, the analysis signals that the potential offered by Airbnb is popular among the youth population, who are highly educated and responsive to new technologies. In other words, gentrifiers tend to exploit the benefits of short-term rental. In addition, our model also highlights that positive correlation was normally outlined between Airbnb supply and the rental market; however, by filtering out the partial effects the relationship became negative, which directs attention to the methodological problems of traditional correlation analyses.

Table 3

Regression analysis of Airbnb listings

Independent Variables	Standardized Beta Coefficients	Sig.	VIF
(Constant)	–	0.002	-
young_p	0.367	0.000	1.525
employee	0.497	0.000	4.152
POI	0.391	0.000	2.340
nonUS	–0.146	0.001	1.110
rent	–0.407	0.000	3.583
Dependent Variable: abnb_listing		Adjusted R Square: 0.698	

Source: based on own calculations.

In analysis of the demand side (Table 4), the results show similar values, as the same independent variables significantly affect the concentration of the reviews as in the case of the supply side; however, the exploratory power was weaker at 61 per cent. The same indicators have a negative or positive impact on the demand side rather than on the supply side. This cause-effect relation between the two regressions might be traced back to the capitalist market mechanism and the balanced supply and demand approach.

We have conducted the same regression analysis considering Airbnb prices but there was no significant relation between the variables and the explanatory power did not reach the 0.3 regression value. Overall, the linear regression models of the socio-economic indicators only partly explain Airbnb supply, demand, and price.

This might be because social and economic processes are not necessarily linearly related to each other, therefore, in future, it would be advisable to analyse these processes by considering other approaches.

Table 4

Regression analysis of Airbnb reviews

Independent Variables	Standardized Beta Coefficients	Sig.	VIF
(Constant)	–	0.030	–
young_p	0.321	0.000	1.525
employee	0.490	0.000	4.153
POI	0.401	0.000	2.341
nonUS	–0.129	0.008	1.110
rent	–0.450	0.000	3.583
Dependent Variable: abnb_rev		Adjusted R Square: 0.609	

Source: based on own calculations.

Conclusions

Owing to the heavy debates around the sharing economy and Airbnb, there is a rising interest in the spatial distribution of Airbnb listings in major cities and the factors affecting it; however, the determining role of socio-economic factors has received very little attention from researchers so far. Therefore, the present study seeks to fill this gap with a contribution that analyses the socio-economic factors influencing the spatial distribution of Airbnb listings in New York City.

The results indicated that Airbnb accommodations and the number of reviews are concentrated in those parts of the city that have a young population, a significant number of housing units, and a high number of points of interest. Our empirical findings also showed that there was no strong correlation between Airbnb price and the selected indicators but price moderately correlates with education, household income, and POI supply. Thus, the connection between gentrification and the growing Airbnb offers can be supported by the analysis. The regression analysis revealed that the socio-economic indicators have a 70 per cent explanatory power with respect to Airbnb supply highlighting that the proportion of young people, the employment rate, and the concentration of POI positively influences the number of Airbnb listings. The results signalled similar effects on the demand side with the exception that the explanatory power of the indicators was weaker at 61 per cent.

The connection between gentrification and the number of Airbnb listings indicates that the ongoing displacement processes in gentrifying neighbourhoods will continue in the future as short-term rentals increase the already elevated rent gap in the affected neighbourhoods. This process especially threatens the predominantly black neighbourhoods, where gentrification has already started, but is in the early stage. In these neighbourhoods, despite the ethnic structure of the areas, the majority of the hosts are white (Inside Airbnb 2017b). As a result, they enjoy the benefits of Airbnb while blacks are more exposed to the negative impacts, and often face displacement. Airbnb intensifies the neighbourhood changes related to gentrification because it offers even more profitable investment opportunities. However, these processes could be understood more deeply through longitudinal studies analysing the changes in ethnic structure, the ethnic distribution of Airbnb hosts, and the dynamics of Airbnb offers.

Like other research, this study has some limitations. The first is that the analysis is limited to only one city (New York City), which may not allow us to generalise the results to other destinations. Second, the study presents only a snapshot of Airbnb offerings representing the situation in December 2016. Moreover, we have to note that while linear regression models have a certain explanatory power, these processes could be overwritten by complex and contradictory economic and social effects; they should be complemented by qualitative studies in the future. Considering these limitations, in future, we plan to conduct a longitudinal analysis and extend the number of cities included in the study, and also test our results on spatial autocorrelation. We hope that our study will encourage further research on this topic and raise further interest among geographers and researchers from other disciplines.

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Opportunities for walkability in Szeged and Valencia

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Cities traditionally concentrate a country's resources and talents, and, thus, they have long been the hubs of innovation and economic growth. Recent rapid urbanization has brought numerous challenges to our cities, including overcrowding, noise, and air pollution, to name a few. One area in which cities urgently need to innovate is urban mobility. The use of motorised vehicles requires increasing amounts of space, which drastically reduces the amount and quality of living space for people. This results in various negative economic and social consequences. To improve the sustainability of urban mobility, cities develop environmentally friendly public transit systems and bicycle infrastructures. However, improving the simplest and most basic type of mobility–walking–has long been neglected. Fortunately, urban developers have increasingly realized during the past few years that making our cities more walkable is a critical part of the solution to the urban mobility challenge. This paper aims to answer the question: 'How is the concept of walkability interpreted in middle-sized European cities'. During our research, we conducted intercept surveys (participant observation, questionnaire, and experts' interviews) to investigate the extents of walkability and its improvement opportunities in Szeged and Valencia. We evaluated the findings using descriptive statistical methods. We conclude that the concept of 'walkability' could be useful as a city development tool in mid-sized cities.[1]

[1] This study was conducted in the framework of CityWalk '*Towards energy responsible places: establishing walkable cities in the Danube Region*', DTP1-1-045-3.1 project. The project was co-financed by the European Union and the Republic of Hungary in the framework of the Danube Transnational Programme.

Introduction

Since cities first existed, the basic mode of transportation in them has been walking. Therefore, cities have primarily been walkable settlements, in which the most important activities were accessible on foot. This arrangement worked well until the automobile was invented. The proliferation of automobiles in cities initially offered unprecedented opportunities for urban development, but, at this point, the automobile's benefits have long and increasingly been surpassed by its disadvantages, and disadvantages to urbanization have occurred.

Dysfunctional urban transit systems have had serious negative consequences, and it is not surprising that cities have made sizable investments in overcoming the problems. Although it requires a careful and complex solution, one aspect of sustainable urban transportation that is often forgotten is one that is simple, natural, and, even, relatively inexpensive. That aspect is 'walkability', which is an innovative and simple solution to cities' transportation problems. However, it is important to clarify that walkability is just one, albeit crucial, part of the solution, which includes development of public transit, bicycle infrastructure, and the application of advanced technologies, such as electric and autonomous systems and vehicles. Walkability is a common concept in the US and big cities in Western Europe; however, information on adapting mid-sized cities in Eastern Europe for walkability is less available.

Therefore, this study addresses the concept of walkability in Szeged[2] by contrasting it with a selected European city, Valencia.[3] Despite rapid motorisation, Valencia, similar to many Mediterranean cities, has maintained a high level of walkability. This paper first presents a review of the international literature on walkability to provide a broad context. Second, the topic is investigated from a practical perspective using quantitative methods. Then, the paper describes the empirical participant observation research conducted in both cities during five months, the interviews, and the questionnaire data on the walkability situations in Szeged and Valencia with a discussion on possible changes for the near future. Fourth, the paper provides suggestions for improving walkability in the studied cities based on the empirical results. Last, we summarize the study and present our conclusions about the results. The paper highlights that, within the framework of the study, we aimed to conduct pilot studies in two mid-sized European cities. Using our findings, we hope to obtain underlying information about the adaptability of the concept 'walkability' in mid-sized cities to serve as a foundation for further research.

[2] Szeged is the third largest city in Hungary in population, numbering 162,600. It has a well circumscribed city centre and its transportation is a mixture of walking, cycling, public transit, and personal vehicular transit.

[3] Valencia is the third largest city in Spain in population, numbering 790,201. It has a well circumscribed city centre and its transportation is a mixture of walking, cycling, public transit, and personal vehicular transit.

The theory of walkability and its challenges

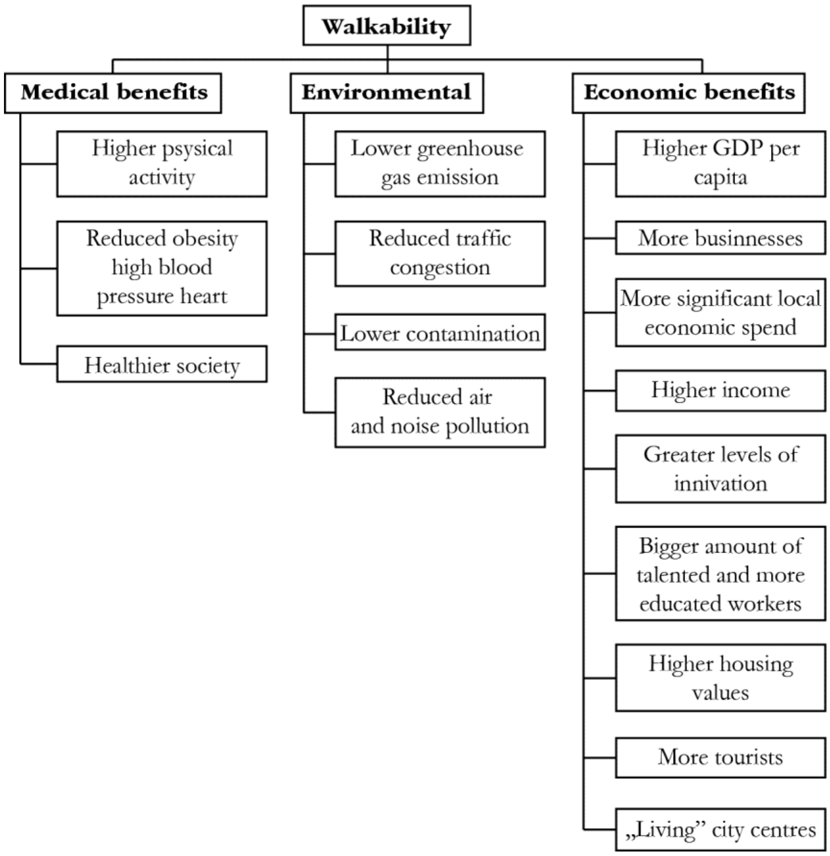
People and their environments have dramatically changed over time. One major change is rapid, and seemingly unending, urbanization. People tend to leave rural areas and move to cities for the advantages of urban lifestyles, such as increased opportunities (Torrey 2004), cost savings (Lengyel-Rechnitzer 2004), access to more information (Lengyel 2010), and because cities are the engines of development, focal points for innovation (Cohen 2006), and areas of clustering (Vas et al. 2015). However, urbanization could have negative as well as positive effects on the natural environment (Sadorsky 2014), which is important to this study's perspective. The disadvantages include inadequate water and sanitation, lack of trash disposal, and industrial pollution (Torrey 2004). Cohen (2006) pointed out that traffic congestion in large cities is an extreme problem, and air pollution is a serious environmental concern. Green areas in cities are shrinking (Rechnitzer 2007) while transportation is increasing (Rechnitzer 2004, ITDP 2011). Therefore, the quality of the urban environment has gradually declined. Moreover, the comfortable access to destinations offered by urbanization displaces physical activity from daily life because moving around is limited to driving automobiles (Pavlik 2015).

Urban transit systems are major sources of negative environmental and other problems, and it is imperative that urban transit is more sustainable. The use of electric transportation combined with low-carbon electricity sources is clearly an important part of the solution (Hawkins et al. 2012) because they are environmentally friendly technologies (Wang–Santini 1993). However, this requires enormous resources and fails to address all of the important challenges of urban transportation. Many cities respond to traffic congestion problems with governmental investments in large-scale public transit systems (Cohen 2006), which is one obvious answer to the situation. However, this approach is expensive and still does not address all of the negative consequences, similar to electrification. Better walkability is a simple, cost-effective alternative way to address the problem that cannot be ignored. Dramatic increases in the use of active transportation (walking and cycling) for urban transportation is necessary. Although improved walkability and more walking could not replace the benefits of using electric automobiles or improving public transit, it probably is the most important part of the solution, particularly in small or poor cities. Rechnitzer (2007) claimed that the inner transportation connections of cities must be developed.

To gain a clear picture of the concept of 'walkability', this paper next presents the subject and highlights the advantages and possible effects of walkable communities based on previous studies conducted around the world. To deal with the issues of walkability, one must understand the meaning of 'walkability', and, based on various definitions, we can characterize neighbourhoods using the term 'walkability'. It means the extent to which it is easy, convenient, safe, and desirable to walk (Speck 2013) to where every important and daily-used establishment is accessible, namely, it does not take a lot of time to reach them.

Figure 1

Some possible benefits of walking



Sources: The author constructed the flow chart based on Giles-Corti et al. (2010), Benfield (2016), Florida (2010), Florida (2011), Leinberger–Lynch (2014), Eidmann et al. (2011), MARC (1998), Benfield (2014), SGA (2015), Florida (2014), Leinberger–Alfonzo (2012), FHWA (2014), Sauter et al. (2016), Simmons et al. (2015), Litman (2017), Swartz (2012), Forsyth et al. (2010), Wedderburn (2013), Cooper-Danzinger (2016), Litman (2014), SKM-PWC (2011), ABW (2016), and WHO (2013).

This section explains the effects of walkability. In walkable neighbourhoods, individuals and communities can enjoy concrete health and environmental and economic benefits (Giles-Corti et al. 2010, FHWA 2014, Sauter et al. 2016). Figure 1 lists some of the many positive effects of walkable neighbourhoods, although the list is not exhaustive. Regarding economic benefits, there are reduced user costs, direct and indirect economic impacts, benefits related to health savings, and environmental benefits (Simmons et al. 2015). Among the positive impacts on the economy, walkable places have relatively more businesses (Benfield 2016), higher incomes (Florida 2010), more innovation (Florida 2011), higher GDP per capita

(Leinberger–Lynch 2014), more significant money spent, higher property values (Litman 2017, Swartz 2012), and so on. Reducing the number of automobiles could decrease greenhouse gas emissions (Forsyth et al. 2010, Wedderburn 2013), traffic congestion (Eidmann et al. 2011, Cooper–Danzinger 2016), contamination, and air and noise pollutions (MARC 1998, Litman 2014). Regarding the health benefits of walking, there are direct and indirect benefits (SKM–PWC 2011). The physical effects of walking are self-explanatory because increased physical activity reduces obesity, high blood pressure, heart disease, and diabetes, thus creating a healthier society (Benfield 2014, ABW 2016, WHO 2013). Creating walkable compact cities is a global priority (Giles-Corti et al. 2014) because neighbourhoods with those features promote active modes of transportation, such as walking and cycling (TRB 2005). To this end, a complete pedestrian network in the built environment is necessary because it would have a positive influence on walking (Frank et al. 2011, Vale et al. 2016).

How walkability is quantified in communities

This section presents walkability from a practical perspective to gather ideas and establish the framework of the empirical study. By investigating the practical aspects of walkability, we can discover some crucial methods that could be important when quantifying walkability. The measures are important for assessing the current state of walking conditions, the changes to them, and setting and realizing goals (Sieff–Weissman 2016). Indicators are essential to measure and compare the features of streets and neighbourhoods (Porta–Renne 2005). In addition, quantification of walkability could have an essential role in transportation planning activities (Kuzmyak et al. 2006). Walk Score, Walkability Audit, and Transportation Walkability Index include methodologically important aspects that served as crucial inputs to this study. These methods contributed to the preparation of the questionnaire and interviews used in the study.

1. Walk Score, which measures the walkability of any location, was developed by the Walk Score advisory board (Walk Score 2007). To obtain the points of a given address, hundreds of walking routes to nearby amenities were analysed, and the distances to amenities in each category were the basis of the points. Walk Score analyses population density and road metrics to identify pedestrian friendliness. Based on the given points, addresses are classified into categories from the lowest to the highest scores: Walker's Paradise (90–100), Very Walkable (70–89), Somewhat Walkable (50–69), Car-Dependent (25–49), Car-Dependent (0–24). Based on the measurement of the extent of walkability in cities, some rankings are available for the most walkable cities and neighbourhoods in the world.

2. Walkability Audit is a method presented with an example by Eidmann et al. (2011). The authors measured the walkability in North Adams, US, through a Walkability Audit. The method used to evaluate streets for their walkable characteristics is a Walkability Audit, which considers numerous criteria (Agrawal and Schlossberg 2007). After the assessment, every street section is given a quantitative score and a qualitative assessment, which are used to make recommendations for improving the walking quality. The quantitative part of the audit tool comprises several parts and the specific criteria are ranked in each part on a scale of 1 = *worst* to 5 = *best*. The factors considered for commercial streets are sidewalks, crosswalks, signage, aesthetics and amenities, and safety. In the course of assessing these factors, impediments to walking in specific areas and areas for improvement can be identified. The qualitative part of the audit tool includes the presence of bicycle amenities, public transit stops, types and numbers of people present in the area, amount of available parking, and the streets' overall connectivity, which describes the dangerous and unpleasant parts of the area under evaluation. The project group used Geographic Information System (GIS) to identify the areas to be assessed on an aerial map and then input their data.
3. Transport Walkability Index is another method to assess the walkability of neighbourhoods, which was demonstrated with an example by Giles-Corti et al. (2014). The authors proposed that the goal of the Transportation Walkability Index is to measure transportation walkability and that calculation of three main variables is required, which are residential density, street connectivity, and land-use mix, because these characteristics are associated with walkability (Ewing–Cervero 2010, Clifton et al. 2015). After the calculation and harmonization of these data, the researchers imported the data to a GIS platform. Walkability indices are increasingly popular (Manaugh–El-Geneidy 2011). Without doubt, the correlation with travel behaviours could differ across individuals and households (Manaugh–E-Geneidy 2011).

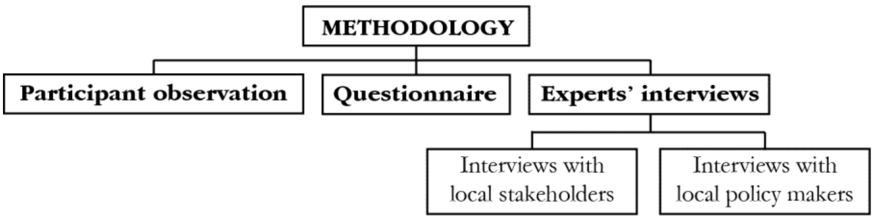
Considering everything about the quantifiability of walkability, it is clear that many aspects of the above-described methods could be applied to this study's analysis.

Walkability surveys in Szeged and Valencia

We quantified walkability in two middle-sized European cities, Szeged and Valencia. The methodology was mixed methods research in light of the study's purpose. The mixed methods included participant observation, citizens' survey, and experts' interviews with city stakeholders and policymakers (Figure 2). The interviews were personally conducted because one co-author resided in Szeged and another author resided in Valencia.

Figure 2

Structure of the methodological process



Source: Author.

There are unquestionable limitations to the survey we conducted. First, the two cities differ in size, extent of development, and transportation systems. In particular, Valencia has an underground system with several lines. All of these differences could influence the interpretability of the survey's results. However, this might not be a problem because Szeged and Valencia have well circumscribed city centres. This is important because the walkability of a city centre is decisive for every city. From the methodological perspective, the following points are essential to highlight regarding the mixed methods empirical research.

1. The first level of the primary research comprised personal observations conducted in both cities. These observations were important to gain insights into the walkability situations of the cities and to develop the questionnaire and the experts' interviews before surveying the citizens. During the personal observations, which were participant observation, field notes were taken to ensure records. Furthermore, we used several tools from the list developed by Gehl and Svarre (2013): counting, mapping, tracing, photographing, and test walks.

