Local convergence clubs in Hungary: the role of initial and structural factors in club formation, 2001–2020

Zoltán Egri
(corresponding author)
Hungarian University of Agriculture and Life Sciences,
Institute of Rural Development and Sustainable Economy,
Hungary
Email: egri.zoltan@uni-mate.hu

Julianna Csugány
Eszterházy Károly Catholic University,
Faculty of Economic and Social Sciences,
Eger, Hungary
Email: csugany.julianna@uni-eszterhazy.hu

Tamás Tánczos
Eszterházy Károly Catholic University,
Faculty of Economic and Social Sciences,
Hungary
Email: tanczos.tamas@uni-eszterhazy.hu

This study identifies convergence clubs based on district-level income per taxpayer in Hungary and investigates how initial conditions and structural characteristics affect clubs' emergence. To do so, we perform a two-step procedure, using the log t-test to delineate districts that converge towards the same steady-state condition, and then employing ordinal logistic regression to analyse the role of factors that influence club membership. Our results demonstrate that no global convergence occurred in Hungarian districts between 2001 and 2020 after verifying the presence of six convergence clubs. Our analyses confirm the club convergence hypothesis, finding that clubs' formation is primarily influenced by initial conditions (initial income, human capital). Stable and persistent inequalities are evident between clubs, which do not seem to be resolved in the long run. The authors propose a club-specific development toolkit to address these inequalities.

Keywords:
convergence clubs,
club convergence,
locality,
log t-test,
logit model

Online first publication date: 31 October 2024

Introduction

The issues of territorial income inequalities have featured prominently in academic research and in economic and territorial policy strategies over the last 2 to 3 decades (Barro–Sala-i-Martin 1995, Quah 1996, Iammarino et al. 2017). Interregional convergence and balancing (equalisation) are also strongly relevant for and clearly linked to the main policy objectives of the European Union (EU). Article 158 of the Treaty of Rome (EU 1957) addressed the issues of strengthening economic and social cohesion, reducing territorial disparities and helping rural areas to catch up. This topic raised considerable interest in East-Central Europe, including Hungary, during regime change and afterwards (Capello–Perucca 2013, Smętkowski 2015, 2018, Kotosz–Lengyel 2018). Socio-economic and political changes (regime change), the impact of globalisation and the European integration processes have significantly deepened territorial differences in Central and Eastern Europe (Smętkowski 2018, Gorzelak 2020, Ezcurra–Del Villar 2021). These objectives are also clearly reflected in Hungary's spatial development policy, which is aimed at, for example, reducing territorial disparities (and achieving a balanced spatial structure), promoting territorial socio-economic growth and catching up and dynamising external and internal peripheries and underdeveloped regions (OFTK 2014).

According to previous literature, convergence processes can basically be examined from two perspectives, which are referred to as beta (β– and sigma (σ–). According to Barro–Sala-i-Martin (1995), an inverse relationship emerges between the initial development level and the growth rate, and all economies converge to the same steady state, but only if the units of observation are homogeneous in some respect (Mankiw et al. 1992). Convergence to this steady state is called absolute or unconditional β-convergence. In the case of conditional β-convergence, reaching a steady state depends on initial income and other country-specific factors (qualification, rate of population change, investment and other relevant characteristics), and the steady state may vary from one territorial unit to another (Mankiw et al. 1992). The σ-convergence approach implies a reduction in the dispersion of income per capita, i.e. a reduction in inequality (Friedrich-Eckey–Türck 2007). Quah (1993, 1996) argued strongly against traditional β- and σ-convergence studies, claiming that they do not adequately capture the phenomenon of income convergence, dynamics and mobility. Baumol (1986) and Baumol–Wolff (1988) delineated convergence clubs showing similar income paths within a certain set of countries in the world, demonstrating that countries are converging to their group- or club-specific equilibrium states, i.e. multiple spatial equilibrium states are present. Regions' long-term growth paths are determined by the initial and structural conditions for each group (representing club convergence; Galor 1996, Azariadis–Stachurski 2005, Bartkowska–Riedl 2012). The above convergence processes have been validated at country and regional levels, and several analyses have addressed these topics (Durlauf–Johnson 1995, Friedrich-Eckey–Türck 2007, von Lyncker–Thoennessen 2016, Cutrini 2019, Szakálné Kanó–Lengyel 2021).

This study aims to describe the local specificities inherent to the phenomena of convergence club formation and club convergence in Hungary. Several previous analyses have confirmed the presence of convergence clubs at regional level in

Hungary. At the NUTS 2[1] level, various analyses have revealed differing income paths for Hungarian regions, with the north-western part of the country and the capital producing two-thirds of the gross domestic product (GDP), while other regions have been part of the lowest income club in the EU since Hungary's accession (EC 2017, Iammarino et al. 2017). Lengyel–Varga (2018) classified Hungarian counties into 'multi-speed' clubs based on their development paths, giving them labels such as 'centre', 'foreign direct investment (FDI) manufacturing', 're-industrialising', 'knowledge centre' or 'rural'. The multi-speed regional EU and Central and Eastern Europe have been examined in various analyses (Alexiadis 2013, Cutrini 2019, Szakálné Kanó–Lengyel 2021, Iammarino et al. 2020), describing the differentiated income paths of the NUTS 2 and NUTS 3 regions in Hungary. Iammarino et al. (2020) classified EU regions into different types of development traps at different income levels, with the majority of Hungarian regions attributed to the 'regions trapped at low levels of income' group. However, very little evidence has been produced concerning convergence club formation and club convergence at the local level in Hungary.

The remainder of this paper is structured as follows. Following this introduction, the theoretical background describes convergence clubs, the club convergence hypothesis and the processes of income inequality at the international and local (Hungarian) level. This section argues that NUTS 2/NUTS 3 and lower territorial levels are suitable for describing income inequality (convergence/divergence) processes, and convergence clubs in particular. After that, the methodologies used for describing convergence club formation and club convergence and the databases used for the analysis are described, followed by the presentation of the main local results for the Hungarian geographical space, and the discussion of the results. Finally, the paper ends with a summary.

Convergence clubs and the club convergence hypothesis (subnational [regional] perspective)

The practical applicability of convergence clubs and club convergence hypothesis has been tested by many authors (Baumol–Wolff 1988, Durlauf–Johnson 1995, Quah 1996, Le Gallo 2001, Bartkowska–Riedl 2012, Alexiadis 2013, von Lyncker–Thoennessen 2016, Cutrini 2019, Li et al. 2018, Szakálné Kanó–Lengyel 2021). The convergence club phenomenon is characterised by 'polarisation, persistent poverty and clustering' (Galor 1996: p. 1056), i.e. clubs and their formations can be described in clear spatial dimensions. At the subnational (regional) dimension, this approach clearly shows the role of spatial spillovers and geographical proximity (Bartkowska–

[1] The nomenclature of territorial units for statistics (NUTS) classification is a hierarchical system for dividing up the EU territory. NUTS 2 refers to basic regions for the application of regional policies and NUTS 3 is small regions for specific diagnoses.

Riedl 2012, Alexiadis 2013, Ayouba–Le Gallo 2020). In the context of economic growth and spatial economic agglomeration, new economic geography (Krugman 1991) was also clearly linked to convergence club theory. However, the existing majority of convergence club delineations are incapable of accommodating individual heterogeneity that occurs in economies in transition, allowing for a wide range of possible time paths. Phillips–Sul's (2007, 2009) log t-test method is innovative in identifying clubs with different steady-state conditions but does not provide an answer to the question of club formation.

Although conditional convergence and club convergence appear to be competing hypotheses (Galor 1996), they are actually complementary. Factors such as human capital, income inequality, fertility, international capital flows and technological progress and diffusion, among other considerations determine the income trajectories of individual regions as well as the steady states of individual clubs (Alexiadis 2013).

The inclusion of the two hypotheses in one model is based on the Phillips–Sul (2007, 2009) log t-test, and this study explains club formulation using ordinal logistic regression. Bartkowska–Riedl (2012) were the first to analyse the 206 NUTS 2 regions of the EU15, Switzerland and Norway using the coupled methodology for the period 1990–2002. PS clubs (6) indicate the core–periphery relationship within the region, explained by initial conditions (labour, capital, human capital, income) and structural characteristics (services, high-tech production). The analysis over a longer time span (1980–2007) confirms the role of initial and structural factors in club formation, which is also influenced by the significant presence of geographical factors (latitude, capitals) (von Lyncker–Thoennessen 2016). Cutrini (2019) explained the new millennium's income club trajectories for the EU28 regions as a whole based on the presence of manufacturing and knowledge-intensive services.

Local income inequalities, with particular reference to convergence clubs/club convergence

Detecting inequalities at the lower level of territorial units (below NUTS 3), which are in some way related to convergence, has been addressed by several authors. The methods used for convergence analysis are the same as those used at higher territorial levels (country, region) (Barro–Sala-i-Martin 1995, Quah 1996, Le Gallo 2001, Le Gallo–Fingleton 2013, Monfort 2020).