   During the two-month fieldwork of daily observations in the Szeged city centre, which lasted 50 minutes each on average, 200 people on average passed by the observation spot, meaning that we recorded a total of about 12,000 observations. In Valencia, the foot traffic averaged 300 people per 50-minute period, which totalled approximately 18,000 observations. Observations were performed at 15 different locations in both cities, such as busy intersections, important destinations (post office, medical centres, schools, and so on), and critical road intersections (where drivers and/or cyclists and pedestrians coincide or are close to each other). We followed 47 guided tourist group routes in Szeged and 53 of these routes in Valencia.
2. During questionnaire development, we created a list of questions adapted from some previous studies, the methods of Walk Score and the Walkability Audit, and our personal observations. It was important to put Szeged and Valencia into an international context based on existing scientific achievements. Because of the contributions of researchers, the questionnaire had two questions that were adopted from international research (a study by Southworth

conducted in Santa Rosa and a study on Toronto Public Health, 2012). The questionnaire was prepared for citizens in their first language. There were 18 closed-ended questions focusing on the most important factors of walkability. The benefits of a closed-ended questionnaire are its easy statistical analysis and possible quantification, if necessary; however, unfortunately, people cannot elaborate their thoughts. Altogether, 129 respondents completed the questionnaires in the two cities and the sample sizes in Szeged and Valencia were approximately equal. The samples were not representative.

3. The third level of the study comprised experts' interviews, in which we talked with five citizens in each city to gain deeper familiarity with the residents' ideas. These people were relatively more connected to particular aspects of walkability. For example, they were part of a civil organisation fighting to protect the environment, teachers/professors with influence on future citizens, dedicated to healthy lifestyles and frequent walking, or part of the community government with an influence on city planning. The structure of the experts' interviews differed depending on the interviewee. During the interviews, we asked open-ended questions similar to the questions in the online questionnaire to understand why people tend to think in a particular way about the walkability of their cities. The interviews with the two city policymakers (one from each city) included open-ended questions specific to the cities' current policies on walkability. These open-ended questions solved the limitations of the questionnaire's closed-ended questions because the interviewees could elaborate their answers.

Results of participant observation

We used the tools suggested by Gehl and Svarre (2013) in the following ways. We counted the people entering a certain shop and a gymnasium (as examples) to identify the most important establishments in people's daily lives. During the mapping, we drew symbols on a map to determine the frequency with which disabled people used certain streets. Tracing was a tool used to assess the numbers of pedestrians who avoided certain streets because of the lack of adequate lighting. We photographed to record the conditions of the walkways and crosswalks. Furthermore, we applied test walks in which we followed guided tourist groups to determine where they were going and the routes they used. The purpose of our participant observation was to prepare a basis for the questionnaire and experts' interviews.

Considering everything, the walkability of the two cities was different in some respects (e.g. there was significantly better infrastructure for disabled people in Valencia). However, there were similar features (e.g. both city centres were excellent place to walk). It is notable that both cities' centres were much better laid out than the layouts of the neighbourhoods. For example, all of the important institutions were concentrated in the city centres, whereas not all of them were present in the neighbourhoods, which is understandable from the perspective of the city governments because they aim to make their cities appealing to visitors, who are relatively more likely to visit the centres. The outcomes of the participant observation were preliminary results and we aimed to minimize our subjectivity, although that is obviously impossible. We hoped to use these results to supplement the detailed questionnaires and interviews.

Results of the survey

The first section of the questionnaire asked for the respondents' opinions of their neighbourhoods from different standpoints. There were five response options (*strongly disagree, disagree, neutral, agree,* and *strongly agree*) provided for every statement.[4] The opinions significantly differed between the two cities on some of the statements. First, the most outstanding was the number of trash cans on the streets in the neighbourhoods. Only 33% of Szeged respondents agreed that the number of trash cans was sufficient, whereas 62% of the Valencia respondents agreed with the statement. Second, 88% of the Szeged respondents agreed and 11% of them disagreed that they had good access to public transit stations (statement 6). In Valencia, 72% of the respondents agreed that they had good access, which is 16 percentage points below the 88% in Szeged, and 12% disagreed to a certain extent. For statement 10, the difference between Szeged and Valencia was in the percentage of disagreements: 19% of the Szeged respondents and 31% of the Valencia respondents disagreed with the statement. Another significant difference was found regarding disturbing objects on the walkways. In Szeged, 38% of the respondents agreed to a certain extent that obstructions, fire hydrants, columns, or lampposts disturbed them while they were walking, but the same problems bothered 21% fewer of Valencia's respondents (17% agreed).

The second section of the questionnaire was similar to the first section, except that the respondents were asked for their opinions on the same walkability features specifically about the city centre.[5] A comparison of the two cities found that the responses were more positive for Szeged than for Valencia. For example, the Szeged responses to statements 1–7 had few disagreements and the maximum percentage was 3%, which is insignificant. Regarding Valencia, disagreements with statements 1–7 also were low. In Szeged, 99% of the respondents agreed with statement 1, meaning that almost every respondent agreed that the Szeged city centre was a good place to walk. Notably, 61% of the Szeged respondents strongly agreed that the public lighting in the city centre was adequate. Generally, the Valencia respondents seemed to be satisfied with the previously mentioned aspects of walking, although their agreement was not as widespread as among the Szeged respondents. Com-

[4] See Appendix 1.

[5] Appendix 2 provides the text of the statements in the questionnaire.

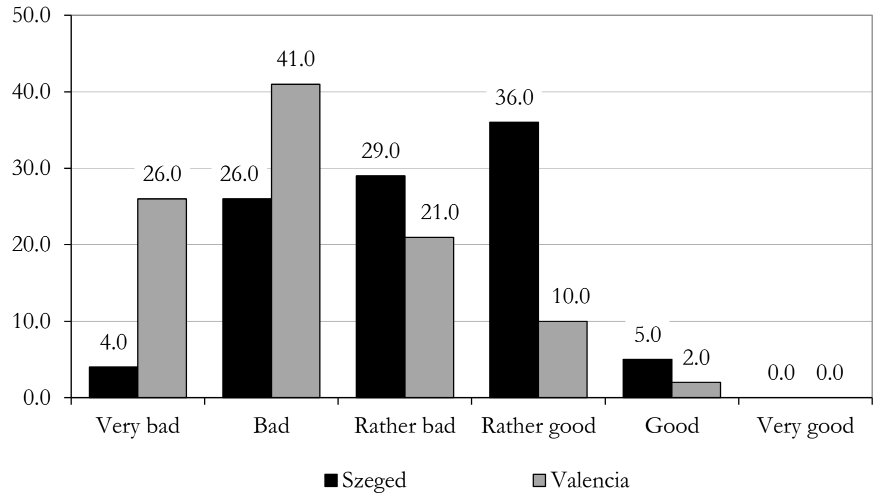
pared to Szeged, 26% fewer Valencia respondents agreed that the public lighting was adequate. Problematic issues in the city centre were similar to those in the neighbourhoods.

The third question concerned the ability to access important places on foot from the respondents' homes. Clearly, the list of establishments was not exhaustive. We asked the respondents about their access to schools, work, shops, banks, post offices, restaurants, hospital/medical centres, public transit stations, and churches. In Szeged, the majority of the respondents reported that, except for banks and hospital/medical centres, they could reach all of the important places on foot. The outstanding items were shops and public transit stations, for which 97.7% of the respondents reported access on foot. Regarding Valencia, the figures differ because we could not locate any places to which the majority of respondents could not walk. It seems that they were relatively more likely to easily reach any of the listed places on foot. In this city, three types of places had the highest accessibility: shops, hospital/medical centres, and public transit stations, all of which were at 97.6%.

For questions 4 through 9, the respondents were asked to choose a value on a scale of 1–6. Question 4 asked for their opinions on how easily a person entering the city centre by automobile would be able to find a place to park. Parking close to the city centre was not considered perfect by the respondents in both cities. On the other hand, a strong difference was found between the cities in that, in Szeged, the highest frequency was 'rather good', at 36%, and, in Valencia, the highest frequency was 'bad' (41%) (Figure 3).

Figure 3

Parking opportunities near the city centres of Szeged and Valencia (%)

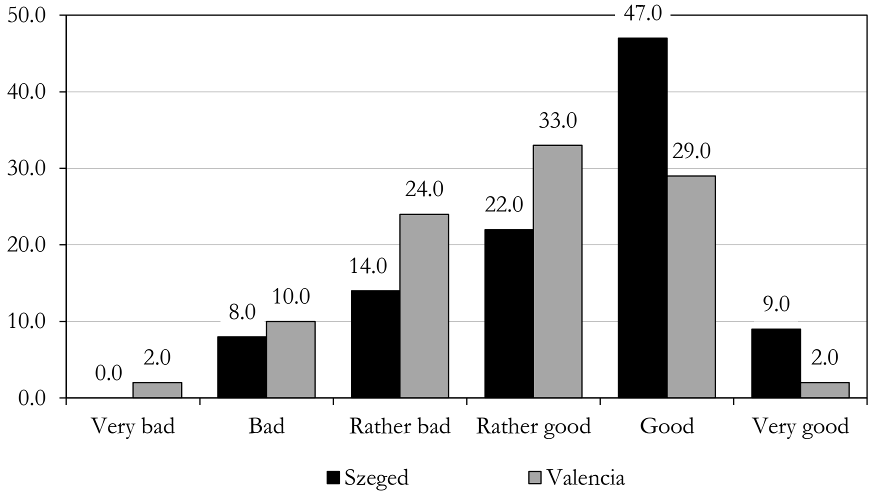


Source: Author.

This significant difference was not found in the responses to question 5, which is about the connections between the suburbs and the city centres. Although the Valencia respondents were most likely to rate their situation as 'rather good' (33%), in Szeged, the respondents were most likely to rate their situation as 'good' (47%). Therefore, it can be concluded that the suburbs are slightly better connected in Szeged than in Valencia (Figure 4).

Figure 4

The connections between the suburbs and city centres in Szeged and Valencia (%)



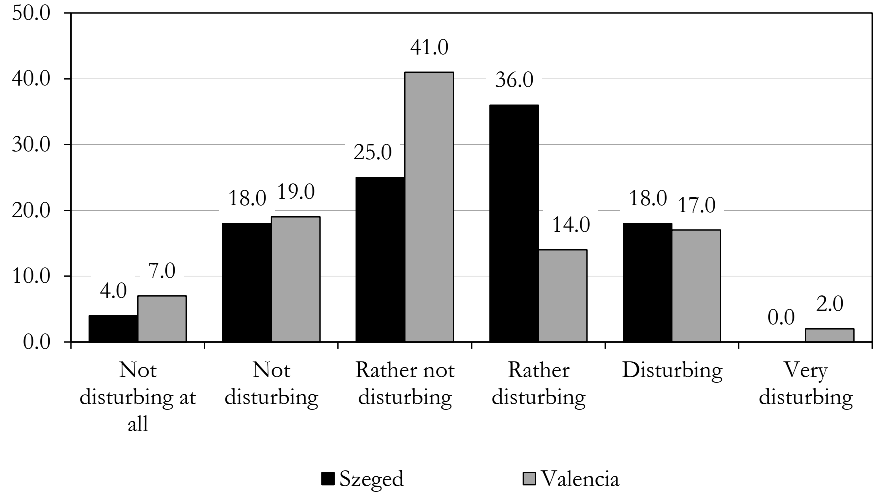
Source: Author.

Question 6 asked about the number of parked cars and the extent to which greenery disturbed visibility. The chart in Figure 5 shows that the Szeged and Valencia respondents assessed their situations differently. In Szeged, a slight majority (53%) assessed the disturbance of visibility as rather serious (combined *rather disturbing* and *disturbing*), whereas, in Valencia, 67% of the respondents chose the opposite options (*not disturbing at all, not disturbing,* and *rather not disturbing*).

Question 7 asked the respondents to assess the respect given to pedestrians by road traffic. There was no significant difference between the two cities regarding vehicles' respect for pedestrians. According to the respondents in both cities, the most important tourist attractions were approachable on foot. Almost no one scored this as *very bad* or *bad* (Figure 6), and the combined *good* and *very good* responses were 68% in Szeged and 64% in Valencia, which are outstandingly high. This could be because tourist attractions are likely to be in city centres and these city centres were relatively more walkable.

Figure 5

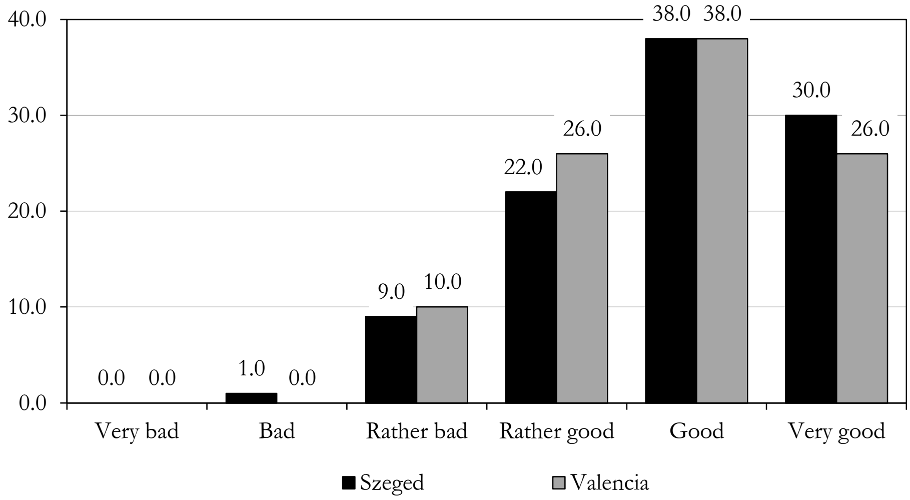
The extent of disturbance of visibility by parked cars and greenery in Szeged and Valencia (%)



Source: Author

Figure 6

Pedestrian access to the most important tourist attractions in Szeged and Valencia (%)



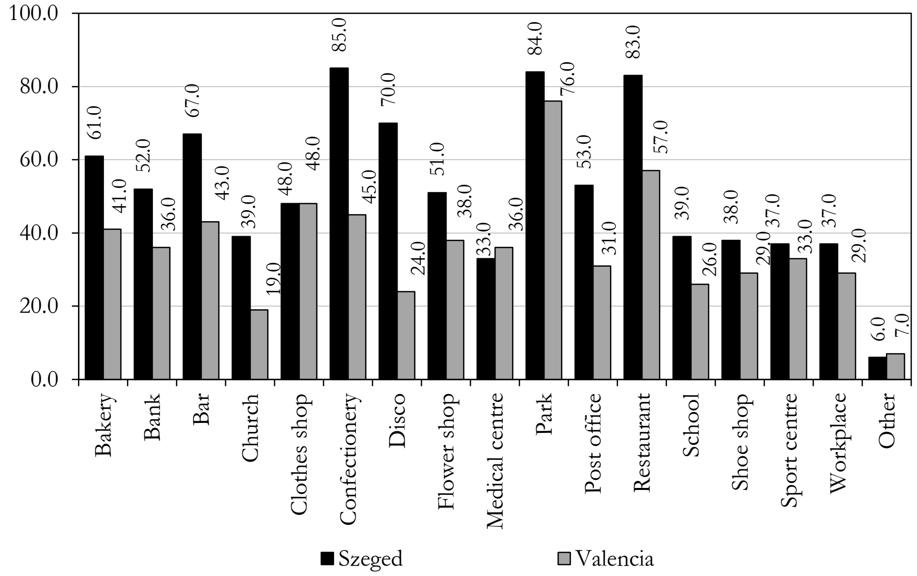
Source: Author.

The last question in this section concerned opinions of the usefulness of increasing the walkability in Szeged and Valencia. Overall, the respondents in both cities wanted walkability to be improved. Altogether, 91% from Szeged and 76% from

Valencia answered that it would be *rather useful, useful*, or *very useful* to do so. Figure 7 shows the extent to which people wanted some institutions in a walkable city centre. The respondents wanted parks and restaurants in Szeged and Valencia; they also wanted bakeries and dance clubs in Szeged (Figure 7).

Figure 7

Types of places desired for the walkable city centres in Szeged and Valencia (%)



Source: Author.

The Szeged and Valencia respondents reported that they would be more willing to walk if the conditions were better, according to the high rate of *yes* answers (70% in Szeged and 67% in Valencia). Their opinions on the numbers of pedestrian zones differed in the two cities. In Szeged, no respondents reported that there were too many, although the majority (55%) reported that the number was *sufficient*. In Valencia, 2% of the respondents reported that there were too many pedestrian zones, yet 53% of them considered the situation *insufficient*. Another difference between Szeged and Valencia concerned the average number of days on which the respondents walked for any reason. The Szeged respondents walked more than the Valencia respondents and there was more than three-fourths of a day difference between the two cities' averages: (5.09 days in Szeged versus 4.31 days in Valencia). Considering the amount of time taken for daily walks, the majority of the respondents in both cities (78% in Szeged and 72% in Valencia) walked zero–2 hours per day.

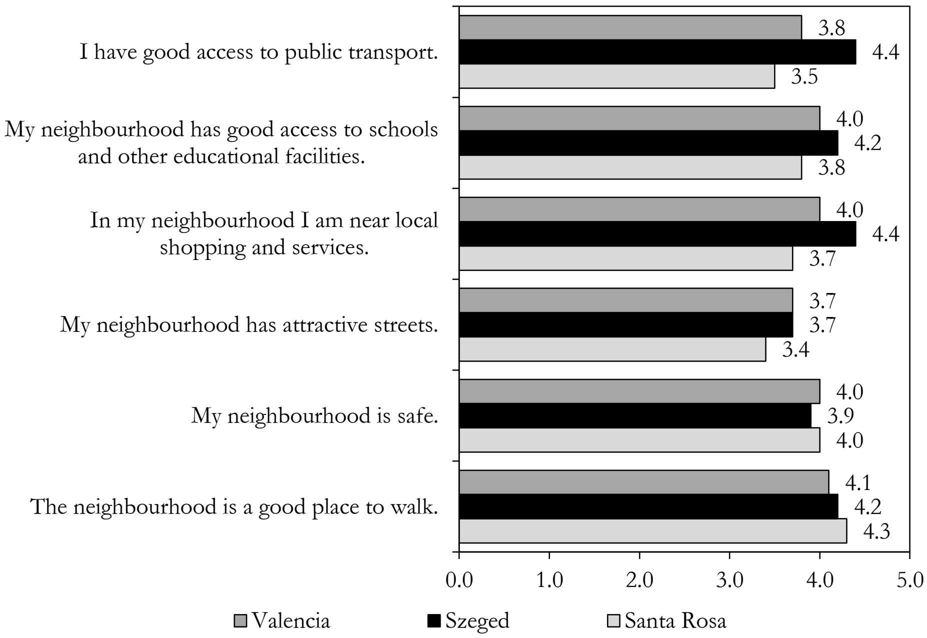
The last part of the questionnaire was about the respondents' characteristics with respect to gender, age, where they lived in the city, and whether their health was appropriate for walking. In Szeged, 65.5% of the respondents were women, and, in

Valencia, 69% were women. The respondents were in various age groups, but, in both cities, young adults aged 16–25 participated in the study more than people of other ages (49% in Szeged and 53% in Valencia). The respondents were from different parts of the cities. Regarding health, all of the respondents reported that his or her health was appropriate for walking.

To conclude, we argue that, overall, the levels of walkability in Szeged and Valencia could be improved and the citizens would appreciate those efforts. Based on the questionnaire data, the two cities had some problems in common regarding layout, but some problems were more evident in one or the other city. For example, in Szeged, everything was relatively more centralized and the major problems occurred in the neighbourhoods, whereas, in Valencia, that difference was not noticeable. Some aspects of development could focus on improving the lighting, the infrastructure for disabled people, increasing the number of trash cans, and establishing more parks, parking spaces, and other appealing features.

Figure 8

Walkability Scores for Szeged, Valencia, and Santa Rosa



Source: Author.

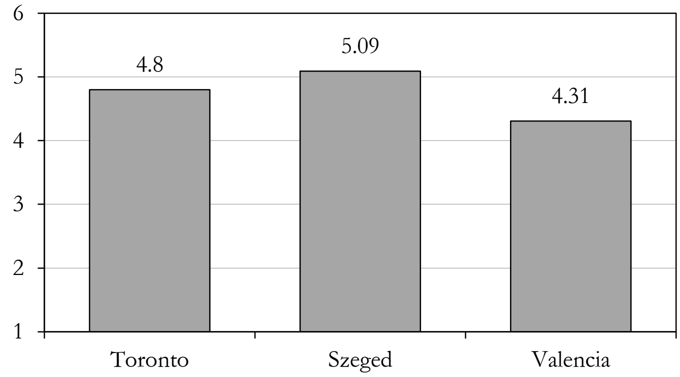
To ensure an international dimension to the study, we compared the results on the first question of our questionnaire to an international survey conducted by

Southworth among 59 residents of Santa Rosa[6]. The respondents were asked to assess their neighbourhoods from different standpoints. Southworth evaluated the answers as quantified data, so we transformed our results to a scale where 1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, and 5 = *strongly agree*. To compare the results, the means were calculated. We compared the answers on six statements (Figure 8). The data found that the ranking of the three cities on walkability was Szeged, then Valencia, and Santa Rosa was last.

We also put the average number of days that the respondents' walked for any reason into an international dimension by comparing Szeged and Valencia to the results of Frank et al. (2012), who studied 1,133 respondents in Toronto, Canada. The residents of Toronto walked a mean of 4.8 days for any reason, which was between Szeged (5.09 days) and Valencia (4.31 days) (Figure 9). The three cities were ranked from most to least average days walked for any reason as follows: Szeged, Toronto, and Valencia. Thus, we conclude that Szeged had better walkability than Santa Rosa and Toronto regarding the Walkability Scores and the average number of days walked for any reason, and Valencia was more walkable than Santa Rosa but less walkable than Toronto.

Figure 9

Mean number of days walked for any reason in Szeged, Valencia, and Toronto



Source: Author.

Results of the experts' interviews

The third level of our primary research was experts' interviews, with which we aimed to solve the limitations of the questionnaire. This was an important effort because the questionnaire used closed-ended questions with scaled response options

[6] We contacted Michael Southworth via e-mail to ask for his papers on walkability. He sent us a copy of his questionnaire used in Santa Rosa to assess liveability. Because the questionnaire seemed useful to our study, we asked him to send us the data related to it so that we could compare it to our results. Unfortunately, the final data were not electronically available, so we used a preliminary version.

that allowed for statistically objective comparisons, but they did not enable us to look into the reasons for the answers. Therefore, the two approaches synergistically complemented each other and they are correctly interpreted together. Below are the results of the experts' interviews conducted with two groups: city stakeholders and city policymakers. During the experts' interviews, we obtained useful information that coloured and complemented the results of the questionnaire as expected.

1. **Interviews with stakeholders**: As stated above, we compared the results of interviews with four stakeholders in both cities who were relatively more involved with walkability than their cities' average citizens. We conducted the interviews individually and the average length of an interview was 25 minutes.

   The first question was whether they had ever heard of walkability. Without exception, the interviewees answered 'no', so it is clear that 'walkability' is a term that had not reached the residents of these cities. The second question was about access to some important places on foot. All of the interviewees in both cities stated that they could easily walk to the majority of important places, such as schools, work, churches, banks, post offices, restaurants, and public transit stations. A Valencia respondent stated 'In Valencia, everything is within walking distance and you can go from one place to another on foot'. A respondent from Szeged stated that she could not get to the hospital/medical centre on foot and this problem surfaced in the questionnaire data as well. The third question was about the conditions of the walkways. More or less, the respondents of the two cities answered the same way, stating that more attention is paid to central areas regarding quality and cleanliness. A colleague from the county centre of Magyar Közút Nonprofit Zrt. stated 'The condition of walking paths is different depending on the neighbourhood. The problem is located in areas that have not been improved yet or the improvement was not qualitatively successful'. In Valencia, the cleanliness of the sidewalks is reportedly problematic, particularly during the summer season.

   We were curious about the amenities that attracted people to walking, such as benches, public lighting, public toilets, trees, and green space. In response to our inquiry, an issue that Szeged and Valencia had in common was lack of public toilets. From the perspective of the positive features of the cities, every Valencia interviewee emphasized the Río Turia, a river that previously ran across the city, but had been transformed after a big flood into a park. One interviewee claimed 'I do believe that Río Turia is highly attractive for people living here and also for tourists'.

   The Szeged interview data supported the questionnaire data on the lack of trash cans in the city. Another significant item that every interviewee considered a problem was the lack or poor condition of benches (caused by homeless people). According to the Valencia interviewees, the city is well lit, but the

Szeged interviewees complained about the lack of adequate lighting in the neighbourhoods. Regarding safety, overall, the interviews revealed no problems; however, there were some complaints. For example, some Valencia interviewees were unhappy about automobile access, even to narrow streets in the city centre where no one would expect them. The Szeged interviewees tended to report feeling unsafe because of inadequate lighting in the neighbourhoods. An area for improvement might be better separation of automobiles from cyclists. Generally, the Valencia interviewees stated that there were too many pedestrians crossing the street even if not all of the crossings were unreasonable. Furthermore, one interviewee stated 'If you follow all the rules, you need to wait a lot'. In Szeged, the interviewees generally reported that the street crossings were safe and crosswalks were well-marked, which could be the result of the city's strict requirements.

Next, the interviewees were asked about disturbing objects and activities on the walkways, such as obstructions, fire hydrants, columns, and so on. The Szeged interviewees pointed out that obstructions usually were the biggest inconveniences. Regarding disability infrastructure, Szeged and Valencia differed based on the answers of the interviewees. The Szeged interviewees claimed 'More attention is paid to this issue in the city centre, but I do not consider Szeged as a city that devotes particular attention to make the city friendlier for disabled people'. From their perspective, tactile paving exists, but it is in poor condition, and one interview stated 'The majority of tactile paving is in such bad condition that even sighted people cannot see them'. The conditions in Valencia were better, according to the interviewees' statements, such as 'Valencia is a very friendly city for disabled people'. Usually, tactile pavements also are in neighbourhoods, but there is a lack of sound signals.

After discussing walkability, and when the interviewees had gained some familiarity with the subject, we asked them for their opinions about the things that make a neighbourhood walkable. In sum, the Szeged and Valencia interviewees stated that benches and parks, cleanliness, and safety, particularly through adequate lighting, were important. The Szeged interviewees also highlighted the importance of clear distinctions between pedestrian and other traffic, a good layout, and a nice environment. Although the Valencia interviewees perceived a balance between the different participants in traffic, wide sidewalks and visibility were the most important factors to them.

We also asked them about the specific improvements they would make to their cities, and it was clear that the Szeged and Valencia interviewees would make different improvements. Szeged interviewees emphasized green space. A member of a civil organisation for protecting the environment mentioned 'Green wall and the green balcony, which is a programme of the European Union, when dwellers get free plants to increase greenery in the city'. They also would improve the public lighting in the neighbourhoods, increase the number of trash cans and benches, and improve the infrastructure to accommodate disabled people. In Valencia, the new government had already implemented some improvements, but based on these data, it seems that the citizens were not completely satisfied. One interviewee stated 'They decided something which could be advantageous and comfortable for the city, but, at the same time, there are many people, many businesses that are complaining about those decisions'.

The final questions were about their characteristics, such as age, medical status, the reasons that they walk, how often they walk, and how much they walk. The average age of the Szeged interviewees was 27 years old and the Valencia interviewees were 29 years old on average. All of the interviewees reported good health appropriate for walking. The main reasons that they walked were either because they enjoyed the outdoors or that they wanted to go to particular destinations. All four of the Valencia interviewees told us that they walked every day for some reason, but the same cannot be stated about the Szeged interviewees. However, despite the more frequent walking of the Valencia interviewees, they only walked an average 70 minutes per day, which was less than that of the Szeged interviewees, which was 110 minutes per day.

2. **Results of the policymakers' interviews**: This section compares the results of the two interviews we conducted with one member of the Szeged government and one member of the Valencia government. The purpose of these interviews was to gain a better understanding of what happens in these cities, what improvement we might expect, and which measures are needed. The interviews comprised 13 open-ended questions and lasted about 40 minutes each.

   Although 'walkability' was an unknown term in Szeged, the city had dealt with it without using that term. In Valencia, our interviewee was familiar with the term and stated that Valencia had dedicated attention to the issue. The Sustainable Urban Mobility Plan (SUMP) was mentioned by both interviewees and it was clear that it was part of both cities' mobility concepts. Sustainable mobility with the related transportation modes was highlighted as usually handled together and that walkability could not be separated from that. When asked about the reasons for implementing sustainable mobility, particularly walkability, the answers were different. The Szeged interviewee stated 'There is a complex reason. Partially there is a need to deal with it, partially there is a given situation, partially there are local issues, and, probably, the most important is that we have a truly committed deputy mayor'. The Valencia interviewee stated 'First of all, the Kyoto Protocol Plan and, besides, the SUMP guide from the European Union called Planning for People'.

Both interviewees mentioned that the European Union ensures resources. Because emphasis is on social legitimacy, the citizens of Szeged and Valencia are involved in the decision-making process. 'In the new Mobility Plan, there will be different work groups, even a civil group' was stated by the Szeged interviewee. However, 'In Valencia, there is a public participation process, called Open Mobility Table, where different sectors, different collectives can meet with politician at the regular meetings'.

The timing of the concept's implementation is different between the two cities because the Szeged government was developing the SUMP concept at the time of the interview and had just started the planning period a few weeks before the interview. However, the Transport Concept of 2007 (which is a strategic basic document of the city, a concept that contains the investment fields of the given timeframe) was future-oriented, and, therefore, there would not be a paradigm shift. Instead, socialization would mean a change, and some activities would overarch periods. On the other hand, Valencia was already realizing change. It was redesigning its public transit lines to connect the various parts of the city, even the outskirts, and there were measures for the city centre near the Central Market that aimed to close, or at least limit, automobile access to the centre and to change the directions of certain streets. During major changes, everything does not always smoothly happen, which was the case for Valencia. The main problem with the citizens occurred when traffic was directed away from the neighbourhood of the Central Market. Regarding problems during the realization period, the Szeged interviewee told us that the individuals responsible for the projects were project managers who needed to know everything about the complex projects, and other problems were the deadlines for filing applications, the calls for applications were not always direct, and there were many modifications of requirements during the application period.

From a budgetary perspective, developing walkability is a complex issue and the costs cannot be strictly defined. First, it is challenging to individually manage the various sustainable modes of transportation and the costs that can be measured are not the only costs. It is claimed that, in Valencia, the direct and indirect costs must be separated. About one year ago, there was a change to Valencia's management, and it currently does not have a large budget allocation for mobility. Consequently, low technology and inexpensive measures are employed, as elaborated in the previous paragraph.

The interviewees of Szeged and Valencia strongly agreed on recommending walkability for other cities, although, concerning the advantages and disadvantages of walkability, they highlighted different factors. The Szeged interviewee mentioned health as a physical advantage of walkability. Someone who works in an office is likely to need 20–30 minutes of physical exercise during the day, which walking could solve. The Valencia interviewee focused on the importance of the historical city centre, and stated 'The historical city centre was built centuries ago and not designed for heavy traffic; therefore, we have to redesign it to be able to maintain its beauty. People also would be able to enjoy the sightseeing attractions without cars that disturb them'. He also stated that children would be able to play in safer conditions if traffic were limited.

Synergy among the three methodologies

By comparing the results of the observations, questionnaires, interviews with stakeholders, and interviews with policymakers in Szeged and Valencia, we identified numerous similarities and differences in the participants' opinions. Without being comprehensive, this section presents some of the most outstanding items.

Table 1

Comparison of the walkability of Szeged and Valencia based on the observations

Variable	Questionnaire results on the more walkable city	Experts' interviews
Accessibility of shops and services	Insignificant difference between the cities	Insignificant difference between the cities
Accessibility of public transit	Szeged	Insignificant difference between the cities
Accessibility of hospital/medical centres	Valencia	Valencia
Crosswalks/pedestrian street crossing	Insignificant difference between the cities	Szeged
Infrastructure accommodations for disabled people	Insignificant difference between the cities	Valencia
Safety	Insignificant difference between the cities	Valencia
Attractiveness of street	Szeged	Valencia
Cleanliness	Insignificant difference between the cities	Insignificant difference between the cities

Source: Author.

The best comparisons were between the questionnaire data and the experts' interviews with stakeholders because of the similarity of the questions. In general, larger differences between the two cities were found based on the experts' interviews, probably because these interviewees could articulate their thoughts and be specific in the interviews. Overall, Szeged and Valencia needed improvements; however, considering some of the most important factors, the level of walkability apparently was better in Valencia than in Szeged. There were several ways that the two cities did not differ, but Valencia seemed to be better regarding access on foot to hospital/medical centres, disability infrastructure, safety, and attractiveness of streets (Table 1). Thus, our study found that walkability is an urban feature whose quantification is complex and difficult, and, therefore, it cannot be investigated with a single method. At least two, and, more than two if possible, synergistically complementary methodologies are needed. We suggest that walkability researchers employ several methods when quantifying walkability because doing so would provide the most complete picture of this complex topic.

Quantified walkability as the basis of tailor-made walkability development tools

This study, using the above-described methodology, provides an opportunity to develop tailor-made actions to increase the extent of walkability based on the results of the investigation. The measures described below could be part of an innovative city development toolbox for Szeged and Valencia.

Generally, considering the complex analysis of the situation, walking conditions could be improved by exploiting opportunities for land-use planning, zoning, subdivisions, site plan reviews, and street and highway designs. We propose that, when constructing an overall town layout, the focus should be on people, not automobiles, and walking should be promoted with a few changes, such as traffic speed control, safe walkway conditions, well-marked crosswalks, enjoyable and interconnected streets, and a sense of safety. To revitalize the current substandard walkable areas of a city, collaboration between the public and private sectors is essential. There are many ways to make neighbourhoods or cities more walkable, such as limiting automobile access, mixing transportation modes, improving parking access, improving transit service, protecting pedestrians, encouraging cycling, and shaping the spaces. These changes are not necessarily expensive. Cities usually prepare plans when they want to dedicate attention to improving walkability, and these plans are termed 'walkability plans'. Considering the general aspects described above, we recommend walkability plans for both cities, based on our analysis of the situation, using tailor-made tools.

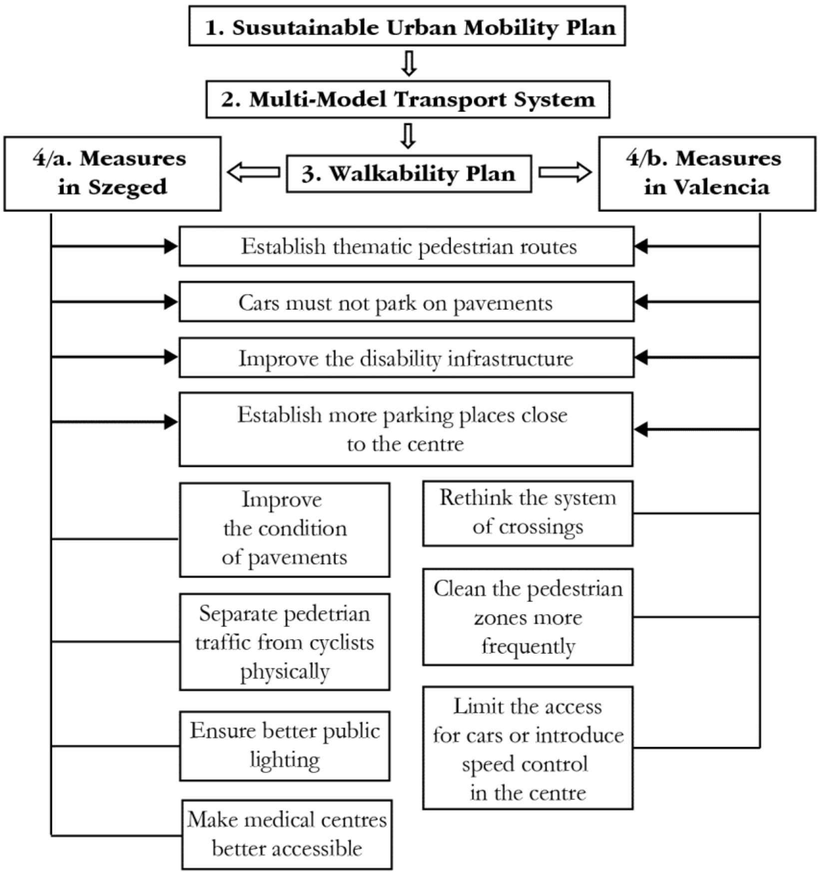
When we consider all factors together, we can offer many ideas for handling the situation, although, in our humble opinion, the best alternative would be that Szeged and Valencia stay on their current paths toward implementing Sustainable Urban Mobility Plans that highlight the importance of pedestrian traffic. We suggest that one possible solution to improve walkability could be establishing multi-modal transportation systems that strongly emphasize walkability. We support Lerner-Lam et al.'s (1992) idea that rethinking our approach to development and planning could be a key to creating walkable communities.

Thus, the first steps for both cities should be creation of multi-modal transportation systems in light of the requirements of the Sustainable Urban Mobility Plans

(Figure 10). Regarding walkability, we would personally advise Szeged's and Valencia's policymakers to have regular interaction with citizens. Regarding multi-modal transportation systems, we would recommend that Szeged and Valencia develop Walkability Plans. These Walkability Plans could include specific objectives aimed at overcoming their respective walkability shortcomings. Based on our empirical research and the investigation of general solutions to increase the extent of walkability, we created a list each for Szeged and Valencia detailing possible actions that they could take. Some of these actions are similar or the same for the two cities, but some of them are targeted to one or the other city. The most important aspect of these measures is their simplicity and cost-efficiency because they mostly concern organizational matters.

Figure 10

Possible scenarios in Szeged and in Valencia for improving the level of walkability



Source: Author.

We emphasize that these actions represent possible scenarios and are not the only effective solutions. However, the first four steps might be applicable to other cities eager to create a more liveable and walkable place for residents. After the fourth step, the measures are specific to Szeged or Valencia based on our empirical research findings. Similar steps could be identified for any city after a comprehensive study that reveals areas for improvement. Another significant aspect to consider is that these measures should not be implemented without thorough grounding and assessment of all their aspects and possible outcomes. Otherwise, a decision could lead to negative assessments of walkability.

Summary

This study sought to answer the question 'How is the concept of walkability understood in two mid-sized European cities, Szeged and Valencia'. To address this question, four main steps were taken, and the results are reported in this paper.

First, we studied the basic issue that this study aimed to tackle, which is the negative transportation-related effects of urbanization. Experts usually handle this situation with the help of electric transportation and public transit, and walkability is a less popular alternative solution, although it is relatively more innovative and has similar positive effects. We demonstrated the challenges to walking, the evident solutions to those challenges, the concept of 'walkability' and its benefits, and pointed out its positive effects on economies, health, and the natural environment. Second, three methods were presented to quantify walkability in communities through examples: Walk Score, Walkability Audit, and Transportation Walkability Index. Then, our empirical study was presented, for which we personally conducted fieldwork in Szeged and Valencia. The methodological structure had three levels: participant observation, survey, and personal interviews with experts (stakeholders and policymakers). These methods were essential because of the complexity and difficulty of quantifying walkability, and the three methodologies synergistically complemented each other.

In addition, Szeged and Valencia were examined in an international context for a better interpretation of the responses to two of the questions in the questionnaire. The international comparison suggested that Szeged and Valencia were relatively walkable cities. Compared to each other, some aspects favoured Szeged, and, from other aspects, Valencia seemed more walkable. However, based on the strategic dimensions of walkability, Valencia would be considered the more walkable city.

Some general solutions might help both of these cities to improve their neighbourhoods' walkability, such as land-use planning, street design, zoning, speed control, and protecting pedestrians. However, we also found that it is essential to provide specific recommendations to Szeged and Valencia, such as improving the conditions of pavements and ensuring adequate public lighting in Szeged, but cleaning the pedestrian areas more often and rethinking the crossing system in Valencia. Both cities should focus on creating multi-modal transportation systems that strongly emphasize walkability to ensure sustainable urban mobility. This action plan also would be feasible for other cities that want to improve their local economies and transportation systems with an innovative city development toolbox.