Mastronardi–Cavallo (2020) examined income inequality within Italian municipalities using the Gini index, highlighting its economic and spatial dynamics. Higher intra-municipal inequalities are typical in dense urban spaces (with a high share of tertiary education and young people). Rattsø (2008) and Rattsø–Stokke (2010) described income inequalities in Norwegian municipalities from the 1970s to the early 2000s using absolute and conditional convergence, Markov chain, kernel density estimation and σ-convergence methods. The results provide a complex and diverse picture of income processes, demonstrating unconditional convergence as well as the presence of convergence clubs. Using β-convergence and spatial autocorrelation studies of local incomes in the Belgian province of Limburg, Peeters (2008) reveals cumulative divergence of incomes and increasing spatial concentration of high-income municipalities from 1991 to 2000. Maulana–Aginta (2022) analysed the convergence of real wages in 34 Indonesian provinces between 2008 and 2020 using the PS log t-test. The authors delineated three convergence clubs, the formation of which was determined by manufacturing employment, investment rate, labour force participation and initial wage level. Aginta et al. (2022) also used the PS method to analyse the evolution of per capita gross regional domestic product in Indonesia's 517 districts between 2000 and 2017, revealing that five convergence clubs exhibit independent steady-state status. Tipayalai–Mendez (2022) demonstrated the emergence of income convergence clubs in Thailand from 1995 to 2017. The results reveal three convergence clubs with strong spatial dependence. Ayouba–Le Gallo (2020) investigated the spatial distribution of per capita income at the local level in Western European countries. According to spatial autocorrelation results, the income pattern is significantly characterised by spatial heterogeneity between high own and high neighbour and low own and low neighbour areas. Resende et al. (2016) conducted a conditional β-convergence study at different spatial levels in Brazil using spatial econometric regression methods. The results show significant conditional convergence at lower levels (municipality, micro-region), with finer geographical scales indicating the spatial limitations of spillovers in several cases.

Income inequality studies focused on Hungarian micro-regions have taken different approaches depending on the interpretation of the concept of convergence. Examining the income inequality decline in Hungary means a test of the Williamson (1965) hypothesis. According to the σ-convergence studies from the convergence literature (Kotosz 2016), the initial moderate level of inequality in Hungary was followed by rapid differentiation and then stagnation until the mid-1990s, and since the turn of the millennium a gradual decline in internal inequality has occurred at all territorial levels (Dusek 2006, Németh–Kiss 2007, Pénzes 2019, Egri 2020). Pénzes (2019) identified the inequality paths of Hungarian districts after the millennium using regression equations fitted to Hoover indices (taxable income, municipal economic power)[2] within districts. Concerning taxable income, the results show a dominance of stagnation and convergence, while mosaicism is also a prominent phenomenon in the case of municipal economic power. Dusek (2006) was very critical of the theory and practice of territorial convergence in Hungary, based on the experience of 1988–2004. The conclusion of his methodologically diverse paper (employing σ-convergence, spatial autocorrelation, spatial moving average and linear regression, among other techniques) is that convergence cannot be understood without considering institutional, historical, demographic and other relevant factors, and that the change in inequality over time is not unidirectional. Several analyses have shown absolute β-convergence at the local level after the regime change, in terms of economic activity

[2] Municipal economic power is a disaggregated indicator of GDP for lower territorial levels.

and other alternative indicators (Csite–Németh 2007, Balás et al. 2013). Czaller (2016) presented the conditional β-convergence of gross value added at the sub-regional level for the period from 1993 to 2012. The results indicated that the external return to scale and the free flow of production factors contribute to rapid convergence.

In most cases, convergence clubs are identified in an implicit manner, where each level of the settlement hierarchy can form independent and stable clubs, and territorial units with higher aggregation (districts, sub-regions, counties, regions) can form convergence clubs (Dusek 2006, Németh–Kiss 2007, Lőcsei 2010, Balás et al. 2013, Pénzes 2019). Dusek (2006) used the spatial moving average method to define local income groups (i.e. convergence clubs) at municipal levels (metropolitan agglomerations, outer and inner peripheries and other forms) that are based on spatial similarity and concern the change of regime and the millennium period. Major (2007) employed a Markov chain to model the movement and stability of sub-regional incomes in the decade following the change, actually detecting Quah's (1996) convergence clubs. Egri (2022) identified convergence clubs in Hungary based on local spatial autocorrelation analyses, demonstrating their mobility and persistence after the 2000s.

We contend that the international and Hungarian results indicate that the local level is suitable for expressing or describing different convergence processes and can add value for assessing the results at a higher spatial level. In addition, it is clear from previous research that forces acting towards the formation of spatial income clubs are also present at lower territorial levels in Hungary, shaping the spatial distribution of the phenomenon under study with different amplitudes.

Therefore, the basic assumption of our study is that the appearance of spatial convergence clubs is clearly a viable reason behind income inequality in Hungary. We hypothesise that the emergence of convergence clubs can be explained by the main characteristics of the initial period and the phenomenon of club convergence can also be interpreted at the local level. Therefore, this study delineates local units with similar local income paths, in addition to identifying the factors of influence. To the best of our knowledge, this is the first analysis to be conducted at the local level in Hungary, and our study provides a novel approach for explaining territorial convergence processes from this perspective.

Data and methods

Methods

This study's analysis of income convergence in Hungary is conducted in three steps:

- we use kernel density estimation to describe income distribution,
- the Phillips–Sul (2007, 2009) method to identify convergence clubs and, finally,
- ordinal logistic regression to identify the factors that influence clubs' formation.

Since geographical proximity can be assumed to have a role in convergence clubs' formation (Le Gallo 2001, Le Gallo–Dall'Erba 2005), we also calculate global and local Moran's Index (Moran's I).

Kernel density estimation

The kernel density approach to convergence can capture the evolution of income distribution across districts over time. The analysis suggests that convergence occurs when the shape of the cross-sectional distribution becomes unimodal in the function of time. In this non-parametric framework, the appearance of multiple modes is usually associated with the existence of convergence clubs (Quah 1993, 1996), which is in contrast to general and single convergence. We estimate incomes using the Gaussian (or normal) kernel function based on the simplicity of calculation and the automatic calculation of the optimal bandwidth (Leonida–Montolio 2001).

Log t-test

We then use a regression based on the convergence test to examine the behaviour of local income in Hungary between 2001 and 2020. The panel variable of income (X_{it}) is as follows: $X_{it} = g_{it} + a_{it}$, where g_{it} is the systematic factor (which includes the permanent common component) and a_{it} is the transitory component. To consider temporal transitional heterogeneity, the equation can be modified as follows: $X_{it} = \left(\frac{g_{it} + a_{it}}{\mu_{it}} \mu_t\right) = b_{it}\mu_t$, where b_{it} is the time varying idiosyncratic element and μ_t is a single common component. To test whether different regions converge, the estimation of b_{it} has a key function, which is defined by the following relative transition path:

$$h_{it} = \frac{X_{it}}{N^{-1}\sum_{i=1}^{N} X_{it}} = \frac{b_{it}}{N^{-1}\sum_{i=1}^{N} b_{it}}.$$

The relative transition path expresses relative individual behaviour and reveals the relative deviations of the i-th region from the μ_t common growth path. In the case of convergence, the relative transition paths of h_{it} converge to 1, or the cross-sectional variance of h_{it} converges to zero in the long run.

$$H_t = N^{-1}\sum_{i=1}^{N} (h_{it} - 1)^2 \to 0 \; as \; t \to \infty$$

The cross-sectional variance of h_{it} and H_{it} might decrease even if no overall convergence occurs and only local convergence exists within certain subgroups. For this reason, the PS method proposes to consider the following semi-parametric specification of coefficient b_{it}:

$$b_{it} = b_i + \frac{\sigma_i \xi_{it}}{L(t)t^{\alpha}},$$

where b_i is constant (time invariant), ξ_{it} represents i.i.d. N(0,1) random variables across i, but is weakly dependent over t, $L(t)$ is a slowly varying increasing function (with $L(t) \to \infty$ as $t \to \infty$) and a is the decay rate, or in this case, the convergence rate. The null hypothesis of convergence can be written as H_0: $b_i = b$ and $a \geq 0$ versus the alternative

H_1: $b_i \neq b$ for all i or $a < 0$. Different transitional paths are possible under H_0, including temporary divergence.

Based on the results, Phillips–Sul (2007, 2009) recommended the log t convergence test, which involves estimating the following ordinary least squares regression with a robust covariance matrix:

$$log\left(\frac{H_1}{H_t}\right) - 2logL(t) = a + \beta logt + u_t, for\ t = [rT], [rT] + 1, \ldots, T,$$

where $H_t = N^{-1}\sum_{i=1}^{N}(h_{it} - 1)^2$, H_1/H_t is the cross-sectional variance ratio, β represents the speed of convergence for b_{it}, $-2logL(t)$ (where $L(t) = log(t + 1)$) is the role of a penalty function and improves test performance particularly under the alternative, r assumes a positive value in the interval (0, 1) to discard the first block of observation from the estimation and $[rT]$ is the integer part of rT. The PS method proposes using $r = 0.3$ for a low number of samples (T < 50).