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Indicators for the economic dimension of sustainable agriculture in the European Union

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Over the past decade, the concept of sustainable development became inevitable on assessing economic, social, and environmental processes. Although the concept of sustainable agriculture also includes environmental and social aspects, the economic facet is still important for decision makers and researchers because of the increasing needs of the worldwide growing population. Moreover, the economic dimension of agriculture is also important because agriculture viability and compatibility are key determinants of its future. Consequently, we compiled an indicator system on the agricultural sustainability based on statistical data, which describes four dimensions of agriculture sustainability (food supply, environment, economy, and society). The indicator system consists of 44 indicators and can serve as a basis for developing composite indicators. Based on the indicator system and the composite indicators of the performance of EU countries, this study analyses economic dimension of EU agriculture (12 indicators). The results allow spatial comparisons and monitoring development over time. The performance of Hungary in terms of the economic dimension of sustainable agriculture is then analysed in comparison with its regional competitors.

Keywords:
sustainability,
agriculture,
composite indicators

Introduction

The concept of sustainable development was defined by the Brundtland report (Our Common Future), in 1987. Complementary to the Lisbon agenda, the EU adopted an equally ambitious Strategy for Sustainable Development (SDS) at the Gothenburg Summit, in 2001, which was to underpin all EU policies and actions. However, a number of unsustainable trends have worsened since 2001.

Agriculture is a special branch of the economy. Agricultural production is a nature-related activity, and has significant impact on the state of the environment, while also being an integral part of rural life. On one hand, it has remarkable influence on rural areas and, on the other hand, it is dependent on them in many aspects.

Agricultural production is multi-purpose as there are economic, environmental, and social roles of agriculture (OECD 2001, Boody et al. 2005, Rossing et al. 2007, Feher–Beke Lisanyi 2013, Królczyk et al. 2014, Huang et al. 2015). The main task of agriculture is food and fibre production, which describes both its productive or economic functions. Over the past decades, new tasks related to the economic function came to the fore, including controversial biofuel production (Fekete–Farkas et al. 2011, Popp et al. 2014). The profitability and viability of agricultural activities is vital. To achieve this, the production efficiency and competitiveness of the entire sector are essential.

Earth's growing population requires a large amount of surplus production of food. As such, the increase of utilized agricultural areas and/or of production efficiency are inevitable if consumption patterns remain unchanged. Therefore, the efficiency and economic dimension of agriculture sustainability are emphasised compared to the sustainability of other economic sectors. Although consumption is generally harmful to the environment (Kovács 2016), production and consumption of food are inevitable for life.

Indicator system of sustainable agriculture

A reliable indicator system describing sustainability becomes a pronounced requirement of decision-makers. Moreover, there is also an intensified expectation from the public to gain information on social and economic processes in terms of sustainability. Numerous organizations and scientific institutions have developed indicators and indicator systems that measure the performance of agriculture in terms of sustainability (e.g. MAFF 2000, INEA 2002, Valkó–Fekete–Farkas 2014). However, they are not fully adapted to Hungarian and European Union agriculture, most covering national context and not allowing spatial comparisons. These sets of indicators including numerous indicators do not provide a comprehensive picture. Consequently, there is a need for an indicator system that provides easily understandable information even on complicated, multi-dimensional issues such as sustainability. Besides, agriculture-related indicators are underrepresented in the indicator systems for sustainable development created by the United Nations and Eurostat.

There is a need for an indicator system that describes agricultural production of EU member states in terms of sustainability and is also capable of evaluating certain sustainability areas, thus presenting results, based on composite indicators, that are easy to communicate. This type of indicator system has not yet been developed for the EU. The indicator system presented in this study is based on statistical data and can serve as a basis for producing composite indicators describing sustainability domains. It can also compare the sustainability performance of individual countries and monitor development over time; however; it obscures regional differences within a country. The indicator system has been validated by Hungarian and international experts with expertise in the sustainability of agriculture by filling in questionnaire aiming at the determination of the weights used for the development of composite indicators.

The theoretical framework of the indicators of sustainable agriculture in this study was built on a definition of sustainable agriculture from synthesising literature sources. The sources for the creation of the definition include: EU 2012, Farkasné Fekete et al. 2004, Kirchmann–Thorvaldsson 2000, National Research Council 2010, OECD 2001, RISE 2016, SARE 1997, Smith–McDonald 1998, Takácsné György et al. 2008, USDA 1999, Valkó–Farkasné Fekete 2014, Van Cauwenbergh et al. 2007.

The four points of the synthesised definition identified the domains of the indicator system, which are as follows:

– production of good quality, safe, and healthy foods; satisfaction of needs–food supply;
– conservation of natural resources, protection of the environment, creation of animal welfare–environment;
– efficiency, competitiveness, economic viability, ensuring profitability–economy;
– improving the quality of life in rural areas, social justice, and development of attractive rural landscape–society.

Methodology of developing composite indicators for the sustainability of agriculture[1]

For the design and execution of the research, the 'Handbook on Constructing Composite Indicators', released by the OECD (2008), was used. According to the theoretical framework, 44 indicators were chosen and elaborated for the four domains. However, in this study, only the domain Economy is analysed, with its 12 indicators. Only the indicators for which data are available for EU member countries during 2000–2012 were selected. The data source for the Economy was the Eurostat database. Nearly 15 thousand data items were gathered for the entire indicator system, followed by data checking and editing, as well as the input of missing data. All phases of the process were carried out in a planned way, the most appropriate imputation method for the particular data type being used. Through the phas-

[1] The research that serves as a basis for this article was carried out during 2013–2015 by Gábor Valkó, and the results were compiled in his PhD dissertation (Valkó 2015).

es of indicators' selection and collection of basic data, the quality requirements developed by Eurostat and OECD were followed (Eurostat 2011, OECD 2012). The time series for 2000 to 2010 were used for analysis. An examination of the relationship between indicators using correlation matrices was carried out prior to finalizing the indicator system. The correlation matrices were compiled using the Pearson correlation test on the 2010 data, separately for the four domains and for the entire indicator set. The relationships between individual indicators can be explained. However, the number and strength of these relationships are not such that would reduce the reliability of the indicator system. Based on correlation analysis, the inclusion of each indicator in the system is reasonable (Table 2 includes the indicators for the domain Economy).

To develop composite indicators, the normalization of indicator system data was carried out using the min-max method, with the application of the following formula (OECD, 2008):

$$I_{qc}^{t} = \frac{x_{gc}^{t} - \min_{teT} \min_{c}\left(x_{q}^{t}\right)}{\max_{t\in T} \max_{c}\left(x_{q}^{t}\right) - \min_{t\in T} \min_{c}\left(x_{q}^{t}\right)},$$

where

x_{qc}^{t} = value of indicator *q* for country *c* and year *t*;

I_{qc}^{t} = normalized value of indicator *q* for country *c* and year *t*.

The weights required for the calculation of the composite indices were determined by expert opinion. In the literature (OECD 2008), this procedure is referred to as the budget allocation process (BAP). During this process, experts distribute 100 points for the indicators according to their importance, in terms of the target determined by the theoretical framework of the indicator system. Determination of weights is complex, and it is difficult to make an informed decision because of the too many circumstances to be considered and the limited information. For this reason, the experts who had difficulties in the distribution of 100 points were offered to determine the rank of indicators in terms of their contributions to the sustainability of agriculture. The opinion of the experts giving ranks was processed by converting the ranks to weights using the following formula:

$$w_i = \frac{r_{\max} - r_i + 1}{\sum_{i=1}^{n} r_i},$$

where

w_i = weight of indicator *I*;

r_i = rank of indicator *i*.

The aggregation of indicators was performed using linear aggregation by adding the normalized and weighted values of the indicators according to the formula (OECD, 2008):

$$KI_c = \sum_{q=1}^{Q} w_q I_{qc} \ ,$$

where

$\sum_q w_q = 1$ and $0 \leq w_q \leq 1$ for all $q = 1,...,Q$ and $c = 1,...,M$;

KI_c = value of composite indicator for country c;

w_q = weight of indicator q;

I_{qc} = value of indicator q for country c.

The weight system of the composite indicators was developed using the results of an expert survey. The survey research was carried out between 28 October 2014 and 6 January 2015. Questionnaires were sent to a total of 102 experts (including international experts), with expertise in sustainability of agriculture. Of these, 60 experts returned the questionnaire, representing a return rate of 59% (Table 1); 65% of the respondent experts held at least a PhD degree and the rest at least an MSc.

Table 1

Number of questionnaires sent out and received during the expert survey

Expert	Number of questionnaires sent	Number of questionnaires received	Return rate, %
Hungarian expert	60	41	68.3
International expert	25	12	48.0
Expert from an international organization (outside Hungary)	17	7	41.2
Total	102	60	58.8

Source: own research.

When compiling a composite indicator system, a number of subjective decisions have to be made, which may substantially influence the composite indicator values. Therefore, the robustness and reliability of the composite indicators were measured using sensitivity analyses for the following areas: compilation of indicator system, type of weighting system, and expert selection. The values of the key composite indicator for the sustainability of agriculture calculated with modified conditions were then compared with the results from the original method. Based on the results, only the selection of the type of weighting system influenced significantly the values of composite indicators.

Research results

Indicator system of sustainable agriculture

The established system of indicators for the economic dimension is shown in Table 2. Twelve indicators were chosen of the indicator system and were grouped in two sub-groups so that the importance of the indicators could be assessed more easily by the experts.

Table 2

Indicators of domain economy of the indicator system for sustainable agriculture and their weights

Theme	Indicator	Unit	Goal*	Weight
	Efficiency, competitiveness			
Resource use	Output per intermediate consumption in agriculture	-	+	19.3
Efficiency of land use	Gross value added per hectare of utilized agricultural area	EUR/ha	+	21.8
Labour productivity	Gross value added per labour input in agriculture	1000 EUR/ annual work unit	+	20.5
Competitiveness in foreign trade	Ratio of exports and imports of agricultural products	-	+	14.2
Yields	Yields of cereals	100 kg/ha	+	13.7
Utilization of agricultural land area	Share of unutilized agricultural area as a percentage of total agricultural area	%	-	10.6
	Economic viability, profitability			
Replacement of means of production	Gross fixed capital formation per consumption of fixed capital in the agriculture	EUR	+	15.3
Diversification of production	Standard output of farms with non-agricultural activities as percentage of total standard output	%	+	15.7
Research and development	Research and development in agriculture EUR 1,000 of gross value added	EUR	+	17.3
Age composition of farmers	Ratio between percentage of farmers below 35 and 65 or older in terms of standard output	-	+	13.5
Agricultural income	Agricultural income – indicator 'A'	2005 = 100	+	22.4
Subsidy dependency	Agricultural subsidies in percentage of gross value added	%	-	15.8

* '+' means a maximization goal, while '-' means a minimization goal.
Source: own research.

Indicator system of the economic dimension of sustainable agriculture

Within the sub domain 'Efficiency and competitiveness', the largest weights were assigned to the indicators of efficiency of land use, labour productivity, and resource use (Table 2). The utilization of agricultural land area was, however, considered the least important one by the experts. The standard deviation of the evaluation of each indicator for labour productivity was relatively high (10.8), while in the case of the indicators' 'yields' (5.6) and 'utilization of agricultural land' (5.7), it was rather low.

The index of agricultural income was assessed as the most important from the sub domain 'Economic viability and profitability' (Table 2). There was a relatively high evaluation of the indicator 'R&D', while the lowest average weight was assigned to the 'age composition of farmers'. The standard deviation of each indicator was relatively low, the highest being the 'diversification of production' (9.1), while the lowest was R&D (6.0).

The sub domain 'Economic viability and profitability' was considered slightly more important (52.2) than 'Efficiency and competitiveness' (47.8) by the experts. A high proportion of experts (37.9%) assigned the same importance to both areas. The indices of the sub-themes had a moderate standard deviation (13.0).

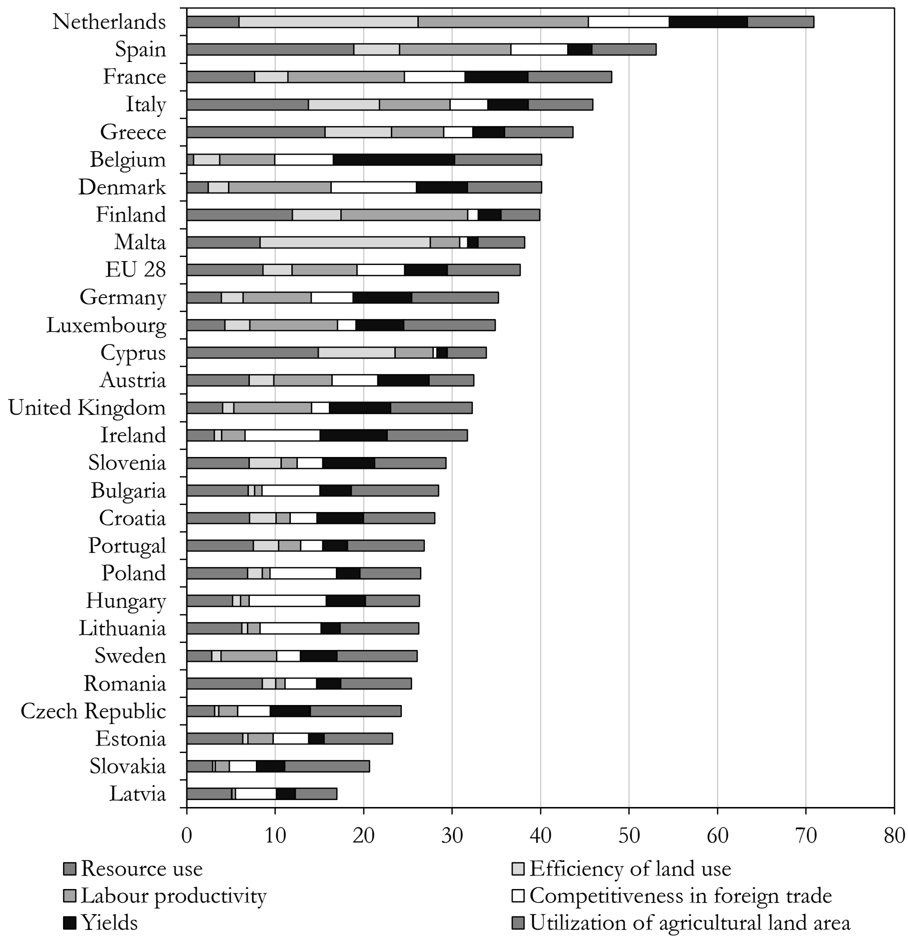
Values of the indices in the domain 'Economy'

The composite index for the sub domain 'Efficiency, competitiveness' within 'Economy' is extremely high in the Netherlands compared to other member countries in 2010 (Figure 1). The Netherlands is followed by Spain and France, while Latvia, Slovakia, and Estonia had the least efficient agriculture in the EU in 2010 on the basis of index values. Hungary's performance is similar to that of Poland and Lithuania, but behind the EU average regarding the level of efficiency and competitiveness on the basis of 2010 figures. The Netherlands reached the highest values for land use efficiency and labour productivity, and the second highest index for foreign trade competitiveness and yields. Latvia, as a counterpoint to the Netherlands, had the lowest values for land use and work efficiency indicators.

The EU as a whole registered a 12% increase in the efficiency and competitiveness of agriculture between 2000 and 2010 on the basis of the composite indicator. The highest growths were detected in Finland (175%), Cyprus (80%), Latvia (78%), and Poland (50%), while the largest decrease took place in Ireland (27%) and Hungary (7%).

Figure 1

Values of index components for 'Efficiency, competitiveness' in EU member states, 2010

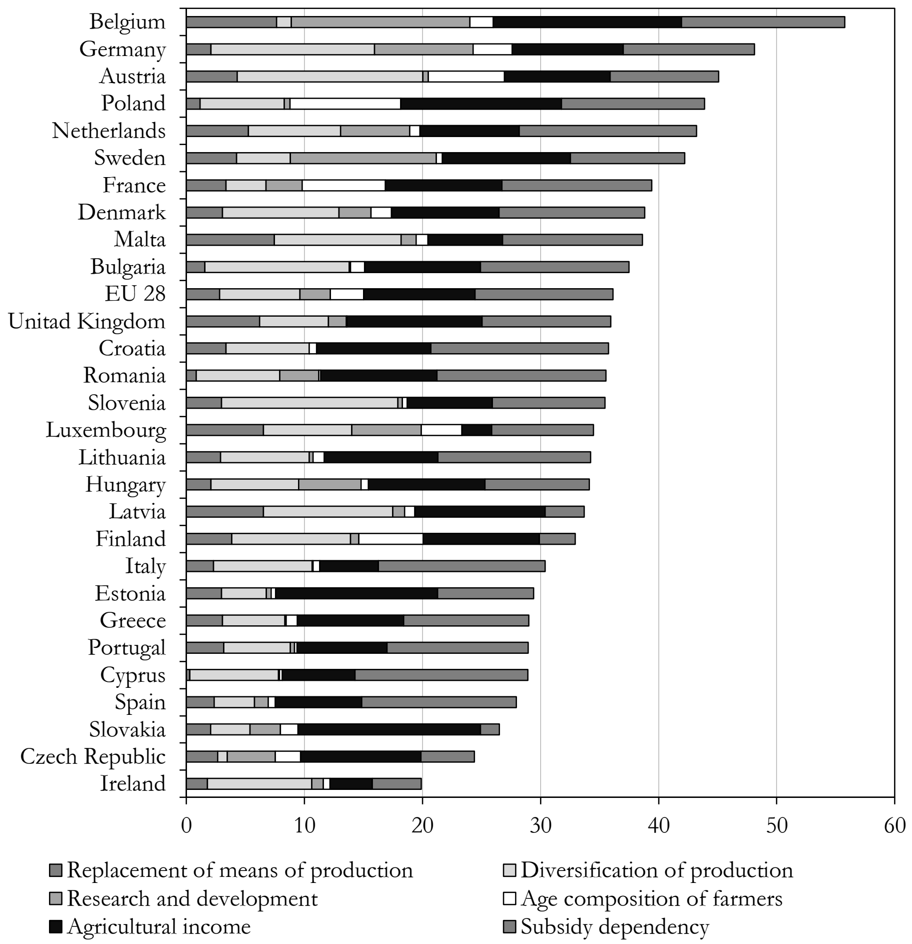


Source: own calculation based on Eurostat data (Eurostat 2014).

According to the indicators for 'Economic viability, profitability' for 2010, Belgium reached the highest values, followed by Germany and Austria, while the lowest values were found for Ireland, the Czech Republic, and Slovakia (Figure 2). Belgium had the highest score in the EU in the areas of research and development and level of farm income, while for the diversification of farming only the Czech Republic had a lower value. Ireland performed generally poorly, except for diversification.

Figure 2

Values of index components for 'Economic viability, profitability' in EU member states, 2010



Source: own calculation based on Eurostat data (Eurostat 2014).

The composite indicator for the sub domain 'Economic viability, profitability' increased most in Romania (46%), Poland (35%), and Belgium (33%) between 2000 and 2010, while decreases were registered in Ireland (42%), Italy (28%), and Bulgaria (24%). The growth in Hungary (10%) was above the EU average (4%).

The composite index of sustainable agriculture 'Economy' had the highest values in the Netherlands and Belgium in 2010, and the lowest in Ireland, the Czech Republic, and Slovakia (Figure 3). Poland is the only country of Central and Eastern Europe that had a higher indicator than the EU average. The composite index for –

'Economy' is shown in Figure 4. The two leading countries were the Netherlands, with the most efficient agricultural production in the EU, and Belgium, with the most viable and profitable agriculture in 2010.

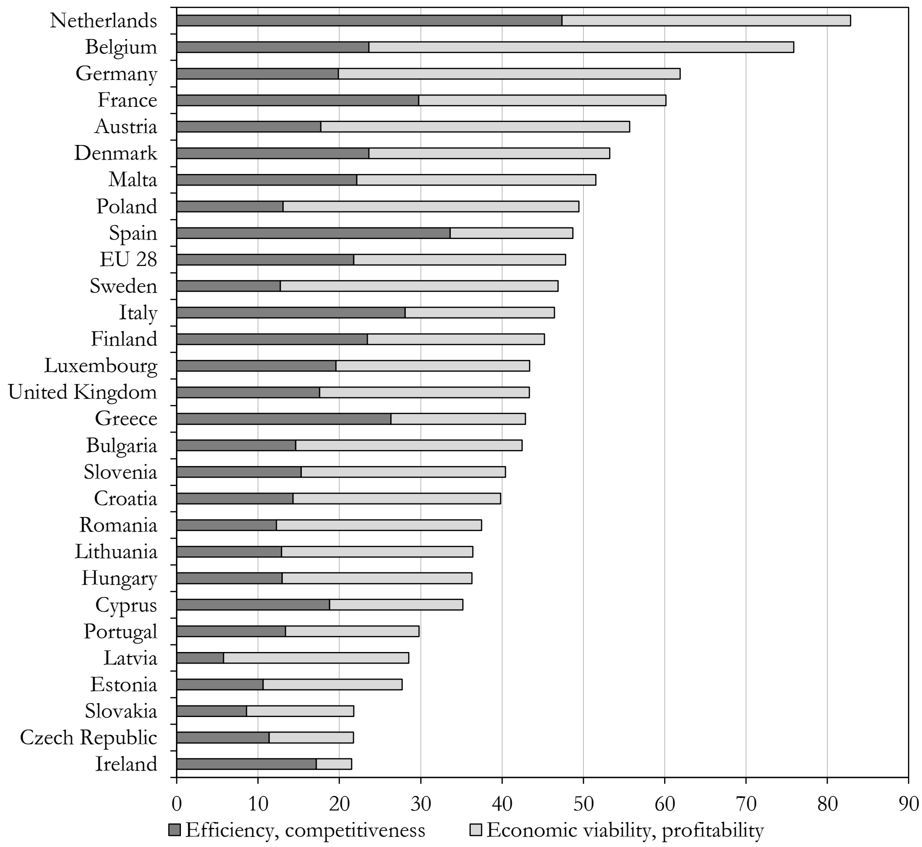
Figure 3

Values of the index for the Economic dimension in EU member states, 2010

Source: own calculation based on Eurostat data (Eurostat 2014).

Figure 4

Values of index components for 'Economy' in EU member states, 2010

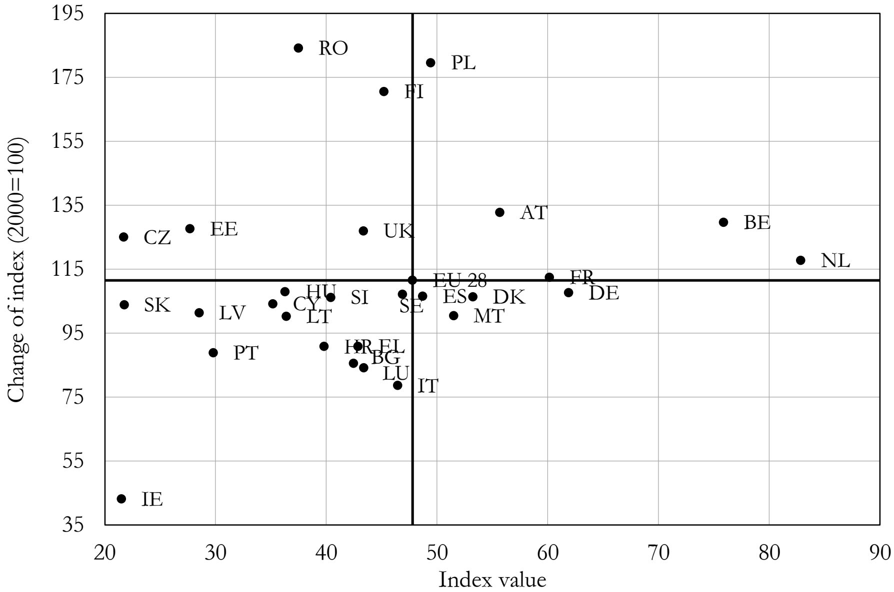


Source: own calculation based on Eurostat data (Eurostat 2014).

The composite index of the economic dimension achieved the highest growth in Romania (84%), Poland (80%), and Finland (71%), while it decreased most in Ireland (57%) and Italy (21%) from 2000 to 2010. The increase in Hungary was 8%, slightly below the average growth of the EU (11%). The 2010 values of the index and the relative changes in their values compared to 2000 are displayed in Figure 5.

Figure 5

Values of the index for 'Economy' and the rate of change compared to 2000 figures in EU member countries, 2010



Source: own calculation based on Eurostat data (Eurostat 2014).

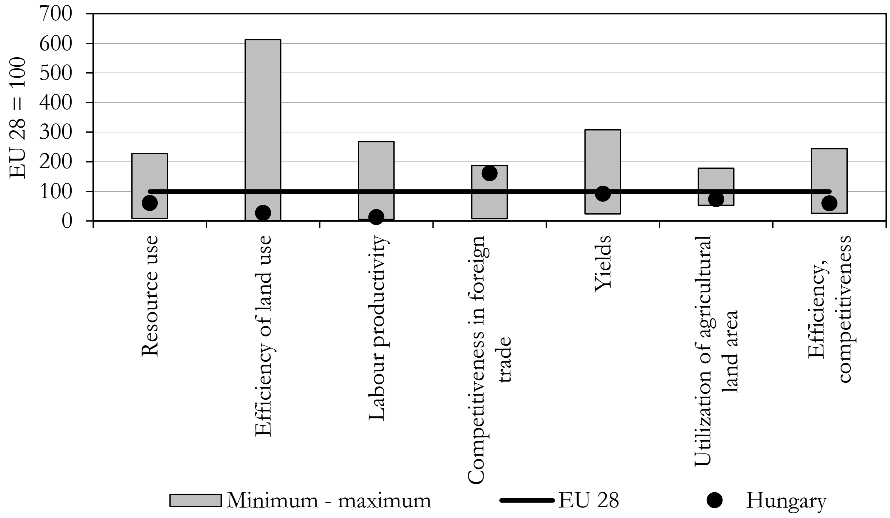
Values of the domain 'Economy' for Hungary

Within the domain 'Economy', the indicator measuring efficiency and competitiveness for Hungary was significantly below the EU average in 2010 (Figure 6). The largest backlog was observed in work productivity, efficiency of land use, and resource use, while foreign trade competitiveness performed above the EU average. The composite indicator value slightly declined in Hungary between 2000 and 2010, while the EU average showed an increase. The deterioration of its relative position is primarily a result of the negative trend experienced in the field of foreign trade competitiveness and farmland utilization, while in the area of resource use, relative improvement occurred compared to the EU average.

The Hungarian index for the sub domain 'Economic viability, ensuring profitability' was below the EU average (Figure 7) for 2010. Hungarian agriculture showed a significant shortfall compared to the EU average for the age composition of farmers, supply of production equipment, and aid dependency. The indicator for R&D was, however, above the EU average. The changes experienced in Hungary between 2000 and 2010 do not deviate significantly from the EU average of the individual indices in direction and degree. The composite index moved closer to the EU average, over the 11 years under analysis, but it was still below it in 2010.

Figure 6

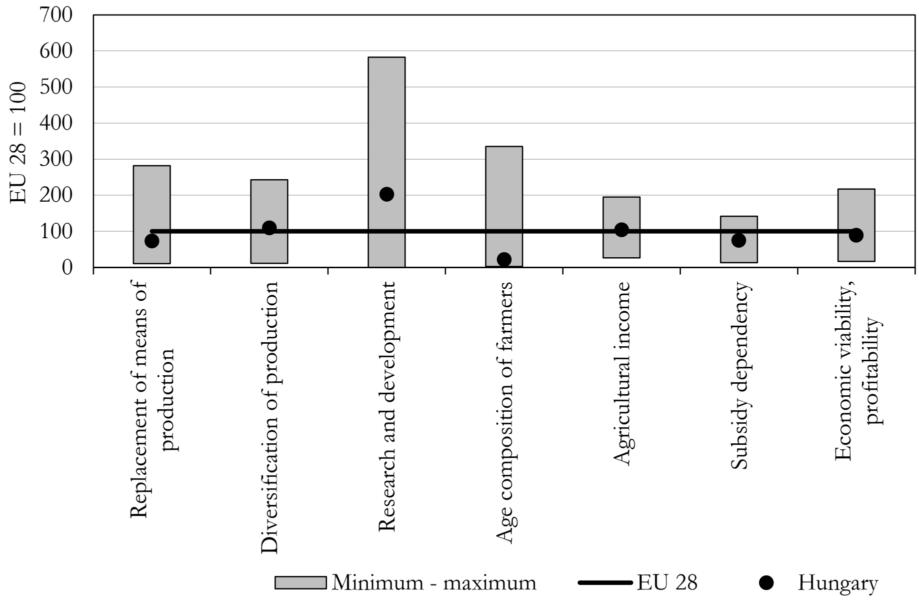
Values of indicators for 'Efficiency, competitiveness' in Hungary compared to the EU average, 2010



Source: own calculation based on Eurostat data (Eurostat 2014).

Figure 7

Values of indicators for 'Economic viability, profitability' in Hungary compared to the EU average, 2010

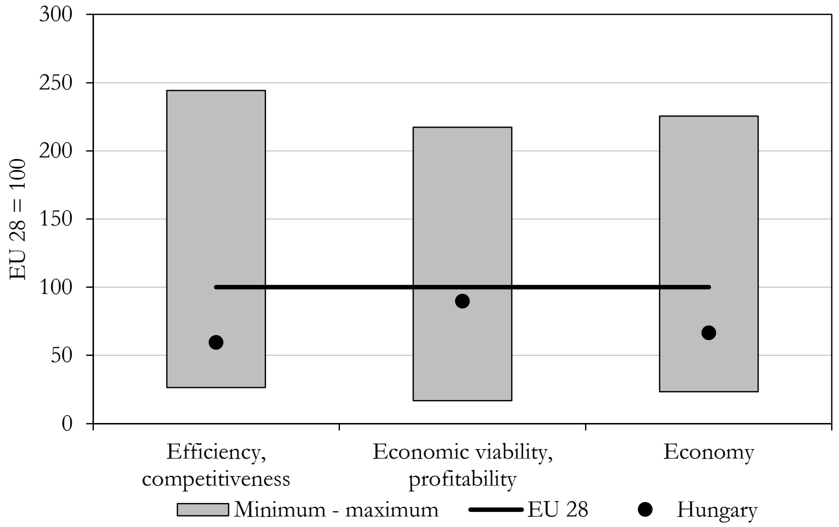


Source: own calculation based on Eurostat data (Eurostat 2014).

Hungary fell behind the EU average in terms of the economic dimension of sustainable agriculture according to 2010 figures, a lag rather resulting from the difference in 'Efficiency and competitiveness' than 'Economic viability and profitability' (Figure 8). The position of Hungarian agriculture relative to the EU average showed a slight deterioration in 'Efficiency and competitiveness' between 2000 and 2010, while there was a slight improvement in terms of viability and profitability.

Figure 8

Values of indices for 'Economy' in Hungary compared to the EU average, 2010

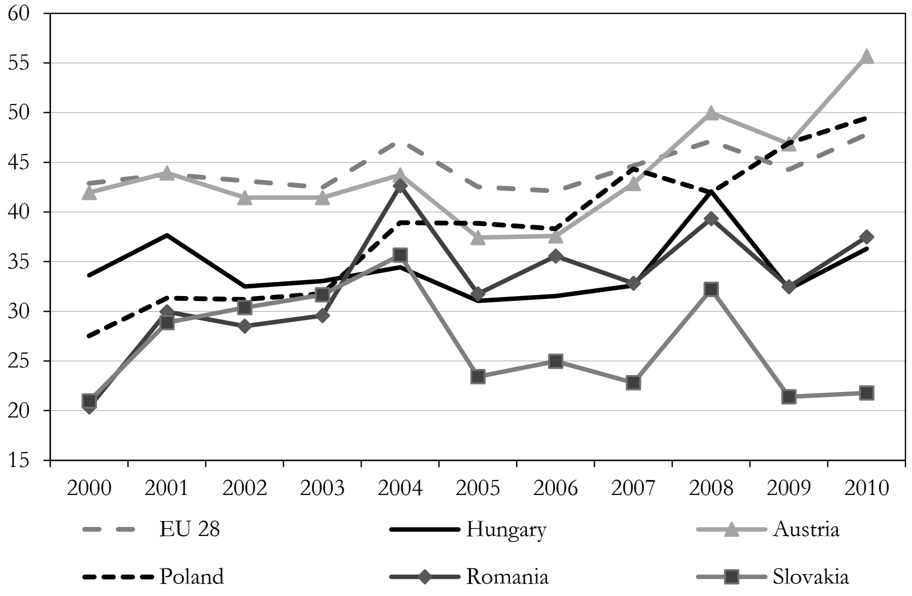


Source: own calculation based on Eurostat data (Eurostat 2014).

Comparisons with regional competitors are shown in Figures 9 and 10. The composite index of 'Economy' grew most for Romanian and Polish agriculture between 2000 and 2010 among the studied countries. The Polish agriculture reached a higher index value in 2010 than the one in Hungary, and caught up with Austria. It is worthwhile noting that the Romanian and Hungarian indices moved mostly together recently. The most significant growth was detected in Romania and Poland between 2000 and 2010, while data for other countries have not changed significantly, apart from the Slovakian index, which experienced growth between 2001 and 2008.

Figure 9

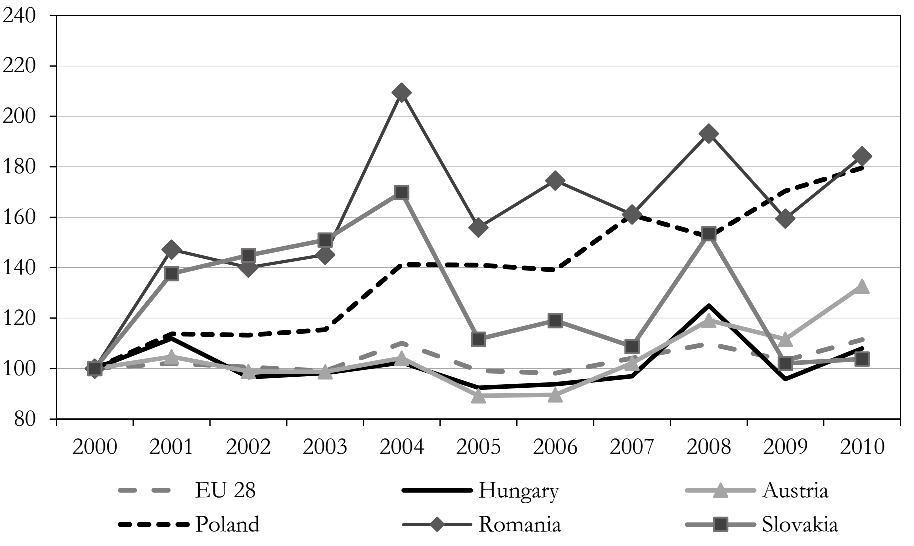
Indices of 'Economy' for Hungary and the regional competitors, 2000–2010



Source: own calculation based on Eurostat data (Eurostat 2014).

Figure 10

Changes of the indices for 'Economy' for Hungary and regional competitors, 2000–2010 (2000 = 100)



Source: own calculation based on Eurostat data (Eurostat 2014).

Discussion – Study limitations

The quality of the composite indices is influenced by the theoretical coverage of specific areas by relevant indicators supported by adequate quality basic data. For this reason, it is essential to improve the accessibility and quality of basic data for the scientifically sound examination of sustainable agriculture. An additional problem in many areas is long data production time, which also needs improvement. Creating indicators at a lower territorial level is currently not possible in many areas because raw data are not available, a deficiency that could be eliminated by applying proper data collection methodologies or estimation procedures that could enable the dissemination of data at a lower territorial level.

The most important difficulty related to composite indicators is the lack of their widespread acceptance. Their values can be significantly affected by the theoretical framework, scope in the indicator system, and methodology of the weight system essential for their calculation. In many cases, subjective decisions are needed for the development of an indicator system. However, the communication value and role of composite indicators in decision support are indisputable. It is necessary for a composite index that its methodology has appropriate political support, is laid for broad consensus, and is widely accepted.

The system of indicators and the related composite indicators in this research can support European and national agricultural policy decisions, as well as shape the Common Agricultural Policy and its components. They have a good communicating power, since the composites are easy to interpret for the general public. A distinct advantage of the indicator system is that it is suitable for the systemic tracking of changes in agricultural production, both at national and EU levels.

Conclusion

Based on a literature review, we compiled the definition of sustainability of agriculture, which served as a basis for the development of an indicator system for agriculture sustainability, based on macro data. The data for the indicators have been compiled for the EU member countries for 2000–2012. Based on the indicator system, composite indicators were then developed for the domains of sustainable agriculture. In this study, the domain 'Economy' is analysed using such composite indicators. Spatial and temporal comparisons make it possible to overview the processes in terms of the economic dimension of sustainable agriculture in EU member countries. According to the results, the composite index for 'Economy' had the highest values in the Netherlands and Belgium, while the lowest in Ireland, the Czech Republic, and Slovakia in 2010. The index value increased in the EU by 11% from 2000 to 2010. Romania, Poland, and Finland had the highest growth rate, while Ireland and Italy had the largest decrease in the EU. Hungary registered a growth rate (8%) below the EU average.

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Regional health inequalities in the European macroregion from the East Central European perspective

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This study analyses the regional health inequalities in the European macroregion, with particular emphasis on the mortality trends in East Central Europe. On one hand, our research aims focus on the territorial fragmentation of the examined area, the identification of main breaklines, and examination of mortality factors affecting differentiation. On the other hand, we identify the socio-economic differentiation behind regional disparities in health status.

According to our results, beyond the traditional east-west division of the European macroregion, additional "micro-cracks" can be detected through the different variables describing health status. Previously, the East Central European region was somewhat unanimously disadvantaged, but now it is far from being homogeneous. The main drivers of regional divide are still non-communicable chronic diseases, with the main priority attached to cardiovascular one. Our results suggest that, besides the mortality slope, a parallel economic performance gradient can also be observed.

Keywords:
regional health inequalities,
East Central Europe,
mortality crisis

Introduction

Nations on the eastern and western sides of the Iron Curtain – created after World War II and viewed as the political metaphor of a divided Europe – established their own socio-economic systems. The line dividing the two blocks also led to the emergence of an epidemiological (Boncz–Sebestyén 2006) (or healthcare) iron curtain (EC 2008). The spatial patterns of health status still show this persistent division between East and West (Mackenbach et al. 2013). The eastern side is characterized by a specific phenomenon (i.e. the so-called health paradox). This paradox means a strikingly high rate of premature mortality in societies under transition, this region showing a considerably worse general health status than justified on the basis of economic indicators (Cornia–Paniccia 2000, Kopp–Skrabski 2001, Kopp–Réthelyi 2004).

The features and characteristics of the health paradox can be summarized as follows. This phenomenon emerged during peacetime, over a period with no known cases of global/regional infection, famine, or any natural disaster (Ruminska–Zimny 1997, Cornia–Paniccia 2000). While life expectancy at birth had been similar in the two blocks until the 1960s, the socialist block had been struggling with stagnation and involution from 1965 (Cornia–Paniccia 2000). Different mortality trends can be seen even within the socialist block. Prior to more recent socio-economic changes, Hungary was among the countries with the worst mortality status and trends, although Russia, the Ukraine, and the Baltic states were facing a deeper crisis (Kopp–Skrabski 2007). The mortality crisis mostly affected the economically active age groups, particularly men, and not the typically vulnerable groups (children or elderly people). Men were especially vulnerable to and primarily affected by excess mortality (Meslé 2001, Meslé 2004, Weidner–Cain 2003, Grigoriev et al. 2014). On the eastern side of the iron curtain, the second half of the past century saw a widening gap between life expectancy of men and women (Daróczi 2004), which continues to remain rather wide even today (Bálint 2010, Vitrai 2011).