β equals $2a$, where the value of α other than 0 is studied using a robust one-sided t-test for heteroscedasticity and autocorrelation. The null hypothesis of convergence is rejected *if* $t_b < -1.65$ at 5% significance level. Moreover, the size of parameter β is also relevant as $0 \leq \beta \leq 2$ indicates relative convergence, implying convergence in growth rates, while $\beta \geq 2$ means absolute convergence. If convergence for the entire sample is rejected, the testing procedure is applied to convergence clubs, following the clustering mechanism (Phillips–Sul 2007, 2009).

- Step 1 (cross-section last observation ordering): order the districts according to the last panel observation of the period.
- Step 2 (formation of the core group of k^* districts): the log t-test is run for the first $k = 2$ districts. If $t_k > -1.65$, both districts form the core group (G_k). Following this, the log t-test is run for G_k plus the next district. In case of t_k $(k = 3) > t_k$ $(k = 2)$, the district belongs to G_k. This mechanism is conducted as long as t_k $(k) > t_k$ $(k - 1)$ for all $N > k \geq 2$. If t_k $(N - 1) > t_k$ $(N - 1)$, the remaining panel converges. If the condition $t_k > -1.65$ does not hold for the first two units, we drop the first unit and repeat the process. If $t_k > -1.65$ does not hold for any units chosen, the whole panel is divergent.
- Step 3 (filter the data for new club members): we add one remaining district at a time to the core primary group with k members (G_k) and run the log t-test again. All districts that have a t_k higher than the critical value c are added to the core group. If $t_k > -1.65$ is met for this group of districts, it is the first convergence club. If not, we raise the critical value and repeat the procedure until $t_k > -1.65$.
- Step 4 (recursion and stopping rule): we create a second group including all districts we could not filter in step 3 and run the log t-test on this subgroup again. If $t_k > -1.65$, the remaining units form their own convergence club. If $t_k < -1.65$, we repeat steps 1–3 to find another convergence club for all remaining units. If no further club is found, the remaining districts diverge.

Merging*:* Based on the previous results, as a final step we test whether individual clubs can be merged into larger clubs. In the first step, we run the log t-test on the first and second clubs. If the t-statistic is greater than −1.65, then the clubs are merged. We repeat the test after adding the next club and continue until the t-statistic indicates that the convergence hypothesis is rejected. The final convergence clubs are formed after all possible mergers are completed.

We employ the original Phillips–Sul (2007, 2009) methodology to detect convergence clubs in our analyses.

Ordinal logistic regression

However, according to von Lyncker–Thoennessen (2016), the PS method is insufficient for proving the existence of club convergence, proposing the two-step procedure of Bartkowska–Riedl (2012). It is suggested that PS clustering be conducted as a first step, then the factors leading to the formation of each cluster are identified using so-called ordinal logistic regression. In this case, the dependent variable is c, which indicates the districts in a given convergence club. Clubs can be ranked according to equilibrium income to obtain an ordinal-level outcome variable. Based on the club convergence hypothesis, we assume that initial and structural conditions matter in the evolution of steady-state income (Galor 1996, Azariadis–Stachurski 2005) to form convergence clubs. Therefore, the regression equation is as follows:

$$y_i^* = X_i\beta_i + \varepsilon_i,$$

where club membership is related to a latent variable (y_i^*), which represents an individual region's steady-state income, X_i means the initial explanatory factors, ε is the residual with logistic distribution and i (1…175) refers to the number of regions. y_i^* and β_i estimation is based on the maximum likelihood technique. We calculate the (marginal) effects of the estimated probabilities to assess the weight of each explanatory variable in determining club membership. Marginal effects estimate how a unit change in an explanatory variable changes the probability that an average region belongs to a given club, while holding all other variables at the sample average. Finally, we report Nagelkerke's R-squared (R^2) as the goodness-of-fit measure (McKelvey–Zavoina 1975).

Spatial analyses

To test the neighbourhood effect and spatial dependence, we use a global autocorrelation test to reveal average patterns in the performance of the districts under study. We capture this correlation using the global Moran's I (Moran 1948).

$$I = \frac{n}{S_0} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(y_i - \bar{y})(y_j - \bar{y})}{\sum_{i=1}^{n}(y_i - \bar{y})^2}$$

where n denotes the number of districts, $\bar{y}$ is the arithmetic mean of the indicator under study and $S_0 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}$. The value of w_{ij} is 1 if i and j are neighbouring regions, otherwise the value is 0. The expected value of Moran's I is $-1/(N-1)$. I values above $-1/(N-1)$ indicate positive spatial autocorrelation, in which similar values, whether high or low, show spatial clusters. I values below $-1/(N-1)$ indicate negative spatial autocorrelation, in which neighbouring values differ.

We use a local test function of spatial autocorrelation to determine the spatial patterns, i.e. the local Moran's I statistic suggested by Anselin (1995). The local Moran's statistic can be used to detect cities that are similar to or differ from their neighbours. The local Moran's I formula is as follows:

$$I_i = z_i \sum_j w_{ij} z_j$$

where z_i, t and z_j are the standardised values of the observation units at time t. For the univariate local Moran's I, z_i, t and z_j refer to the same database. w_{ij} is the spatial weight matrix (Anselin 1995). The Moran scatter plot generated by the test classifies the settlements into four categories according to their location in the four quadrants of the plot, including (1) high–high (HH): high value locations where the neighbourhood also has a high value, (2) high–low (HL): high value locations where the neighbourhood has a low value, (3) low–low (LL): low value locations where the neighbourhood also has a low value and (4) low–high (LH): low value locations where the neighbourhood has a high value.

Data and data sources

In the absence of official GDP estimates, a basic indicator for income inequality is the real income per-taxpayer subject to personal income tax, with base year 2001. This indicator is inherently limited (as is GDP), but it is suitable for expressing the economic potential of smaller regions (Lengyel 2012, Rattsø 2008, Peeters 2008). However, notably, Barro–Sala-i-Martin (1995) applied their pioneering findings for GDP per capita as well as personal income and obtained similar results. The income data source is the National Spatial Development and Planning Information System [1].

The detection of local (below NUTS 3 level) inequalities has clearly gained importance in recent times (Rattsø 2008, Peeters 2008, Mastronardi–Cavallo 2020), leading to the publication of various econometric and spatial econometric analyses. We employ the district territorial level (former LAU1)[3], which is organised according to the district's relationship between the city and its (theoretical) catchment area.

The time span of the analysis is between 2001 and 2020, which covers the country's regime change transition and accession to the EU as well as the 2007–2008 financial crisis, followed by a major economic boom. Therefore, the panel database contains income data from 175 districts for the period 2001–2020 (T = 20), i.e. the study covers a total of 3,500 observations.

[3] LAU means local administrative unit. The upper LAU level (LAU1, formerly NUTS 4) has been defined for most (but not all) EU countries.

Referencing Galor (1996) and Bartkowski–Riedl (2012), the emergence of district convergence clubs is attributed to the following initial and structural factors, which refer to the year 2001 (Table A1, see in Appendix,) districts' technological development and production structure is expressed by the number of active enterprises per 10,000 inhabitants in high-tech and medium–high-tech manufacturing and knowledge-intensive services (HTKIS). The general fertility rate is the number of live births per 1,000 women aged 15–49. Based on Castelló-Climent–Doménech (2021), human capital is a modified complex indicator that includes infant mortality, average number of school classes completed and life expectancy at birth (the indicators are normalised and then averaged arithmetically). The reason for choosing this complete approach is that human capital only considers qualifications and knowledge and does not consider all other human capital characteristics (Mankiw et al. 1992). Income inequality within a district is expressed by the Robin Hood index (Nemes Nagy 2009), which shows the disparities in the distribution of taxpayers and taxpayers' income within a district. The proxy indicator for international capital flow is the corporate tax benefit per thousand inhabitants due to foreign investment in a business enterprise (FDI). We express the initial income situation using the real income per-taxpayer subject to personal income tax in 2001. This study captures location, geographical proximity and spillover effects (Quah 1996, Egri 2022) using the average real income per-taxpayer subject to personal income tax in neighbouring districts. A neighbourhood is defined as a district with which a region shares a border (queen neighbourhood). The data source is the [1] and the Hungarian Central Statistical Office [2].

The analyses are performed using the R ConvergenceClubs package (Sichera–Pizzuto 2019), Stata 16.0 and GeoDa 1.20, and the map diagrams are prepared using ArcGIS.

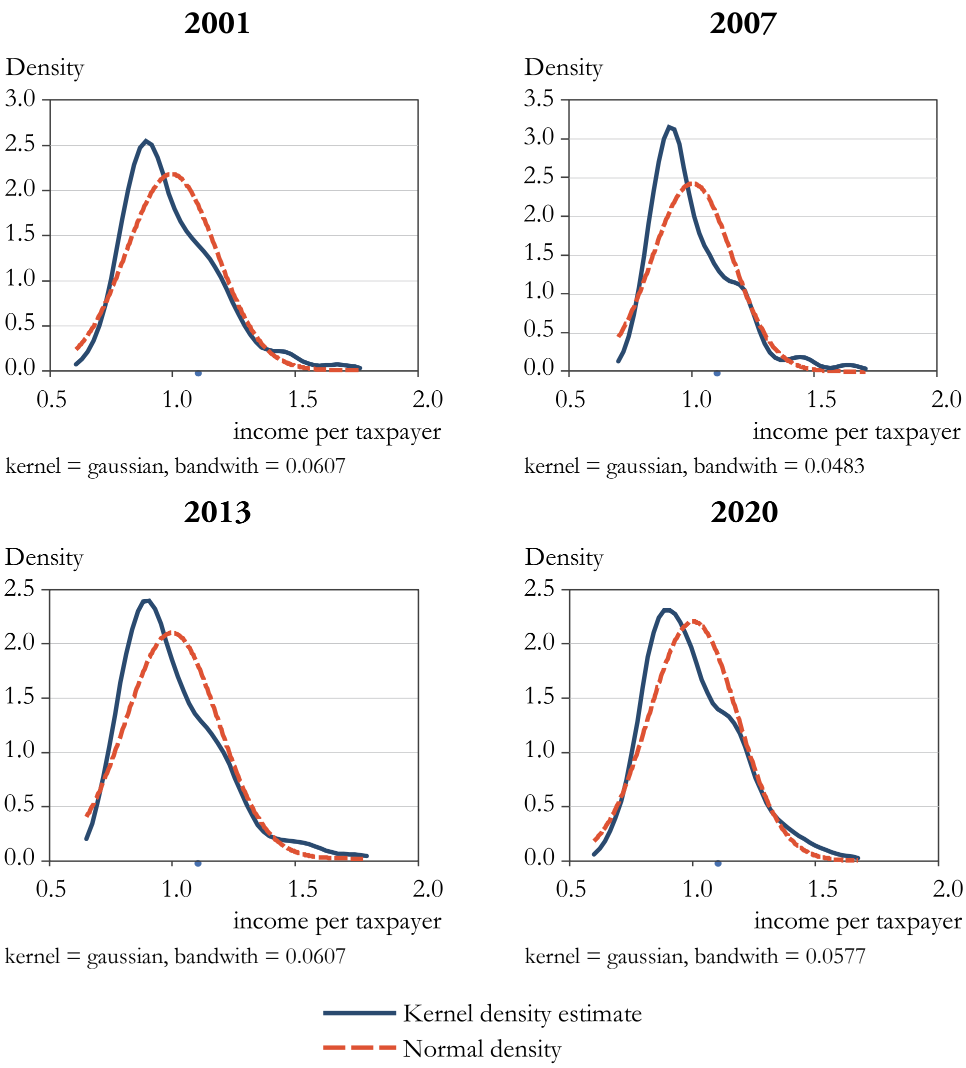
Results

Results of local convergence club analyses

For the few time points highlighted (2001, 2007, 2013, 2020), territorial income is primarily characterised by bimodal distribution, i.e. the concentration (clubbing) of districts is evident at certain income levels. (Figure 1). The first dominant mode is districts with incomes below the mean (around 90% of the mean), while the second is districts with income above the mean (at relative incomes of 1.15–1.20) throughout the period under study. In addition to these two stable convergence clubs, smaller clusters below and above the relative income of 1.6 per taxpayer emerged in the initial period (2001, 2007), i.e. more developed districts have diverged. However, in the second half of the period under study (2013, 2020), these groups become homogenised, and the size of the right tail decreases.

Figure 1

Kernel density functions for district income



The kernel density estimation reveals stable conditions in Hungary between 2001 and 2020, wherein income distribution is characterised by persistent formation of convergence clubs, with no significant or unidirectional overall convergence over the period under study (as indicated by the deviation from the normal density at all points in time).

Based on the log t-test methodology for convergence clubs, we conclude that the 175 districts do not converge to a common steady state in the period under study, as the t-value is well below the threshold of −1.65 (t-value = −127.688) (Table 1). Accordingly, we can reject the phenomenon of global convergence and assert that convergence clubs are present, which confirms the results of the kernel density tests.

Table 1

Log t-test of convergence for Hungarian districts

Country	Beta (std. error)	t-value	Per-taxpayer income (1,000 HUF)	
			2001	2020
Hungary	−0.926 (0.007)	−127.688	892.8	1,554.3

Note: the null hypothesis of convergence is rejected when the t-statistic is less than −1.65.

The 175 districts are primarily classified into seven clubs based on the Phillips–Sul algorithm, with a t-value > −1.65 for all clubs (Table A2, see in Appendix). The first two clubs are merged in the merging step, and the resulting new club also has a t-value above −1.65 (Table 2). The first two original clubs prior to merging have a beta coefficient with a positive sign, while the beta coefficient of the new club 1 becomes negative (−0.021) and cannot be considered statistically significant. Phillips–Sul (2009) achieved the same results. Based on their (and our) interpretation, this convergence club can also be considered independent, but it is also weaker compared with the remaining clubs.

Overall, this indicates that an independent steady state exists for six clusters (i.e. multiple equilibrium states across the country), with clearly differing growth and catch-up paths in the areas under study. No non-converging (diverging) district clubs are evident in Hungary between 2001 and 2020. The first club includes 34 districts, 15 in the second, 47 in the third, 51 in the fourth, 20 in the fifth and 8 in the sixth (Table A3, see in Appendix).

Therefore, the results reveal a 'multi- or six-speed' Hungary with clear initial and final time differentiation (Table 2). The majority of the beta values are between 0 and 2; therefore, the results do not show absolute convergence within any club; only relative (conditional) convergence (i.e. the convergence of growth rates can be observed between 2001 and 2020). Therefore, it is reasonable to assume that convergence within clubs is not only determined by the initial income position but also by other conditions (Borsi–Metiu 2015, Cutrini 2019).

The speed of convergence is the highest for clubs 5 and 6 (29.8% and 21.15%), while the others exhibit much lower and less significant values.

Table 2

Log t-test (final) results

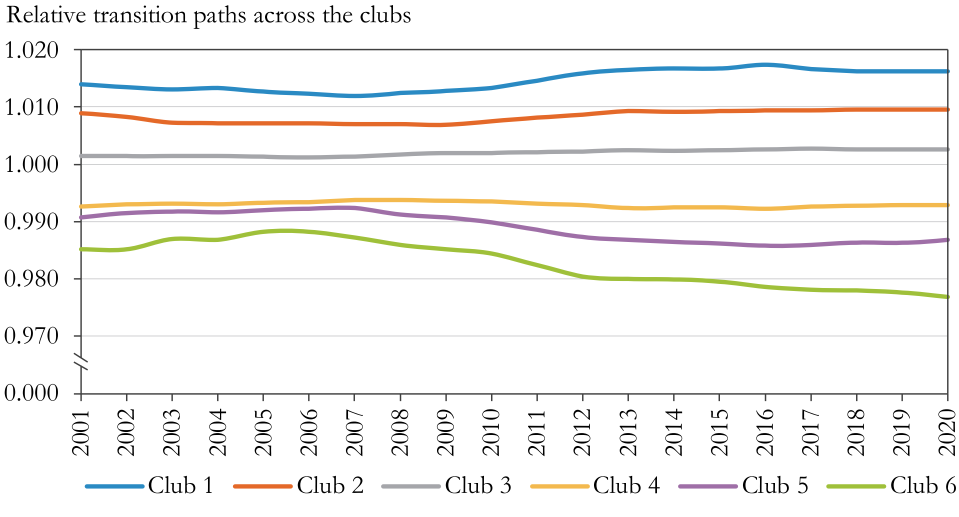
Clubs	Number of units	Beta (std. error)	t-value	$\hat{\alpha}$	Per-taxpayer income (1,000 HUF)	
					2001	2020
Club 1	34	−0.021 (0.073)	−0.288	−0.0105	1,087.8	1,854.0
Club 2	15	0.131 (0.084)	1.566	0.0655	881.5	1,586.2
Club 3	47	0.016 (0.052)	0.312	0.008	797.0	1,433.7
Club 4	51	0.02 (0.039)	0.504	0.01	694.5	1,230.5
Club 5	20	0.596 (0.102)	5.821	0.298	655.7	1,110.6
Club 6	8	0.423 (0.064)	6.560	0.2115	602.7	966.1

Note: α is the speed of convergence based on taxpayer income expressed in real terms (base year 2001).

The panel data contain one outstanding, one high, two average and two lagging clubs, based on income per taxpayer from 2001 to 2020 (Table 2, last two columns and Figure 2). Figure 2 illustrates the average relative transitions of the six convergence clubs based on income per taxpayer. All six clubs show a clearly distinct transition path in terms of performance over the entire period. The initial income levels differ significantly and seem to strongly influence the values of per-taxpayer income paths in the period from 2001 to 2020.