As far as the causes of death are concerned, there are clear differences behind Europe's east-west division. The increased occurrence of cardiovascular disease in eastern countries and the beneficial impacts of the cardiovascular revolution (prevention plus innovative technologies and interventions) in western countries produced significant differences in Europe (Daróczi 2004). Additionally, the socialist region is substantially affected by mortality attributable to neoplasms (Daróczi 2004, Meslé 2004), digestive diseases, and "man-made"[1] causes of death (Caselli et al. 2002, Ruminska–Zimny 1997, Meslé 2002, Grigoriev et al. 2014). However, the causes of excess mortality are different within the Eastern bloc: for example, at the time of the epidemiological crisis, circulatory diseases (in Poland and Bulgaria) and neoplasms and digestive diseases (in Hungary and Romania) contributed to a significant decrease in life expectancy at birth (Meslé 2004).

As summarized by Daróczi (2013) and Simonyi (2015), excess mortality may be linked to the forced processes typical of the socialist era (economic restructuring, social and political changes, emergence of informal economy, self-destructive lifestyle) and to the burden of adaptation. It should be noted that stress (as the invisible hand), as well as psychiatric and behavioural factors also play a major role in the high premature mortality rates (Kristenson et al. 1998, Cornia–Paniccia 2000, Kopp–Skrabski 2001, Kopp–Réthelyi 2004). With reference to Preston (1975) and Vagero (2010), Leon (2011) notes that the Iron Curtain also impeded the diffusion of knowledge and understanding on the prevention and treatment of non-communicable chronic diseases. In his opinion, the health status backwardness of Eastern Europe is attributable to the lack of necessary skills and strategies to deal with such diseases.

The process of socio-economic transition/transformation was also coupled with an adaptation crisis in East Central Europe and the Commonwealth of Independent

[1] Today it mostly refers to external death causes (e.g. murder, suicide, road accidents). Formerly, the alcohol-related diseases also belonged to this category (mostly in the USSR) (Daróczi 2004).

States. Socio-economic changes generated a significant level of excess mortality in the region. Factors such as the abrupt and ill-managed labour market changes (job uncertainty, reduced wages, unemployment, and underemployment), impoverishment, rising inequalities, erosion of public institutions (legal order, education, healthcare) also contributed to the level of psychosocial stress (Ruminska–Zimny 1997, UNDP 1996, Kopp et al. 2007, Kopp–Skrabsi 2009, Cornia 2016). The rapid changes of socio-economic transition disturbed the 'social compass' of individuals (Csepeli et al. 2004, p. 7). There was also an increase in divorces, acts of violence (crime, murder, suicide), and migration. In each of the affected countries, mortality characteristics (gender aspect, causes of death, age group) were the same as those in the pre-transition period and were supplemented with new phenomena, such as sexually transmitted diseases and Human Immunodeficiency Virus (Ruminska–Zimny 1997). Male life expectancy at birth decreased by five years during 1989–1994 in the Russian Federation, while, in Hungary, it exceeded the 1989 level in 1996 for the first time (KSH STADAT 2016).

Caselli et al. (2002) called for a systematic approach to mortality (i.e. the theory of epidemiologic transition) (Omran 1971, Olshansky–Ault 1986) to explain the mortality crisis of the Eastern bloc, but clearly referred to this phenomenon as an exception. The region managed to surpass the era of epidemics but remained hopelessly fixed in the age of degenerative and man-made diseases.[2]

According to Mackenbach et al. (2013) (based on the thoughts of Rudolf Virchow)[3], the – still present – division between East and West is attributable to the failure of various broadly defined (e.g. smoking, alcohol consumption, public road safety) health policies or healthcare systems. According to the current explanation issued by WHO (2013), health disparities between countries in the eastern and western parts of Europe are associated with two main groups of factors. These are, on one hand, differences in exposure to preventable health hazards that result from inequities in the social determinants of health, and behaviour and lifestyles (e.g. unhealthy diets, high blood pressure, dangerous or stressful working conditions, and air pollution) and, on the other hand, differences in the accessibility and quality of healthcare services.

Regarding the macro level health inequalities of the European region, the effect of path dependency is significant, which means that "decisions taken in the past largely determine the set of decisions that can be taken in the present and in the future" (Lengyel–Bajmócy 2013, p. 13). According to Simonyi (2015), the majority of social and health problems affecting East Central Europe today can be considered a heritage of the socialist era. After the regime change, the process of path creation (Simonyi 2015) already started, even if only marginally, through directly or indirectly health-related policies devised as political responses to social challenges.

[2] These studies concern the period 1965–1995.

[3] 'Medicine is a social science, and politics is nothing more than medicine on a grand scale.' (Virchow 1848)

By using the strong presence of spatial dependency for supplementing adverse qualitative and quantitative changes in health status, Bálint (2010) assigned a spatial dimension to path dependency.

Research questions and ideas

The general objective of this study is to analyse the regional health inequalities of the European macroregion, with special regard to the processes and characteristics of East Central Europe. The following study questions and assumptions were proposed.

Is there an epidemiological iron curtain or east-west division in today's regional Europe?

Health status shows macroregional disparities between countries in the two blocks. Certain indicators (life expectancy at birth, infant mortality rate, age-standardized mortality rate etc.) provide clear visual evidence for the duality in Europe (Boncz–Sebestyén 2006, Richardson et al. 2013, Marmot 2013, Jaworska 2014, Maynou et al. 2015). Additionally, the regional east-west division might be observed within affected countries (Kibele 2012, Marmot 2013). Nevertheless – given that regional mortality inequalities result from a combination of numerous factors – it is important to examine whether this type of differentiation also exists along with more study dimensions at regional level in Europe.

Are there further breaklines in the examined European area? Do they appear at regional or national levels?

Former studies have mostly highlighted the various differences between East and West, or examined health status disparities according to groups of countries linked by geographical, historical, political, and cultural similarities (Meslé 2001, Meslé 2004, Daróczi 2004, Avdeev et al. 2011, Sírová 2011, Mackenbach et al. 2013, WHO 2013). Factors affecting health and health inequalities display an uneven spatial distribution (CSDH 2008), and individual spatial levels show different competences. Generally, the organisation of healthcare falls into national competence, although a regional approach is applied in large countries (e.g. United Kingdom, Spain) (Mackenbach et al 2013). Furthermore, in EU member states, regional development policies are run on a community basis, while agriculture is managed under a common policy. However, the subnational level has increasing autonomy in relation to social and economic decisions, many of which relate to the social determinants of health and health inequalities (WHO 2013). As a result of these impacts, the health dimensions described in this study are characterized by a versatile spatial structure.

What are the main health characteristics that determine spatial disparities?

The typical characteristics, diseases, and groups of diseases (non-communicable chronic diseases including particularly cardiovascular diseases) of the east-west divide have already been clearly identified (Bobak–Marmot 1996, Meslé 2002, Meslé 2004, WHO 2013). Based on the cause of death approach, this paper uses mathematical/statistical methods to identify health variable(s) that enjoy(s) priority in the regional diversity of mortality. According to our hypotheses, non-communicable chronic diseases are typical determinants of the spatial structure of mortality in European regions, similarly to the disparities seen at national level.

What is the extent of socio-economic differences behind the regional breaklines of health status?

Numerous theories and models explain the socio-economic inequalities of health status (Preston 1975, DHHS 1980, Acheson 1998, Wilkinson-Marmot 2003, CSDH 2008, Mackenbach 2012, WHO 2013). Based on our literature review of regional health inequalities at the European level, few studies discuss the socio-economic inequalities of health status affecting the entire or parts of the region (e.g. the European Union) (Richardson et al 2013, Marmot 2013, Stańczyk 2015, Maynou et al. 2015). We carried out a regional analysis of the socio-economic inequalities of health status by using the main indicators of the above studies and relevant territorial policies (regional policy, Europe 2020 strategy). As a result, we assume these indicators will influence the regional division of health status, allowing us to demonstrate the main trends and relationships in the field of inequalities.

Research methodology issues

We examine regional inequalities in four steps. Accordingly, we describe our research logic, main considerations, and work methodology (territorial level, database) below.

1. Operationalization of indicators expressing/causing territorial division. Several criteria must be met to express mortality inequalities. We must use the cause of death approach, as the role of certain diseases (e.g. cardiovascular diseases malignant neoplasms, external causes) is clear in deteriorated health status and reduced life expectancy. Given that a mortality crisis affects the economically active population, we use premature mortality indicators. According to literature, men are the weaker sex in terms of mortality and male mortality must be handled as a priority category during. Health-impairing behaviour is also included among the relevant causes of death through operationalization. Although females are less affected by a mortality crisis, this dimension is also studied.

2. Creating and uploading the required database with relevant information in sufficient quantity. Prior to creating the database, we performed an literature and research reports review to ensure the use of proper and relevant information (Meslé 2002, Daróczi 2004, Meslé–Vallin 2002, Leon 2011, Sírová 2011, Marmot 2013, WHO 2013).

3. We use three approaches for *examining the territorial inequalities of health status*. For technical (statistical) considerations, it is desirable to have an overall picture of each variable of territorial mortality – this way we obtain a preliminary report on regional health inequalities. Consequently, besides descriptive statistics, we applied Pearson and Spearman correlation and univariate global autocorrelation tests. Given that the various empirical sources compare groups of European countries (or individual countries representing such groups) (e.g. Meslé–Vallin 2002, Nolte et al. 2004, Leon 2011), we first describe the progress of regional health inequalities within and between country groups along pre-defined macroblocks. Second, the regions make up the elementary territorial level of the European fragmentation test, where regions with similar health status (NUTS2) are classified into homogeneous groups. Regarding methodology, we use the general linear model (Sajtos–Mitev 2007) for macroregions and – due to the numerous advantages (applicability, interpretation) – two-step cluster analysis for grouping mesoregions (Sajtos-Mitev 2007). These steps answer the first and second research questions. The created clusters are then placed on a map. While doing that and addressing the third research question, we identify the health characteristics that determine territorial disparities in the European macroregion.

4. Finally, the *regional disparities of health status are compared with socio-economic inequalities.* During assessment, we describe the 'rough' socio-economic breaklines behind the mortality differences identified in our study. This answers the fourth research question/hypothesis by using discriminant and regression analysis.

Delineation

The delineation we use does not correspond to the Europe or European region defined by the WHO or that based on evident geographical or cultural considerations. Actually, our description of territorial inequalities for mortality applies to a smaller area – the European Union (28 member states) plus Norway. Therefore, any reference to the European macroregion (or Europe) in our findings refers to this area and not the larger areas mentioned in the above literature sources, that is, including the European CIS, Balkan, Mediterranean, and Caucasian countries. The reason is that a scientifically correct and reliable, as well as diverse, set of indicators is available only for this smaller area. Although in the European Union healthcare is not treated as common or community policy, the need for a supranational level for health policies and for the control of health inequalities is present – which may affect even the European Economic Area – such as policy documents, strategies, and scientific papers (EC 2007, EC 2009, WHO 2013, Richardson et al. 2013). Thus, the analysis of the macroregion can be considered relevant from a technical viewpoint and may contribute to the foundation of a community development.

NUTS2 regions are the area units for both country groups and regional analyses. The classification is based on the NUTS2013 amendment, which entered into force in 2015. The analysis excludes the overseas departments of France, autonomous regions of Portugal (Azores and Madeira), autonomous cities of Spain (Ceuta, Melilla), and the Canary Islands.

Database

When compiling the database, we tried to meet the criteria of the abovementioned research methodology. Therefore, we selected the following indicators for the study of regional health inequalities, reflecting East Central European mortality progress but also representing the issue at European level.

a) age-standardized mortality rates for 100,000 persons, males, and the 0–64 age group: diseases of the circulatory system (I00-I99), neoplasms (C00-D48), external causes of morbidity and mortality (V01-Y89), diseases of the digestive system (K00-K93);
b) infant mortality rates;
c) gender differences in life expectancy at birth.

Weighting for the age-standardized indicators is provided by the age distribution of the European standard population (Eurostat 2013). Standardization was carried out by Eurostat. The causes of death indicators were uploaded on the basis of the International Classification of Diseases (ICD) codes (10th revision) (see the ICD codes between parentheses). Due to lack of stability, the database currently offers availability only for one year (2013) – low frequency causes of death were ignored and main cause of death groups were not delineated.

The regional socio-economic inequalities of health status were examined using indicators for economic performance, labour market position, and backwardness. Economic value creation (income position, productivity) is characterized with the use of gross domestic product (GDP) per capita (EUR or purchasing power parities (PPP)), household income per capita, and productivity rate (gross regional product per workforce). Labour market involvement is shown via employment and economic activity rates (20–64 age group), unemployment rate (above 15 age group), and not by education, employment, or training (18–24 age group). The operationalized regional indicator of poverty and social exclusion is used for backwardness.

The data were obtained from the online database of Eurostat and ESPON (European Spatial Planning Observation Network) for 2012–2014. SPSS for Windows 20.0 and Geoda 1.6.7 software were used for analysis, while the figures were prepared with ArcMap 10.1.

Results

First, we describe the inequality characteristics of the first six health status indicators by the use of position and shape values, deviation and other values, and global autocorrelation tests (Table 1).

Table 1

The main indicators of health inequalities in the European macroregion

	Diseases of the circulatory system	Neoplasms	External causes of morbidity and mortality	Diseases of the digestive system	Difference in life expectancy	Infant mortality
Minimum	27.65	49.07	12.24	4.00	3.27	0.00
Maximum	267.22	208.26	193.70	73.98	11.07	10.97
Range	239.57	159.19	181.46	69.98	7.80	10.97
Mean	72.49	93.83	44.77	21.94	5.42	3.65
Median	52.55	86.59	37.72	18.32	5.13	3.37
Standard deviation	49.56	28.72	22.21	13.45	1.48	1.52
Coefficient of variation	68.36	30.61	46.61	61.32	27.21	41.76
Skewness	1.98	1.36	2.22	1.54	0.75	2.23
Kurtosis	3.47	2.21	8.57	2.36	0.35	6.53
Number of outliers	42	10	8	19	2	18
Moran's I	0.83	0.80	0.76	0.79	0.84	0.70

Note: The standard error of skewness is 0.147. Regarding Moran's I, the contiguity matrix is based on the four nearest contiguity distance matrices.

The difference between mean and median suggests what the coefficient of variation and range of individual data series clearly indicate as a high presence of territorial disparities in the analysed region. Extreme variability is shown, particularly by the causes of premature death. For skewness and kurtosis, the distribution of study indicators (except for gender differences in life expectancy at birth) cannot be considered normal, while the values for the remaining observation variable exceed the limit of +1.

The strong positive skewness for the causes of premature death and infant mortality is a sign of marked disparities in the region. Data series symmetry cannot be assumed, given that the value of skewness is more than twice that of the standard error. The study of kurtosis shows positive and high values for the causes of premature death (including particularly diseases of the circulatory system and external causes) and infant mortality rates, which also indicates a substantial difference from the normal distribution. Applied health status indicators clarify that non-compliance with normal conditions is coupled with outliers. As our findings refer to the smaller

European region defined above, this region is not treated as a random sample but regarded as an assembly. Outliers are an integral part of this assembly, thus representing its real segmentation and supplying additional information. Therefore – given that our objective is to detect inequalities – the removal or any transformation of outliers is not justified. The global autocorrelation test (Moran's I) provides information on the strong spatial dependence and regular arrangements of study indicators. This means that spatiality and contiguity are also important factors in the regional division of mortality in the macroregion.

The Pearson and Spearman coefficients were used to identify correlations between mortality indicators. Although correlations between health status indicators produce significant results, their strength provides a diverse picture (Table 2). Generally, the various causes of death tend to strengthen each other. In regions with a higher than average premature mortality rate caused by diseases of the circulatory system, high rates of premature death due to external causes, neoplasms, and diseases of the digestive system, and significant gender differences in life expectancy at birth and a rather high rate of infant mortality (and vice versa) exist. These correlations suggest that certain regions are plagued by complex backwardness in health status, while others show favourable conditions, based on the selected indicators.

Table 2

Correlational relationships[4] of mortality variables in Europe

	circul	neop	ext	dig	le_diff	inf
circul	–	0.756**	0.682**	0.790**	0.662**	0.684**
neop	0.552**	–	0.587**	0.798**	0.778**	0.569**
ext	0.538**	0.498**	–	0.666**	0.763**	0.321**
dig	0.720**	0.644**	0.601**	–	0.646**	0.584**
le_diff	0.440**	0.827**	0.601**	0.583**	–	0.319**
inf	0.463**	0.397**	0.246**	0.392**	0.158**	–

Note: See the Pearson coefficients above and Spearman (rank correlation) coefficients below the main diagonal. ** means a significance level of 1%.

In our opinion, the analyses performed on the structure of variables (i.e. descriptive statistics, territorial autocorrelation test, correlation analysis) provide a sufficient basis for the study of the spatial division of mortality in Europe.

[4] Abbreviations of mortality indicators: circul – diseases of the circulatory system, neop – neoplasms, ext – external causes of morbidity and mortality, dig – diseases of the digestive system, le_diff – gender differences in life expectancy at birth, inf – infant mortality.

Examination of spatial diversities by macroregion (country group)

Several authors have already examined diversity by country group, although the European breaklines tend to be different in each source (Vallin–Meslé 2001, Meslé–Vallin 2002, Meslé 2004, Nolte et al. 2004, Avdeev et al. 2011). Eventually, the solution applied by Vallin-Meslé (2001) comes closest to harmonizing the study area considering the various results.

Table 3

Examination areas for territorial differences by country group

Macroregions	Vallin-Meslé (2001) grouping	Adapted grouping
Northern Europe	Denmark, Finland, Iceland, Norway, Sweden	Denmark, Finland, Norway, Sweden
Northwestern Europe	Belgium, United Kingdom, France, The Netherlands, Ireland	Belgium, United Kingdom, France, The Netherlands, Ireland
West Central Europe	Austria, Luxembourg, Germany, Switzerland	Austria, Luxembourg, Germany
Southern Europe	Greece, Malta, Italy, Portugal, Spain	Greece, Malta, Italy, Portugal, Spain, Cyprus
East Central Europe[5]	Czech Republic, Bulgaria, Poland, Hungary, Romania, Slovakia	Czech Republic, Bulgaria, Poland, Hungary, Romania, Slovakia, Estonia, Latvia, Lithuania, Croatia, Slovenia
European CIS and Baltic countries	Estonia, Belarus, Latvia, Lithuania, Moldova, Russia, Ukraine	–
Albania and former Yugoslavia	Albania, Bosnia and Herzegovina, Croatia, Yugoslavia, Macedonia, Slovenia	–
East Mediterranean and Caucasian countries	Azerbaijan, Cyprus, Georgia, Armenia and Turkey	–

Source: Author's elaboration based on Vallin-Meslé (2001) and Daróczi (2004).

In view of the examination area, the European CIS and Baltic countries, Albania and the former Yugoslavia, and the East Mediterranean and Caucasian countries are underrepresented at regional level. Therefore, we moved these countries to other macroregions (Table 3). Particularly, due to their socialist heritage and "new" EU member state status, the Baltic countries, Croatia, and Slovenia were moved to East Central Europe. Due to its geographical location and similarly good health status, Cyprus was reclassified as a Southern European country.

[5] The original paper (Vallin-Meslé 2001) uses the term 'Central Europe'. However, in line with the arguments made by János Rechnitzer (2013) (about the former political establishment, geopolitical situation etc.), the term 'East Central Europe' is thought to be more accurate.

The differences between country groups were identified using GLM (general linear model). This method is a combination of traditional variance and linear regression analyses (Sajtos-Mitev 2007). The dependent variables are the mortality indicators described above, while the fixed (independent) variable is the numeric variable assigned to individual country groups. The number of regions in the various macroregions is different[6] and, according to the results of Levene's test, the variances within groups are not the same in the case of observable variables. In addition to one-way ANOVA (analysis of variance), we have used the Games-Howell post-hoc test, designed for the comparison of medians. This latter test is not sensitive to equal variance and sample size criteria (Shingala–Rajyaguru 2015). The results are shown in Table 4, where the means, number of significant differences between means, and partial eta-squared values explain the division for groups of countries that belong together for geographical, historical, political, and cultural reasons.