Figure 2

Relative transition paths of individual clubs in Hungary (income per taxpayer)

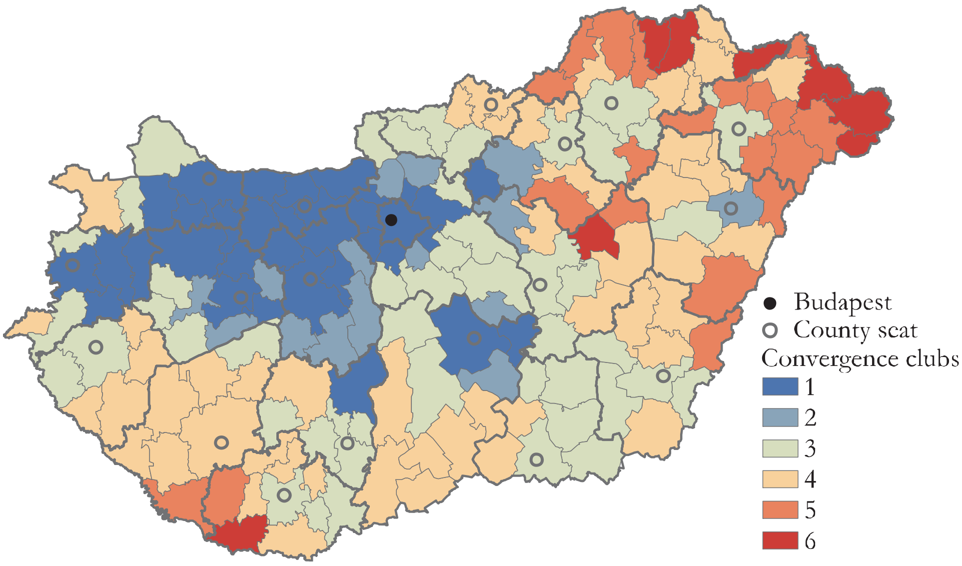


Note: the average relative transition paths are displayed in proportion to the average income level.

Significant relative changes in the paths emerge, particularly from the period between 2007 and 2009 (the start of the financial crisis), with richer (above-average performer) districts becoming richer and poorer (below-average performer) districts becoming even poorer and falling behind during the period under study. It is noteworthy that the relative amplitude of the decline in the least developed districts is more pronounced than the growth of the more developed districts. For the last two clubs, the convergence process shows a strong lagging phenomenon, indicating the poverty trap. Regional disparities tend to stabilise over time and persist after the economic crisis.

Figure 3

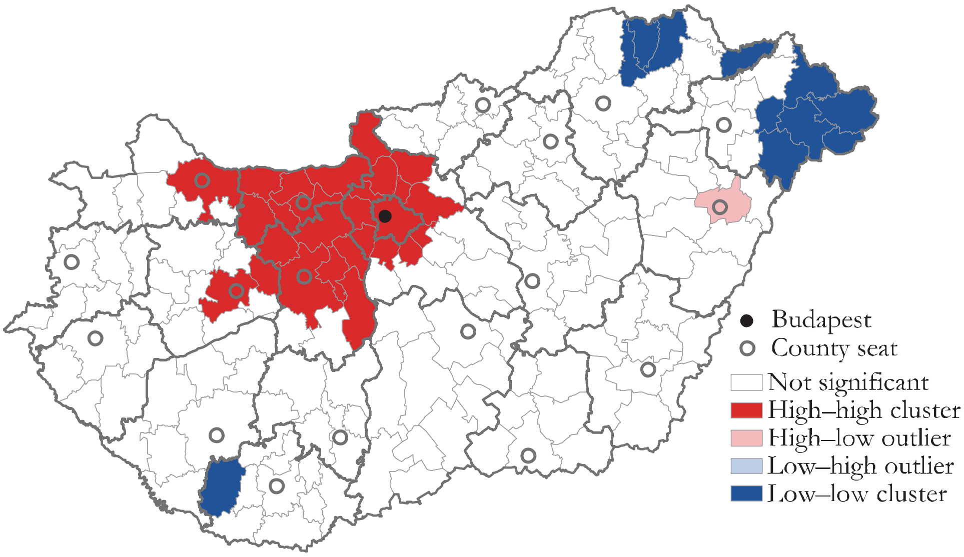
Spatial distribution of income convergence clubs in Hungary (2001–2020)



Further spatial results of the clustering process are presented in Figure 3, revealing a clear spatial agglomeration of income clubs, regardless of higher administrative classifications (e.g. counties). The influence of geographical proximity can be observed for all clubs. This is also confirmed by the global Moran's I values, which show major and significant spatial similarity between 2001 and 2020 (ranging from 0.498 to 0.621, with $p < 0.05$). The spatial concentration is particularly striking for the first club (north-western part of the country) and for the most underdeveloped fifth and sixth club areas in the north-eastern and south-western peripheries. This core–periphery relationship is also confirmed by the local spatial autocorrelation pattern of the income index for 2020, which reveals the neighbourhood similarities of the above-mentioned clubs. The only high–low outlier region is the Debrecen district (Figure 4).

Figure 4

Local spatial autocorrelation pattern of income per taxpayer (2020)



In addition to spatial distribution, the description of each convergence club is based on main endogenous characteristics (qualifications, unemployment and population distribution) (Table 3).

Table 3

Main characteristics of the convergence clubs in Hungary

Clubs	Qualified workforce rate (%)		Unemployment rate (%)		Population density (persons/km^2)		Population (1,000 inhabitants)	
	2003	2020	2001	2020	2001	2020	2001	2020
Club 1	43.5	45.4	2.8	3.0	236.1	244.7	3,755.8	3,895.1
Club 2	35.3	37.5	4.6	4.8	130.5	128.2	871.2	853.4
Club 3	34.3	35.3	5.4	5.2	101.5	93.6	2,819.5	2,599.0
Club 4	28.2	28.7	8.6	7.6	65.4	56.8	1,901.0	1,650.9
Club 5	24.5	22.4	12.8	11.3	65.1	56.8	639.0	557.7
Club 6	22.5	20.9	16.9	12.7	50.0	45.9	190.1	174.6
Total	36.4	37.4	5.6	5.2	109.4	104.6	1,0176.6	9,730.8

Note: data on qualified labour are only available from 2003 onwards. Source [1], [2], calculated and compiled by the authors.

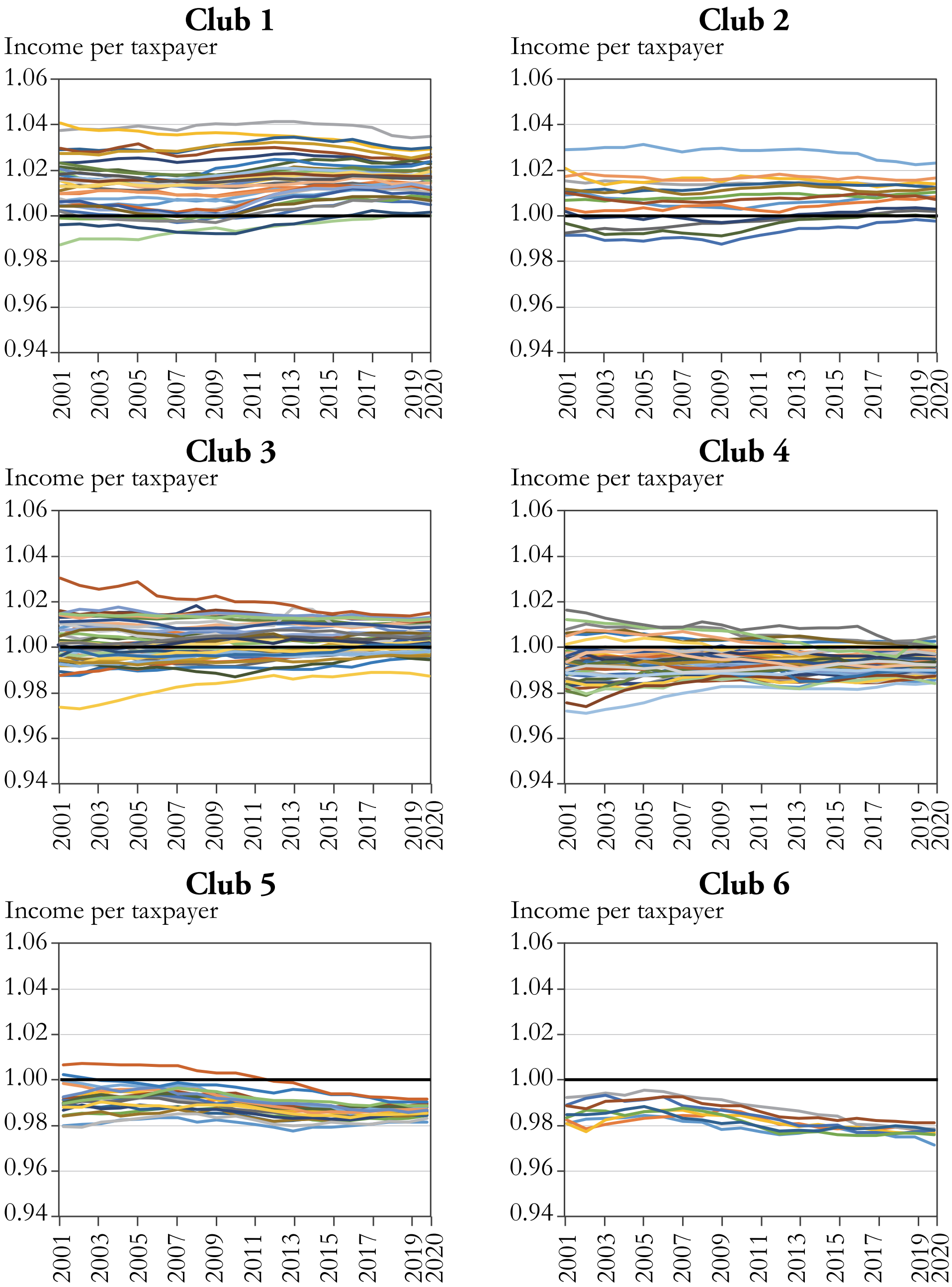
In terms of outstanding income, the first core cluster primarily includes the capital, the north-western county seats and their compact catchment areas (Székesfehérvár, Tatabánya, Győr, Veszprém, Szombathely). This contiguous block is joined by the districts of Paks in western Hungary and Hatvan and Kecskemét in the east. The cluster is characterised by the most favourable endowments in all respects, and during the period under study, incomes have been accompanied by an expansion of resources (particularly qualified workforce and population). A significant concentration of population is located here, with two-fifths of the country's population (nearly four million inhabitants). The second club appears mainly as a hinterland or territorial agglomeration of the above group, with the only exception being the Debrecen district in east Hungary, which includes the country's second largest city. The role of geographical proximity in the club's organisation is prominent and is likely to be a key factor in the fact that this club was already ahead of the national average income per taxpayer by 2020. The club has increased its advantage in the field of qualifications; however, its population is already in slight decline. The third (middle-income) club is primarily made up of the districts of rural county centres (Eger, Miskolc, Békéscsaba, Nyíregyháza, Szolnok, Szeged, Szekszárd, Pécs and Zalaegerszeg) and their narrower and wider catchment areas. The secondary cities of this group are heterogeneous and of decreasing size, some of them with an insular character and very little spatial dynamism (e.g. Miskolc, Pécs and Nyíregyháza). The fourth (also middle-income) club, although in a sense spatially contiguous, can be described by socio-economic peripheral characteristics, concentrating mainly in the south-western, south-eastern and eastern part of the country. Its major metropolitan areas (Kaposvár and Salgótarján) cannot generate significant growth or break out of their geographical environments. These two middle-income groups differ in terms of resources in line with income levels. Qualified workforce and unemployment levels improved over the period under review, while population characteristics exhibit a downwards trend. The last two (lagging) income clubs include contiguous external and internal transport geography and socio-economic peripheries, with improving employment but significant declines in the quantity and quality of human resources.

Figure 5 illustrates the relative transition paths of districts within their respective clubs, providing an opportunity to detect σ-convergence. The relative paths within all clubs between 2001 and 2020 have a predominantly funnel shape, indicating narrowing compared with the initial period, with clear territorial levelling. For each of the local income convergence clubs, the narrowing of gaps increased significantly in the period following the 2008 crisis. The visual impressions are also confirmed by the coefficient of variation values for the analysis of σ-convergence,[4] which indicate equalisation (σ-convergence) within the groups. While σ-convergence can be observed in individual clubs, it is not evident in the entire region.

[4] The CV values (%) for the beginning and end of the period examined and the (linear regression) beta coefficients showing income inequality trends within the clubs are as follows (betas are in parentheses): Club 1: 15.8 →11.6 (–0.288); Club 2: 14.0 → 9.6 (–0.310). Club 3: 13.2 → 8.4 (–0.293); Club 4: 11.7 → 6.7 (–0.281); Club 5: 9.6 → 3.6 (–0.286); Club 6: 5.8 → 3.9 (–0.213). In the case of Hungary as a whole: 18.32 → 18.00 (0.048).

Figure 5

Relative transition paths of districts by convergence clubs

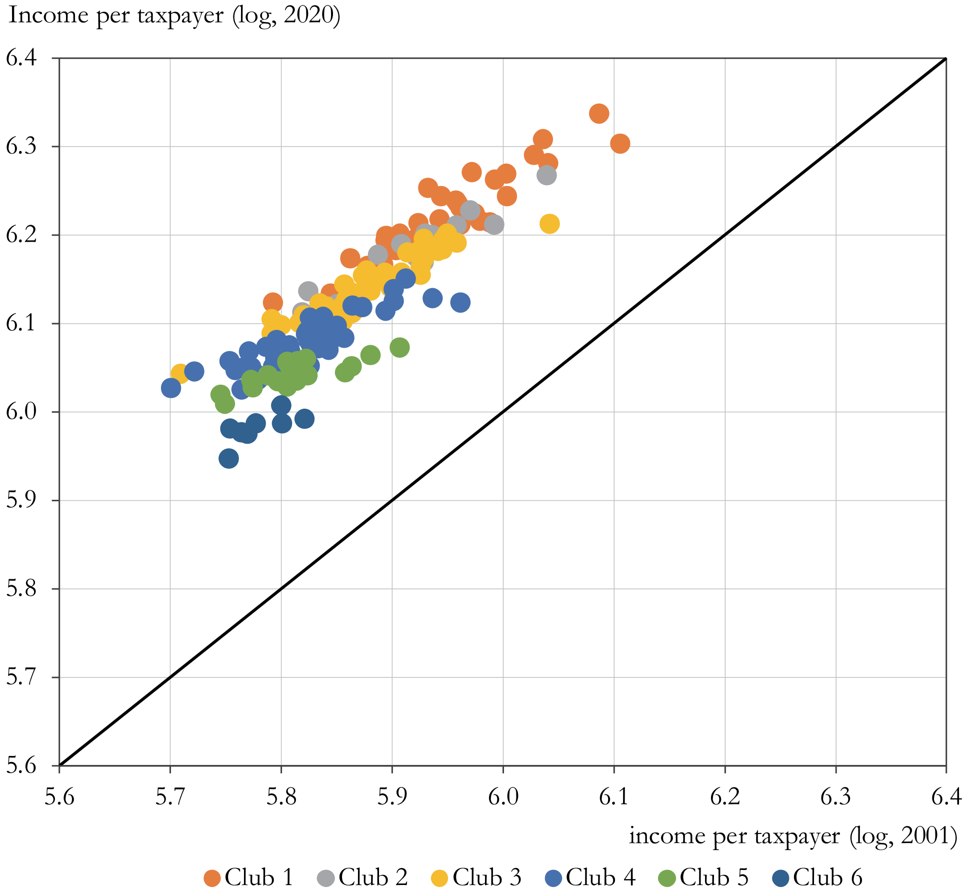


Note: in all cases, the y-axis reveals the districts' relative transition paths, which appear in proportion to the average income level. The thick black line indicates the national average.

Figure 6 illustrates the clubs' evolution in a scatter plot of income per taxpayer (log) between 2001 and 2020. The distance between each point and the 45 degree line shows the average growth rate of each district. The various clubs are vertically staggered according to initial income levels. The findings confirm the club convergence hypothesis, indicating that income paths and different steady-state conditions are actually shaped in alignment with the initial conditions. It is also clear that districts in higher income clubs experienced higher growth over the period under study. In addition, the figure shows that relatively lower income districts in each club had higher growth over the period under study. Therefore, the graphs expose the extremely complex features of local convergence in Hungary, revealing the phenomenon of catching up within each club and the significant differences between clubs.

Figure 6

Scatter plot of income convergence clubs (2001–2020)



Finally, Figure 6 presents a similar illustration of the intra-club income equalisation trends seen in Figure 5, with income differences in all clubs being higher in 2001 than in 2020. (For example, the log income per taxpayer in club 4 varies from 5.70 to 5.96 in 2001 but narrows to a range of 6.03–6.15 in 2020.)

Club formation results

While the results thus far indicate significant differences in income clubs, the club convergence hypothesis is not fully demonstrated, and a proper description of the club-forming effects of initial and structural factors is required. We use the solution proposed by Bartkowska–Riedl (2012) and von Lyncker–Thoennessen (2016) with the help of ordinal logistic regression. Although Galor (1996) identified the phenomenon of club convergence in the presence of traditional production factors (investment and labour), we omit these variables due to the close relationship with additional explanatory (initial and structural) variables and endogeneity (Cho 1996, Czaller 1996, Iammarino et al. 2020). (This is also referred to in Table 3.)