Table 4

Mortality breaklines by country group

	Northern Europe	Northwestern Europe	West Central Europe	Southern Europe	East Central Europe	Partial eta-squared
circul	48.65(2)	47.37(2)	58.55(3)	51.27(1)	155.73(4)	0.737
neop	62.45(4)	84.37(2)	84.97(2)	88.56(2)	135.49(4)	0.602
ext	45.89(3)	40.62(3)	33.34(3)	30.55(3)	74.97(4)	0.525
dig	15.08(1)	17.45(3)	20.76(3)	13.19(3)	41.89(4)	0.602
le_diff	4.28(3)	4.69(2)	4.98(3)	5.44(4)	7.43(4)	0.528
inf	2.59(3)	3.65(4)	3.17(3)	2.97(2)	5.21(4)	0.320

Note: the significant average differences are shown in parentheses for the relevant country group.

In view of ANOVA, the individual group means differ significantly from each other, giving a solid basis for the spatial division between country blocks in health status. The extent of territorial differences, according to partial eta-squared values, varies for individual variables. The difference between blocks is lowest for infant mortality (0.320) and highest for premature circulatory mortality (0.737). Consequently, the unfavourable position of East Central Europe confirms the existence of an east-west spatial division between country groups. The means for East Central Europe are rather unfavourable in comparison with (and always significantly different from) those of other territorial units. We have also performed a comparison using the indicator of relative mortality risk[7] (Sándor 2004, Ádány 2011) from mor-

[6] Number of regions in Northern Europe: 25, North-Western Europe: 87, West Central Europe: 48, Southern Europe: 57, and East Central Europe: 56.

[7] Formula: $\frac{\text{Standardized mortality rate}_{i,t}}{\text{Standardized mortality rate}_{j,t}}$, where i and j are observation units and t the observation time. Observation unit j is considered the reference region.

tality literature. First, the individual indicators of East Central Europe are compared with those of the country group having the second worst mortality. Second, the means of the country groups showing the second and third worst mortality variables are compared using the relative mortality risk (Table 5).

Table 5

Values of the relative mortality risk in the examined area

	The relative mortality risk of	
	East Central Europe	The second worst value
circul	2.66	1.14
neop	1.53	1.04
ext	1.63	1.13
dig	2.02	1.19
inf	1.43	1.15

Note: For East Central Europe, the reference is the country group having the second worst value, which is then compared with the country group showing the third worst value.

The results provide information on the extent of the east-west division. Mortality inequalities are substantial: for example, the probability of men dying prematurely from diseases of the circulatory system in East Central Europe is 2.66 higher than in West Central Europe. Regarding other variables in East Central Europe, the relative mortality risk also shows great diversity, mostly when the country groups registering the second and third worst values are compared.

We also examined the impact of each country group on Europe's territorial division in view of the selected health indicators. For this purpose, we used the tables of regression parameter estimates of the general linear model (Table 6).

Table 6

Regression parameter estimation of the general linear model (circulatory mortality)

Parameters	Beta	t	Sig.	Partial eta-squared
Constant	155.73	45.45	0.000	0.885
Northern Europe	–107.08	–17.37	0.000	0.530
Northwestern Europe	–108.36	–24.69	0.000	0.695
West Central Europe	–97.17	–19.28	0.000	0.581
Southern Europe	–104.46	–21.67	0.000	0.637

The constant in the regression equation indicates the means of the highest value category (here, East Central Europe), which is identified as omitted or reference group in literature (UCLA 2007, Taylor 2011). This serves as a benchmark for calculating the individual group means with the help of the beta coefficients of territorial units.[8] Of course, the regression relationships confirm the circulatory mortality values in Table 4, based on – for each regression coefficient – t-statistic values, significance levels, and partial eta-squared values. In this particular case, the t-values highlight the role played by individual country groups in influencing territorial inequalities. Apart from the reference group (East Central Europe), North-Western Europe has a rather high effect on the spatial distribution of the circulatory mortality in the examined area (Table 6).

Table 7

Partial eta-squared values of country groups by GLM regression

	Northern Europe	Northwestern Europe	West Central Europe	Southern Europe	East Central Europe
circul	0.530	0.695	0.581	0.637	0.885
neop	0.508	0.499	0.425	0.410	0.920
ext	0.187	0.387	0.413	0.466	0.832
dig	0.388	0.510	0.371	0.543	0.834
le_diff	0.379	0.476	0.354	0.285	0.917
inf	0.217	0.163	0.201	0.249	0.780

Supplementary, the partial eta-squared values, present in the regression equation of each variable, are shown by country group (Table 7). As evidenced by our calculations, apart from East Central Europe, Southern Europe and North-Western Europe have a major impact on the spatial structure of health inequalities in terms of the relevant health variables. The former is an important player in the field of external causes, infant mortality and diseases of the digestive system, while the latter is a major actor in circulatory diseases and differences in life expectancy. The spatial structure of health inequalities is influenced only to a lesser extent by Northern Europe in infant mortality and premature deaths from neoplasms, and by West Central Europe in external causes of death.

Mesoregional examination of spatial diversity

The purpose of the mesoregional approach to analysing mortality is to identify the main boundaries of spatial division and classify into homogeneous groups the individual NUTS2 regions showing similar mortality characteristics. For this purpose, we used the algorithm of two-step cluster analysis.

As per Table 2, the pairs do not show too close (above 0.9) correlations, which means there is no excessive redundancy or distortion in the database. However, overall information (common variance) on the group of variables is missing. As such, the

[8] As a special feature, each group is defined as a dummy variable. For example, when estimating the average circulatory mortality in Northern Europe, this macroregion will take the value 1 and the others 0. Accordingly, the equation is y = 155.73 - 1*107.08 - 0*108.36 - 0*97.17 - 0*104.46 (i.e. the value for Northern Europe will be 48.65).

index expressing the adequacy of indicators applied for main component analysis is applied (Table 8). According to the Kaiser-Meyer-Olkin index, redundancy is present among the applied indicators, but only to a moderate extent (Füstös 2009).

Based on the previous results (descriptive statistics, global territorial autocorrelation test, macroregion approach) and correlation relationships, at regional level, there is a clear spatial separation along the examined vectors.

Table 8

Redundancy test for mortality variables

Kaiser-Meyer-Olkin Measure of Sampling Adequancy		0.789
Bartlett's test of Sphericity	Approx. Chi-Square	1367.33
	df	15
	Sig.	0.000

The variables were entered in standardized form into the algorithm of the two-step cluster analysis, which was then run separately for both distance measures (Euclidean and log-likelihood). We opted for the latter measure to ensure a proper technical interpretation of the results. As the method is designed to provide automatic proposals for the optimal number of clusters (Sajtos–Mitev 2007), we first selected this automatic clustering option, and – to identify additional breaklines – we defined the number of clusters. We used the BIC (Schwarz's Bayesian information criterion) applicable to various cluster arrangements (number of clusters), BIC change, and the ratio of changes and distance measures (Trpkova–Tevdovski 2009) to express the quality of homogeneous groups. The created clusters were checked with one-way ANOVA and, where possible (for three or more groups), the Games-Howell post-hoc test was again used for comparing means.

The obtained results were also evaluated in terms of which variables contribute – and to what extent – to cluster formation. Ranging between 0 and 1, the index of predictor importance was evaluated with the F-test. The closer the index to 1, the less likely the separation between clusters is due to chance and more likely due to the impact of a variable (IBM 2012).

The two homogeneous clusters, created with the automatic clustering option, display a marked east-west difference (Figure 1). The coverage for the region with unfavourable health characteristics (Cluster 2) indicates the problem continues to be an issue in East Central Europe.

Table 9

Average mortality gap in the divided European macroregion (2 clusters)

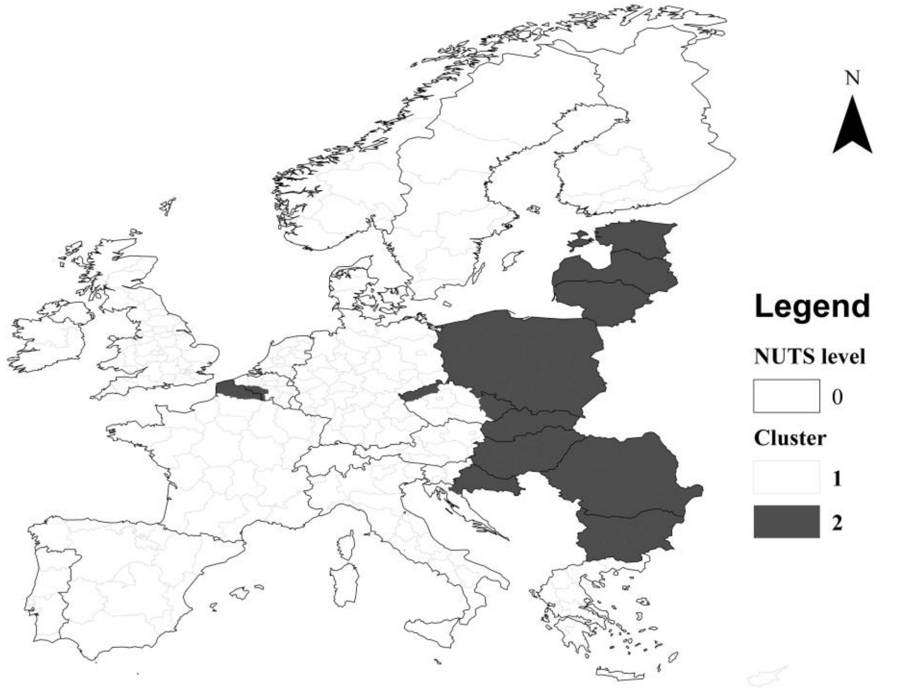
	circul	neop	ext	dig	le_diff	inf
Cluster 1	51.93	83.11	37.25	16.92	4.93	3.21
Cluster 2	164.20	141.65	78.27	44.32	7.65	5.61
Average (examined area)	72.50	93.83	44.77	21.94	5.42	3.65

Note: the ANOVA results highlight the significant difference between cluster means.

In addition to Estonia, Latvia, Lithuania, Poland, Slovakia, Hungary, Romania, and Bulgaria, geographically contiguous blocks free from contiguity relations are formed by Continental Croatia and the eastern areas mostly affected in the industrial transformation of the Czech Republic (Stredni Morava, Moravskoslezsko). The high mortality regions joining from a shorter and greater distance (Severozápad [Cz], Nord-Pas-de-Calais [Fr]) show partly similar socio-economic characteristics (industrial reconstruction leading to unfavourable results, OECD 2004, Ministry of Employment and Solidarity High Committee of Public Health 2002, Laoudj Chekraoui 2014).

Figure 1

Spatial differentiation of the European macroregion in the case of two clusters



Note: BIC: 676.6; BIC change: -523.0; ratio of change: 1.0; ratio of distance measure: 5.8. Switzerland is not included in the analysis.

According to Renard et al. (2015), the high number of deaths and the mortality profile (similar to that of East Central Europe) of Hainaut province (Belgium), neighbouring the region of Northern France, are explained by the long-term economic segregation of the Walloon region and the failure of regional public policies. The framework of this study excludes from the clusters such areas, formerly showing as interim features, such as Eastern and Western Slovenia, Adriatic Croatia, the central part of the Czech Republic, or the East German (former GDR) provinces.

Based on the comparative European analyses of Meslé (2002, 2004) and Meslé–Vallin (2002), in 1995, the countries in these regions belonged to the relatively more developed areas of the eastern part of Europe regarding health status. There is a significant difference between the two blocks in terms of all mortality indicators (Table 9). The eastern part of the examined area displays the following relative risks for premature causes of death (in comparison with Cluster 1): diseases of the circulatory system – 3.16; neoplasms – 1.70; external causes of morbidity and mortality – 2.10; diseases of the digestive system – 2.60. Gender differences in life expectancy at birth are 2.7 years higher in Cluster 2, and infant mortality is 74% higher than in the reference region.

Examining only the major part of Czech Republic from the more developed cluster, its favourable position can be explained by several factors. According to a joint study by Caselli, Meslé, and Vallin (2002), the transformation crisis affecting health status was fairly short in the Czech Republic, and the country's life expectancy at birth began increasing in 1991. As a positive example, Cornia (2016) mentions the rigorous reform steps taken by the Czech Republic during socio-economic transition, thus demonstrating a realistic pace of restructuring and strong labour, social sector, and redistributive policies (WHO 2013, Simonyi 2015). According to an explanation provided by Mackenbach et al. (2013), the Czech Republic is performing better in terms of health status than many other countries in East Central Europe due to its efficient overall health policies, including teenage pregnancies and neonatal mortality, cancer screening and road traffic safety. Rychtarikova (2004) and Mackenbach et al. (2013) highlight the improvement of health status is likely to be attributable to the rapid results of the cardiovascular revolution and the technical progress in the treatment of cardiovascular diseases (surgeries, innovative medicines), thus being less affected by health awareness (alcohol consumption, smoking).

Subsequently, to identify additional breaklines, we defined three and then four clusters. The three-cluster solution continues to confirm the East Central European origin of poor mortality statuses (Figure 2). There is no major rearrangement in the region when Central Moravia (Stredni Morava) or Nord-Pas-de-Calais and Hainaut and moved to the newly formed group with interim mortality indicators (Table 10, Cluster 2).

Table 10

Mortality features in the European macroregion (3 clusters)

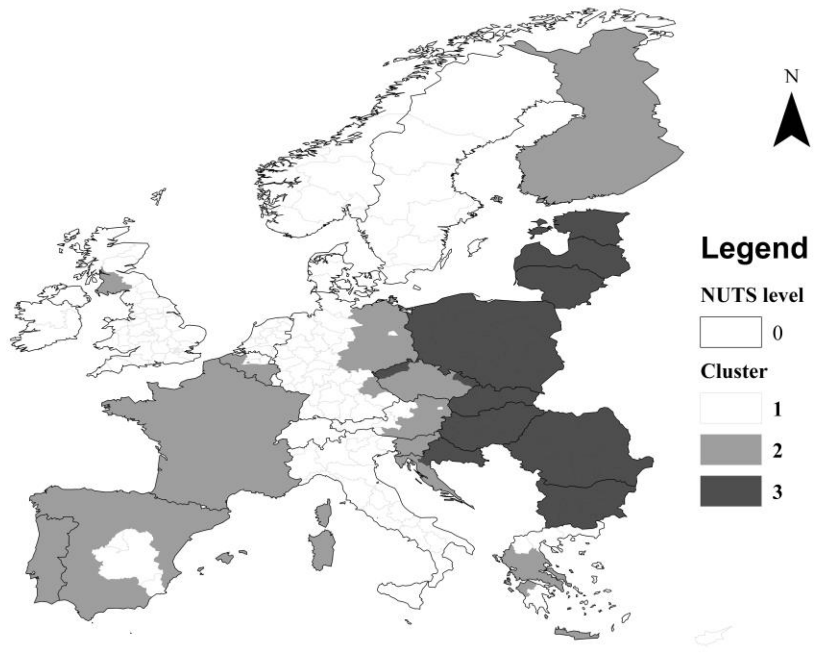
	circul	neop	ext	dig	le_diff	inf
Cluster 1	49.96	75.58	32.49	14.92	4.32	3.42
Cluster 2	56.42	97.58	46.48	21.03	6.05	2.85
Cluster 3	169.45	142.73	79.08	44.89	7.69	5.75
Average (examined area)	72.50	93.83	44.77	21.94	5.42	3.65

Note: cluster means (in general) show a difference on the basis of ANOVA results, while there is a significant difference between each of the three clusters according to the post-hoc test.

This lies along the cluster of least favourable characteristics (Cluster 1), and consists of regions adjacent to it. The other large part of the group is located in Western Europe (Portugal, Spain, France etc.). Cluster 2, showing an average performance for most vectors, is mostly organized in correspondence with current (Finland, Slovenia, France, Portugal, and the majors part of Spain and Czech Republic) or former (GDR) country borders. However, in other cases (e.g. Belgium, Austria, Croatia, Greece) there are signs of regional fragmentation within a given country. The examined European region shows a mortality slope in line with the order of cluster numbering. The only discrepancy is observed in infant mortality, with Cluster 2 outperforming Cluster 1.

Figure 2

Regional differences in the European macroregion by certain mortality indicators (three clusters)



Note: BIC: 641.9; BIC change: -34,7; ratio of change: 0.066; ratio of distance measure: 1.6. Switzerland is not included in the analysis.

When four clusters are defined, some rearrangements can be observed within the individual groups (Figure 3). The East Central European region is affected most by the movements causing a northern-southern split of the cluster, with the worst features hitherto detected. North, the Baltic countries, Poland, central and western NUTS2 regions of Slovakia (Stredné Slovensko, Západné Slovensko, Bratislava), and peripheral regions of the Czech Republic merge with Central Hungary and Continental Croatia into the same cluster. Nord Pas-de-Calais is also part of this group.

South, Bulgaria and Romania, as well as Hungary, except for its central region, and Eastern Slovakia form a single block. For observable variables, mostly the southern cluster (Cluster 4) shows unfavourable properties (Table 11). However, the detached northern group displays significant excess mortality rates – due to external causes of premature death and gender differences in life expectancy at birth – both for southern areas and average values. Except for these two phenomena, the mortality slope is still present in the analysed area.

Table 11

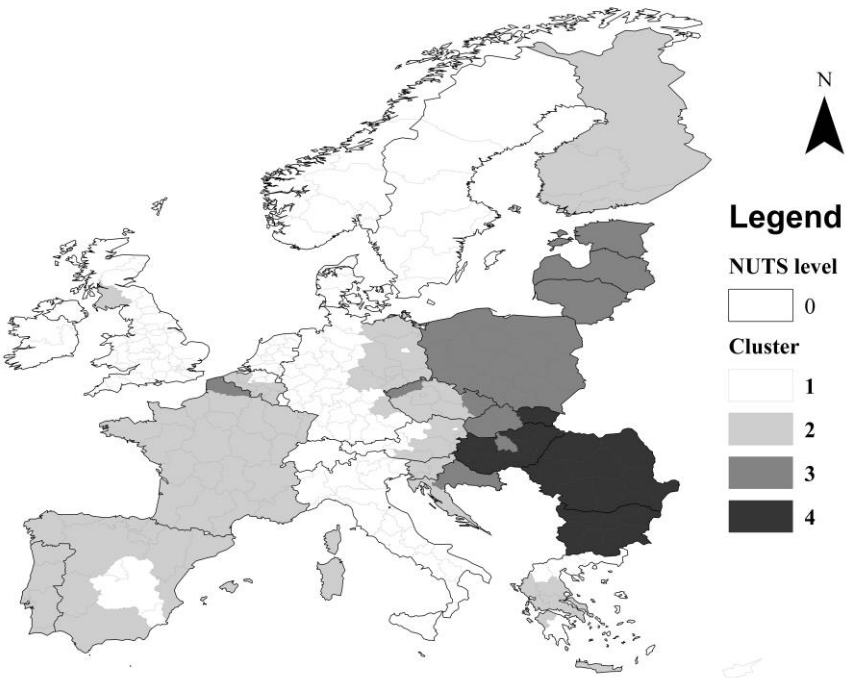
Regional disparities in the European macroregion in case of 4 clusters

	circul	neop	ext	dig	le_diff	inf
Cluster 1	49.96	75.58	32.49	14.92	4.32	3.42
Cluster 2	55.70	96.83	46.05	20.64	6.02	2.85
Cluster 3	144.71	129.78	88.31	38.88	8.03	4.14
Cluster 4	194.44	158.57	65.34	52.12	7.19	7.64
Average (examined area)	72.50	93.83	44.77	21.94	5.42	3.65

Note: Cluster means (in general) show a difference on the basis of ANOVA results, while there is a significant difference between each of the four clusters according to the post-hoc test.

Figure 3

Main breaklines of the analysed area by the four-cluster solution



Note: BIC: 624.5; BIC change: 3.2; ratio of change: –0.06; ratio of distance measure: 2.0. Switzerland is not included in the analysis.