In Appendix, Table A4, we describe the average values of the assumed main club-forming factors according to the convergence clubs created based on the PS algorithm. The preliminary results indicate that the main characteristics of Galor (1996) seem to be significant club-forming factors, and a linear relationship is predominantly drawn based on club averages. (Higher income level indicates more favourable resource supply.) The strongest fault line is typical for the proxy of international capital flow (FDI) as the level in the first group is almost twice that of the second and third clubs, while it is a fraction of the income-prominent group in clubs 4–6. (In the case of club 6, which is affected by the poverty trap, no corporate tax benefit was available for FDI in the initial period.) In all cases, the Kruskal–Wallis test run on the basic data reveals significant differences between the individual convergence clubs, at a significance level of at least 0.002. $\eta 2$ values expressing the degree of significant separation belong to the large effect category in 90% of the cases, while in the case of the infant mortality rate variable the effect is intermediate. The most significant separation is evident for initial income, followed by knowledge level, the human capital index, neighbourhood income, fertility rate, life expectancy and the proxy of technological development

Since the preliminary results only indicate the average differences per club, and cannot point to marginal mechanisms, ordinal logistic regression is necessary.

The final ordinal logistic regression model in Table 4 shows an appropriately good fit in diagnostic terms (pseudo $R^2 = 0.760$), and most of the explanatory variables are significant and suggest an effect that aligns with previous research in the case of each income club.

The results demonstrate that club formation is primarily determined by such factors as complex human capital (health and qualifications), initial income level and income in neighbouring districts. Unit increments in all of these factors maintain the stability of more advanced clubs (1–3), while increasing the probability of leaving more income-deprived clubs (4–6). Accordingly, a unit growth in human capital increases the probability of remaining in the highest income club by 17.6%, while it increases the probability of leaving club 4 by 139.2%. Also, a unit growth in income increases the probability of staying in club 3 by 76.6%. A unit growth in the economic activity (income) of neighbouring areas (spillover effects) reduces the probability of staying in club 4 (i.e. increases the probability of catching up) by 38.7%.

Furthermore, the proxy indicators of technological development and economic structure (firms operating in high-tech and medium-HTKIS) explain club positions with lower probability but higher significance. Similar to the previous factors, unit growth increases the probability of staying for relatively more advanced clubs and the probability of leaving for more income-deprived groups. Fertility and intra-district income inequality function very similarly in terms of club formation, wherein their growth increases the probability of dropping out of advanced clubs and supports the poverty trap status of the less advanced clubs. (Fertility is a highly significant determinant.) The presence of FDI only marginally contributes to the formation of income clubs (the signs are the same as the club-by-club evolution of technological progress), with an insignificant effect in most clubs. We can assume that the characteristic distribution (and concentration) of FDI was already established in the initial period, and the spread of FDI is more typical of middle-income clubs.

Table 4

Determinants of club membership (ordered logistic regression results)

	Marginal effects on probabilities					
	1	2	3	4	5	6
Initial income per taxpayer	0.126** (0.054)	0.196** (0.085)	0.766*** (0.296)	−0.999*** (0.355)	−0.082** (0.039)	−0.006. (0.004)
Initial income per taxpayer (w)	0.049*** (0.016)	0.076*** (0.026)	0.297*** (0.070)	−0.387*** (0.075)	−0.032*** (0.012)	−0.002. (0.001)
Human capital	0.176*** (0.069)	0.272*** (0.105)	1.066*** (0.342)	−1.392*** (0.399)	−0.115** (0.049)	−0.008. (0.005)
Fertility rate	−0.009*** (0.003)	−0.015*** (0.005)	−0.057*** (0.015)	0.075*** (0.016)	0.006*** (0.002)	0.000* (0.000)
Income inequality	−0.020* (0.012)	−0.031* (0.019)	−0.123* (0.068)	0.161* (0.085)	0.013. (0.008)	0.001 (0.001)
High-tech enterprises	0.030** (0.014)	0.047** (0.022)	0.184** (0.079)	−0.240** (0.097)	−0.020** (0.010)	−0.001. (0.001)
FDI	0.002 (0.001)	0.003 (0.002)	0.013* (0.008)	−0.017* (0.010)	−0.001 (0.001)	−0.000 (0.000)
Threshold values	−58.822	−57.783	−55.049	−51.451	−48.731	–
Number of districts	33	15	47	51	20	8

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$, $p < 0,15$. Pseudo R^2 (Nagelkerke) is 0.760. The parallel regression assumption is not violated. Standard errors are in parentheses.

The marginal effects were not verified at the traditional (1%, 5% and 10%) significance levels for club 6 (only in the case of fertility) because of the low number of elements in this club. (Bartkowska–Riedl [2012] proposed merging the last two clubs to reach the appropriate number of elements by clubs as a solution to this.)[5]

The results also indicate that middle-income clubs (3 and 4) have the highest marginal effects, whereby these clubs offer the possibility for efficient interventions during development efforts. This result is obvious from a methodological (mathematical) perspective, and it is also supported by the specificity of these clubs containing potential secondary centres (county capitals) outside the core regions. Strengthening the growth stimulating effects of these areas would be justified to catch up peripheral regions; however, this speculation is beyond the focus of this study.

In summary, the analyses indicate that initial conditions are relevant factors in explaining local convergence clubs and club membership is predominantly determined by human capital and income.

Discussion

The various and complementary analyses clearly demonstrate the marked presence of local-level territorial income convergence clubs and club convergence in Hungary. The findings unambiguously confirm that no universal income convergence towards a single equilibrium state is evident. Rather, districts' convergence club formation, which Quah (1996) showed to be a pattern that is typical of countries around the world, leads to polarising income inequalities and subsequent spatially differentiated equilibrium states in the country.

The local approach to examine Hungary's income growth reveals the prominent role of geographical factors in explaining the spatial context of the convergence phenomenon. The income convergence clubs exhibit a clear spatial pattern, including traditional dimensions of territorial inequality such as the core–periphery dichotomy and strong differentiation along the urban–rural divide and between the north-western region together with the Budapest agglomeration and the rest of the country. Factors such as regionalisation and spatial proximity also strongly influence the locations of geographical income inequality clubs, a phenomenon that is consistent with the results at higher territorial levels (Le Gallo 2001). For example, based on the new economic geography (Krugman 1991), the spatial arrangement of district convergence clubs 1 and 2 suggests the presence of centripetal forces. Moreover, path dependence is also apparent in clubs' spatial organisation, which is particularly noteworthy in the case of Hungary's developed north-western region that belongs to the gravity zone of Vienna (Győri 2006) and in the case of the north-eastern and

[5] We also conducted ordinal logistic regression analysis according to this version, revealing that a significant difference is only evident in the case of the new, combined club (5+6), where the significance levels of the marginal probabilities improve.

south-western peripheries (Győri–Mikle 2017, Pénzes 2020). Furthermore, the individual clubs are clearly distinguishable in terms of endogenous resources, which aligns with previous main regional-level results (Fagerberg–Verspagen 1996, Szakálné Kanó–Lengyel 2021).

In the case of Hungary's micro-regional income convergence clubs, spatial development traps are clearly evident, echoing international results (Diemer et al. 2022, Iammarino et al. 2020), for the poorest districts (poverty trap, Azariadis–Stachurski 2005) and middle-income districts. Low- and middle-income clubs constitute the core area of the low-income convergence club in Hungary, which is also evident at the EU's higher territorial agglomeration level (NUTS 2), with regions that have a GDP per capita on a purchasing power parity basis that is less than half of the EU average (EC 2017). Additional investigations are needed to justify high-income groups' possible development trap situation.

The income movement of geographical convergence clubs align with the circular cumulative causation concept of Myrdal (1957), where richer (above-average performing) districts became richer and poorer (below-average performing) districts became even poorer during the period under study. These trends are particularly notable during the economic crisis after 2008 and in the subsequent period. Also, in line with the findings of Gunnar Myrdal (1957) for developing countries that the amplitude of the relative decline is more pronounced than the growth of more developed countries. The long-term impact of widening spatial disparities is a typical feature and (may) lead to persistent spatial trap scenarios in the future. Considering our results, it can be asserted that the theory of circular cumulative causation (Myrdal 1957) is clearly related to the emergence of convergence clubs. The results also show that convergence clubs' economic and non-economic factors reinforce one another (as shown in Tables 3 and 4).

Club convergence at subnational territorial levels (NUTS 2 regions) is well known and has been presented in detail (Szakálné Kanó–Lengyel 2021, Maulana–Aginta 2022, Aginta et al. 2022), and this phenomenon is also confirmed by our analyses at the local level. The phenomenon of club convergence can also be interpreted as a function of initial factors and structural characteristics in the case of Hungary, confirming the theories of Galor (1996) and Bartkowska–Riedl (2012).