The importance of cluster forming variables (Table 12) highlights the extent of disparities caused in the relevant European area by the health status indicators involved in this study. Within this evaluation framework, premature cardiovascular mortality represents the main determinant of regional health inequalities for each cluster solution. Subsequently, gender differences in life expectancy at birth generate a considerable level of regional fragmentation, followed by premature neoplasms, diseases of the digestive system, external causes, and, finally, infant mortality. In line with our hypothesis, the priority of non-communicable chronic diseases, particularly including cardiovascular diseases, is also valid under the mesoregional approach.

Table 12

Impact of factors on the territorial inequalities of the European macroregion

Cluster solution	circul	le_diff	neop	dig	ext	inf
2	1.0	0.49	0.67	0.67	0.49	0.33
3	1.0	0.87	0.78	0.64	0.53	0.34
4	1.0	0.84	0.83	0.67	0.55	0.57

Socio-economic differentiation of regional health inequalities in the European macroregion

Here, we identify the factors affecting the described health inequalities and determine the socio-economic indicators that make the previously defined mortality clusters differ among them. Instead of building complex explanatory models, our study is limited to highlighting the main trends and relationships of spatial inequalities.

Table 13

Socio-economic inequalities of health inequalities in the European macroregion

Nr. of Clusters	Productivity	GDP per capita
1.	11.07 (66.760)	10.30 (31.369)
2.	10.99 (61.189)	10.11 (25.325)
3.	10.67 (44.720)	9.82 (19.329)
4.	10.34 (32.604)	9.48 (13.952)
Box's M sig.	0.558	0.152
Wilks' Lambda	0.585	0.607
F	63.63	58.12
Sig.	0.000	0.000

Note: the upper part contains the average logarithmised economic performance values of each cluster (PPP units in parentheses), while the lower part shows the main results of discriminant analysis.

First, we applied discriminant analysis for this purpose – a method suitable for determining a linear combination of independent variables that are 'best' at discriminating the relevant predefined groups (for clusters) (Sajtos–Mitev 2007).

The analysis is based on the four-cluster solution for the mortality examination. The method requirements (measurement level of variables, mutually exclusive groups, group size, normality, homogeneity of variance) are fulfilled by two independent variables. The logarithmized values of the productivity rate and GDP per capita – expressing economic value creation and calculated at PPP – indicate parallel inequalities corresponding to the mortality slope. These correlations confirm the main findings of relevant literature sources (Marmot 2013, Richardson et al. 2013), according to which indicators of economic value can explain regional health inequalities for large-scale area units (e.g. EU or a part of it).

The independent variables have a significant impact, but this influence is considered weak/moderate for the purpose of discriminating the groups. Accordingly, there is a relationship similar to that of a Preston curve (Preston 1975, 2007): higher economic performance is coupled with better health status.

Supplementary, we show the regional Preston curve to bring a somewhat new perspective to the relationship between these two phenomena (Figure 4). The dependent variable of regression is life expectancy at birth, while the independent variable is GDP per capita at PPP. According to the logarithmic function best fitting the data series, economic performance accounts for 35.4% of health status heterogeneity. The corresponding regression equation is:

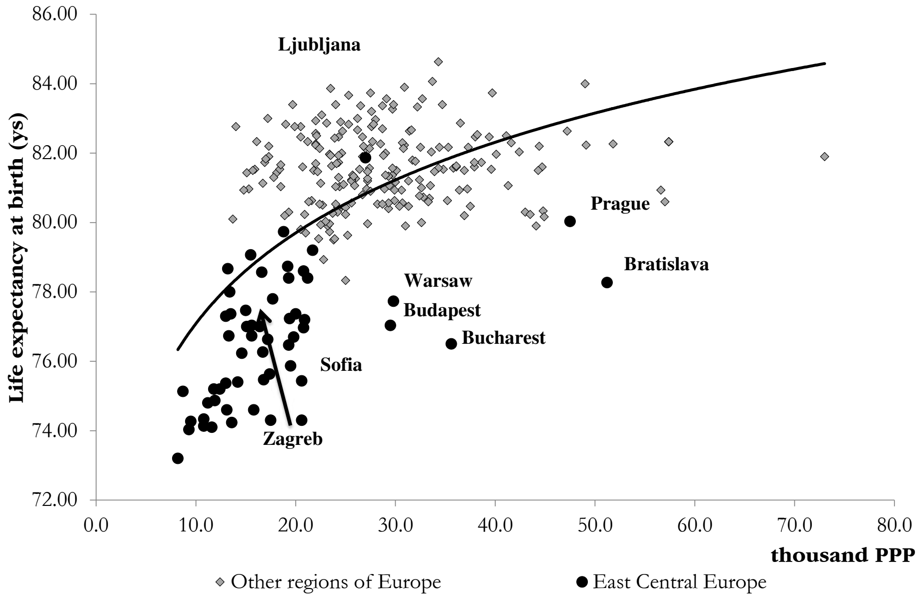
$$\text{Life expectancy at birth} = 3.7698 \ln(\text{GDP per capita}) + 42.635 .$$

This regression function shows a variation significantly higher than justified on the basis of national results (Preston 1975, WHO 2008, Orosz–Kollányi 2016). The study of Orosz and Kollányi (2016) defines the regression curve as an 'expected' health status in relation to economic performance, and examines the location of individual area units in the function. The units below the curve underperform as a result of factors other than economic performance (e.g. economic efficiency, social characteristics, healthcare), while the situation is the opposite for units located above the regression curve.

Contrary to the previous socio-economic examination of health inequalities, the different marking on Figure 4 assigns not to the clusters created, but to the regions of the analysed area (East Central Europe). As per Figure 4, the cross-sectional relationship between GDP per capita and life expectancy produced two distinct patterns: 93% of East Central European regions 'underperform', with the exception of four regions: Eastern and Western Slovenia (Vzhodna Slovenija, Zahodna Slovenija), Adriatic Croatia (Jadranska Hrvatska), and the Polish Sub-Carpathians (Podkarpackie). Figure 4 highlights the capital regions, while Table 14 shows GDP per capita amounts and lists the differences between actual and estimated (through the regression equation) 'expected' life expectancy values.

Figure 4

Preston curve at regional level



Note: The capital regions of East Central Europe are listed.

Table 14

Relationship of the GDP per capita and the "expected" health condition in the capital regions of East Central Europe

Region	GDP per capita (% of EU average at PPP)	Difference in life expectancy
Bratislava	184	–4.98
Prague	173	–2.93
Budapest	108	–4.13
Warsaw	107	–3.47
Bucharest	131	–5.37
Ljubljana	97	+1.04
Sofia	72	–4.38
Zagreb	62	–1.95

Note: Difference in life expectancy lists the differences between actual and estimated (through regression equation described above) "expected" life expectancy values.

Accordingly, despite the economic performance of most regions above the EU average, significant lags can be observed in terms of life expectancy at birth. The Bratislava region, with the highest GDP per person values, is lagging some five years behind the expected level, similar to the Romanian and Central Hungarian regions. The highest value is registered by Western Slovenia (including Ljubljana), but Prague is also in a relatively better position. Based on national (population weighted) averages, Slovenia exceeds the expected health status (+0.62 years), followed by Croatia (–1.20 years) and the Czech Republic (–1.60 years). Lithuania (–5,51 years), Latvia (–4.90 years), and Romania (–3.47 years) are at the bottom of the list. Hungary (–3.40 years) is slightly above Romania, but below Bulgaria (–3.11 years). This means that, under the study conditions, the health paradox exists at regional level as well.

Roughly expressing socio-economic inequalities in health status, both our examinations are suitable only for the detection of general trends and relationships. We did not take into consideration numerous explanatory or country-specific factors (policies, eating habits, lifestyles etc.). As to ill-managed policies on alcohol-related issues, Mackenbach et al. (2013) refer to the example of Finland, which stands second on the mortality slope and does not belong to the group of best performing region in our mesoregional analysis of health inequalities (Figure 2 and 3). When neighbouring Estonia joined the European Union, Finland dramatically and continuously reduced its alcohol tax to compensate for the much lower price of alcoholic beverages in Estonia. At the same time, alcohol-related mortality rates were constantly on the rise prior to the tax increase.

The importance of path dependency, that is, the (naturally) unavoidable impact of the socialist era's heritage needs to be emphasized although not included in the subject of this study or as an explanatory factor in either the discriminant or regression analyses. Nevertheless, the regional distribution of mortality clearly shows the effects of historical heritage (Figures 1–4). Actually, the socio-economic and other impact factors of today's health status (social problems, lifestyles etc.) are typically influenced by the processes and consequences of the socialist era (Simonyi 2015).

Summary

Our study analyses regional health inequalities in the European macroregion, with emphasis on the mortality trends in East Central Europe. On one hand, our research questions focus on the territorial fragmentation of the examined area, identification of the main breaklines, and examination of mortality factors affecting the differentiation. On the other hand, our study identifies the socio-economic differentiation behind the regional disparities of health status.

As evidenced by our examinations of country groups and also by the mesoregional approach, the excess mortality in the examined area is still a burden of East Central Europe. In view of the abovementioned features (major role of non-communicable chronic diseases, involvement of men, vulnerability of economically active age group), this problem causes a marked breakline in the analysed European area. Beyond the traditional east-west division of the European macroregion, additional 'micro-cracks' can be detected through the different vectors describing health

status. Clusters are mostly organized along former and current country borders. In our opinion, these findings reflect the complex impacts of various national regulatory systems, society, politics, economy, and culture.

Our study clarifies that the East Central European region, which used to be homogeneously disadvantaged, is far from being homogeneous today. The western block of areas that enjoyed a relatively better health status at the time of the regime change (e.g. East Germany, Czech Republic) and the western region of Slovenia and Croatia are surpassing the contiguous East Central European block. The regions on the eastern side of the Iron Curtain continue their differentiation along the northern-southern direction, displaying somewhat better indicators in the North than the South.

The methods used do not consider – or consider to a small extent – spatial impacts and contiguity relations. Nevertheless, the indicators reveal the importance of these phenomena in the formation of mortality clusters. As far as the subject of this study is concerned, Europe shows contiguous clusters and centre/periphery zones.

The main drivers of the regional divide are still non-communicable chronic diseases, with cardiovascular diseases taking absolute precedence. According to a report on future trends (Bloom et al. 2011), the most vulnerable countries in terms of economic loss attributable to non-communicable diseases are those classified in the high-income and upper-middle-income groups (e.g. countries in East Central Europe). The global loss generated by cardiovascular diseases and cancer mortality until will amount USD 24 billion by 2030, representing 38% of global GDP of 2010, of which USD 21 billion (88% of total) will be the loss of countries in the said income groups (own calculation by Bloom et al. 2011). Although individual income groups show significant variations in terms of income and population, given the unfavourable demographic and public health situations in East Central Europe, this region will most probably register above-average losses during the period mentioned above.

According to our results of applying a mesoregional approach to identify the socio-economic differentiation behind the regional disparities in health status for the delineated European macroregion, a parallel economic performance (GDP, productivity) gradient can be observed besides the mortality slope. This is refined with further analysis, performed at the NUTS2 level, to obtain a Preston curve, which confirms the health paradox exists at the regional level as well. In other words, most regions in East Central Europe fail to reach an expected health status in view of their economic performance.

Although our study ignored the effects of country-specific and impact factors (e.g. national policies affecting health status) or socialist heritage, literature findings (Mackenbach et al. 2013, Simonyi 2015) highlight the importance of these factors. Therefore, socialist heritage must be handled as an unavoidable background variable in further studies on this topic.

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VISUALIZATIONS

Visualising cities' international scientific collaboration: a spatial scientometric approach based on Scopus data

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Spatial scientometrics deals with measuring, analysing, and visualising science with spatial components (Gao 2014). The first studies discussing the spatial distribution of science were published in the 1970s (Frenken et al. 2009); however, in tandem with the rapid globalisation of science, spatial scientometrics has attracted more attention only recently (Bornmann et al. 2011). One reason for this is that, in the past few decades, research and scientific production have gradually lost their individual characteristics and have significantly internationalised. Measuring and visualising international scientific collaboration patterns of countries, cities, and organisations is an important feature of spatial scientometrics.

In this study, I visualise cities' international scientific collaboration patterns based on two different approaches. Scientometric data are retrieved from the Scopus database. After scrutinising the whole database, I assigned journal articles to the cities to which corresponding authors were affiliated (for more details, see Csomós, 2017). These cities were located in 232 countries and, in total, there were 52,577 affiliated organisations. In the analysis, only the cities that had at least 1,000 journal articles indexed by Scopus over the period 1986 to 2015 were included. These criteria were fulfilled by 2,194 cities. Scopus' search results analyser function made it possible to examine the characteristics of cities' international collaboration, that is, to identify the most important collaborating country (i.e. authors affiliated with that country) for a given city (i.e. authors affiliated with that city). For example, the 240,822 articles produced in Washington, D.C. were co-written with authors from more than 160 countries: 9,537 articles were co-written by authors from the United Kingdom, which emerges as the most important collaborator, 8,420 articles were co-written by authors from Canada, and 7,467, by authors from Germany. Similarly, I defined the most important collaborators of all cities. Figure 1 and Figure 2 show the ten most important collaborating countries with two different approaches.

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Figure 1.
The most important collaborators (countries) of cities worldwide

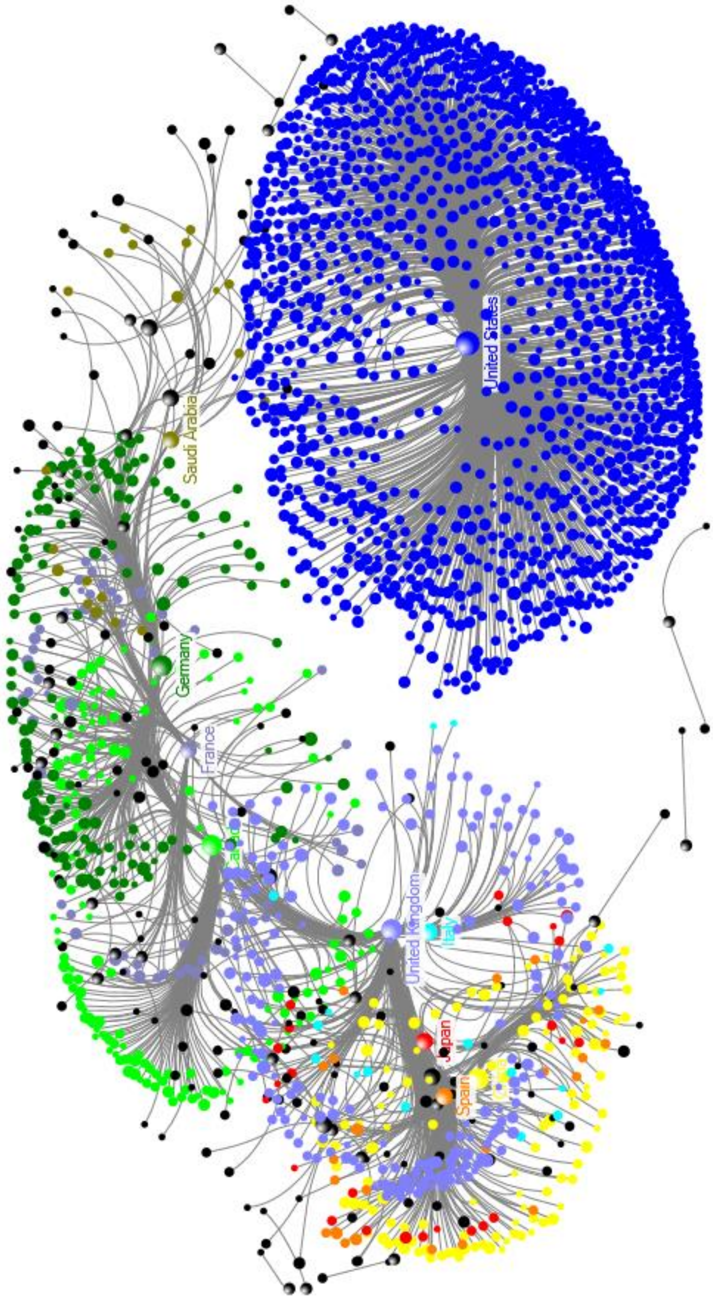
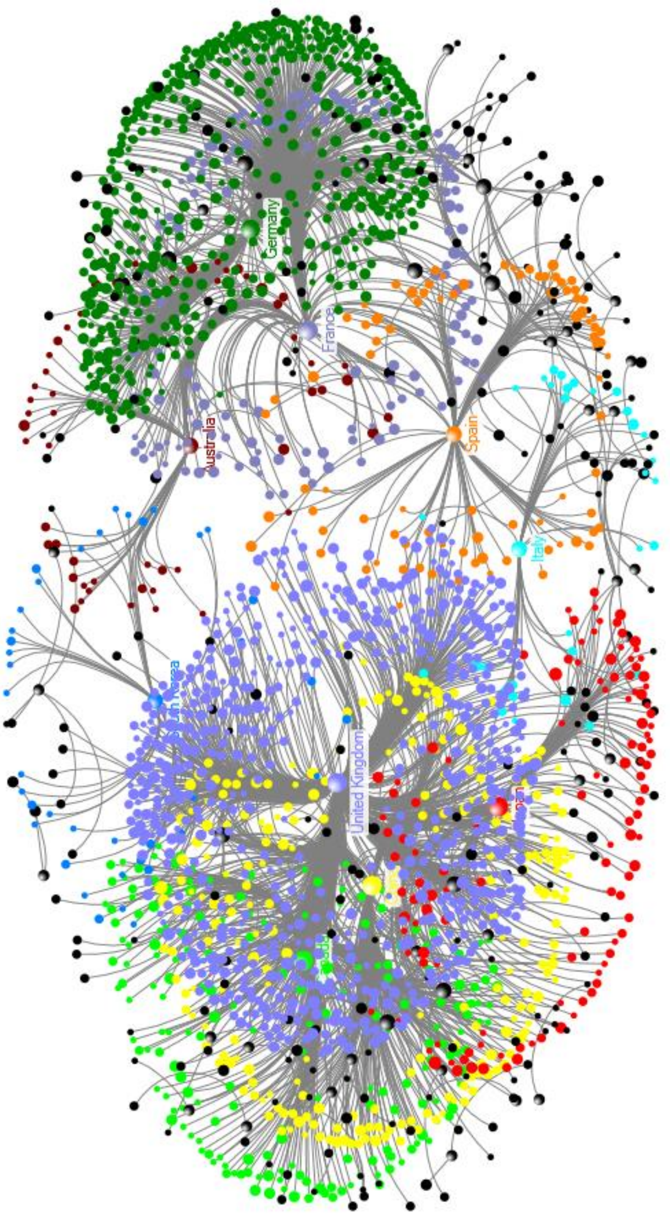


Figure 2.
The most important collaborators (countries) of cities, not including the United States



1) The most important collaborating countries for cities worldwide. The hegemony of the United States in science has been observed by many researchers (see, for example, Paasi 2005, Pan et al. 2012). Figure 1 shows that for 1,261 cities

(57.5 per cent of all cities, or 73.5 per cent if we exclude 478 US cities), the United States is indeed the most important collaborator. The United Kingdom is ranked second, being the most important collaborator for 9 per cent of all cities, followed by Canada, the most important collaborator for 160 cities, with only five outside the United States. In addition to these three English-speaking countries, only Germany (153 cities) and China (121 cities) are considered as important international collaborators. Ten countries (i.e. the United States, the United Kingdom, Canada, Germany, China, France, Japan, Spain, Saudi Arabia, and Italy) are the most important collaborators for 93.3 percent of all cities (Figure 1), making the role of other countries marginal.

2) The most important collaborating countries for cities, not including the United States. In order to examine cities' international collaborations in a more realistic way, the distorting effect generated by the United States' hegemony has to be isolated. To this end, I excluded the country from the sample. Figure 2 shows that, without the United States, the United Kingdom becomes the most important collaborator in the world. However, the United Kingdom, the second-ranked Germany, and the third-ranked China are, all together, the top collaborators for roughly the same number of cities (1,280 cities) as the United States (1,261 cities, Figure 1). This reinforces the unique position of the United States in international science. The ten top-ranked countries (i.e. the United Kingdom, Germany, China, Canada, France, Japan, Spain, Australia, South Korea, and Italy) are the most important collaborators for 89.2 per cent of all cities.

Software: NodeXL

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