Club convergence is significantly shaped by human capital, initial income and neighbourhood effects, and these findings align with those of von Lyncker–Thoennessen (2016) and Bartkowska–Riedl (2012) regarding EU NUTS 2 regions. A complex approach to human capital highlights the significance of qualifications and health status, which was previously somewhat ignored (Mankiw et al. 1992). Improvement of these variables indicates a substantial reserve in the Central and Eastern European region, including Hungary (Egri 2017). Concerning club formation, the spatial spillover effects indicate a complex impact, including the presence of traditional socio-economic interactions (knowledge and information technology spillovers, trade, capital and labour flow, economies of scale and transfer payments, among others; Rodríguez-Pose–Tselios 2015). In addition to income, the factors affecting convergence, including various labour market characteristics, the population's qualifications and health status and the spatiality of economic operations and activity (regionalisation based on spatial autocorrelation) are all verified local phenomena in Hungary (Alpek–Tésits 2019, Hajdú–Koncz 2022, Pénzes et al. 2018, Egri–Kőszegi 2016, Szakálné Kanó 2017, Jeneiné Gerő et al. 2021, Kincses–Tóth 2019).

The indicator of income inequality is partially indicative of the correlations according to the Kuznets (1955) curve. For the more income-deprived clubs (4–6), increased internal inequality contributes to the dropping out of the categories (i.e. in Kuznets models, an increase in inequality is necessary in the first stage of economic development). As to the more advanced clubs, any further increase in inequality threatens continued membership and increases the chances of dropping out. This demonstrates the economic transformation context that was still present at the beginning of the new millennium and was confirmed by Vida (2022) for the post-2010 period.

The presence of high-tech enterprises, which reflects economies' technological development and structural differences, is a significant (but weak) factor in the emergence of convergence clubs that is attributable to a complex phenomenon. This is indicative of a weak territorial innovation system (Lengyel 2012), weak institutional capacities and poor innovation capabilities of companies in Hungary (Rodríguez-Pose–Wilkie 2017, Karbowski 2017).

The less significant correlations for FDI can also be attributed to several factors. First, we use a proxy variable that is suitable for expressing FDI inflow. Völlmecke et al. (2014) noted that FDI-led growth in Central and Eastern European regions only occurs under the condition of technological accumulation linked to human capital. Second, the impact of FDI on growth is generally prevalent in the short run and during boom periods, while it has not been shown in recessionary periods (Gál–Lux 2014). The period under study includes both boom and recessionary periods.

The role of fertility is consistent with previous findings (Galor 1996, Azariadis–Stachurski 2005), and can be considered a significant determinant of the poverty trap in Hungary as well. The demographic transition after the regime change fundamentally altered fertility patterns (Őri–Spéder 2020, Tóth et al. 2024), which exhibit a clear inverse correlation with the conditions of development in the period under study (KSH 2012).

Summary

This study identified income inequality at local level in Hungary; a country affected by socio-economic transformation in Central and Eastern Europe, which has been accompanied by an increase in spatial disparities and their spatial implications, whose detection and improvement is justified for academic and policy considerations. Accordingly, our study examines the differences in income inequality in Hungarian districts after the millennium, with a special focus on convergence clubs. The results can be summarised as follows.

Based on the log t convergence test of Phillips–Sul (2007, 2009), the income per taxpayer for the 175 Hungarian districts (2001–2020) does not exhibit a common steady-state condition. Therefore, global convergence is not typical of Hungarian districts. In contrast, Hungary is shown to be multi-speed, including six income convergence clubs over the period under study.

Significant differences are observed between the income clubs. Although these clubs do not converge, σ-convergence within clubs is also typical. Clubs' movement (catch up or lag behind) is subject to internal and external conditions and cannot be considered automatic phenomena.

Furthermore, the spatial distribution of convergence clubs clearly reflects the specificities of Hungary's income spatial structure. In addition, income gaps appear to be persistent over the period under study and are likely to continue to persist in the long run. Evidence of the poverty trap is particularly striking in some Hungarian districts, demonstrating a steady and rapid lag. From a territorial policy perspective, it is particularly crucial to halt the lag of these areas.

Human capital, initial income and neighbours' income are the primary determinants of club formation, while technological development, fertility, income inequality and FDI also influence districts' club membership. These correlations confirm the validity of the club convergence hypothesis for Hungarian districts.

Moreover, the results emphasise the need for spatially differentiated regional development policies to strategically address regional income inequality. In particular, income traps affect low- and middle-income districts but it may also affect high-income districts (Diemer et al. 2022). According to our explanatory model, the circumstances of middle-income clubs, including second-tier cities, is particularly notable as spatial economic policy interventions could lead to major changes in existing positions. Iammarino et al. (2020) proposed a 'place-sensitive' set of development policy instruments to address territorial disparities in the case of income-based but structurally different spatial development clubs, tailoring public and other (supranational) interventions to the needs of each club. To approximate territorial convergence, we propose applying this toolkit to domestic district categories as well, based essentially on endogenous characteristics.

The delimitation of the convergence clubs is based on the real income per-taxpayer subject to personal income tax indicator, which can be considered limited and does not fully express the economic activity at the district level.

Although it seems to be a suitable proxy variable to replace, for example, gross domestic product or gross value added, an official estimate regarding such indicators would be justified. The replacement of all these indicators is justified in relation to future research on the convergence of indicators expressing economic activity.

Appendix

Table A1

The main characteristics of the applied database

	Mean	Standard deviation	Minimum	Maximum	Obser-vations
Active enterprises per 10,000 inhabitants in high-tech and medium-high-tech manufacturing and knowledge-intensive services	5.53	3.12	0.00	17.91	175
General fertility rate	20.08	3.48	13.56	33.75	175
Infant mortality rate (‰)	8.70	3.87	0.00	23.90	175
Average school classes completed (years)	9.10	0.58	7.94	10.95	175
Life expectancy at birth (years)	71.61	1.28	68.64	74.31	175
Human capital index	0.52	0.15	0.13	0.88	175
Robin Hood index (%)	27.49	11.98	5.52	67.43	175
Corporate tax benefit per 1,000 inhabitants due to foreign participation in a business enterprise (1,000 HUF)	8.89	29.637	0.00	226.49	175
Real income per-taxpayer subject to personal income tax (1,000 HUF)	961.881	233.006	501.734	2,174.292	3.500
Taxable income in neighbouring districts per taxpayer (1,000 HUF)	736.430	122.451	560.221	1,101.554	175

Note: source [1], [2], calculated and compiled by the authors.

Table A2

Convergence clubs before merging step (PS method)

Clubs	Number of units	Beta	Std. error	t-value
Club 1	7	0.157	0.088	1.776
Club 2	27	0.108	0.081	1.327
Club 3	15	0.131	0.084	1.566
Club 4	47	0.016	0.052	0.312
Club 5	51	0.020	0.039	0.504
Club 6	20	0.596	0.102	5.821
Club 7	8	0.423	0.064	6.560

Table A3

Members of clubs (final classification of districts)

Clubs	Members
Club 1	Budakeszi, Dunakeszi, Győri, Paksi, Gárdonyi, Téti, Pannonhalmi, Budapest, Pilisvörösvári, Érdi, Gödöllői, Székesfehérvári, Tatai, Szigetszentmiklósi, Móri, Oroszlányi, Vecsési, Komáromi, Tatabányai, Veszprémi, Szombathelyi, Bicskei, Esztergomi, Hatvani, Kecskeméti, Kisbéri, Balatonalmádi, Sárvári, Csornai, Zirci, Pápai, Celldömölki, Vasvári, Tiszakécskei
Club 2	Szentendrei, Váci, Dunaújvárosi, Debreceni, Gyöngyösi, Martonvásári, Gyáli, Várpalotai, Jászberényi, Ajkai, Balatonfüredi, Nagykőrösi, Kiskunfélegyházi, Sárbogárdi, Enyingi
Club 3	Tiszaújvárosi, Szobi, Szolnoki, Szegedi, Pécsi, Egri, Monori, Szekszárdi, Miskolci, Aszódi, Zalaegerszegi, Körmendi, Tolnai, Rétsági, Dabasi, Nyíregyházi, Békéscsabai, Balassagyarmati, Ceglédi, Ráckevei, Mosonmagyaróvári, Mezőkövesdi, Kőszegi, Gyulai, Nagykátai, Siófoki, Hódmezővásárhelyi, Tapolcai, Bólyi, Szentesi, Hajdúszoboszlói, Pásztói, Lenti, Dombóvári, Makói, Orosházi, Kapuvári, Devecseri, Kunszentmiklósi, Csongrádi, Szarvasi, Bonyhádi, Mohácsi, Törökszentmiklósi, Sümegi, Kunszentmártoni, Kiskőrösi
Club 4	Szentgotthárdi, Kazincbarcikai, Kaposvári, Nagykanizsai, Sátoraljaújhelyi, Kiskunhalasi, Soproni, Sárospataki, Salgótarjáni, Bátonyterenyei, Pécsváradi, Bajai, Letenyei, Kisvárdai, Keszthelyi, Mezőtúri, Füzesabonyi, Bélapátfalvai, Jászapáti, Pétervásárai, Kalocsai, Zalaszentgróti, Karcagi, Hajdúnánási, Komlói, Nagyatádi, Marcali, Kiskunmajsai, Szeghalmi, Tabi, Szentlőrinci, Békési, Tokaji, Hajdúböszörményi, Fonyódi, Szerencsi, Püspökladányi, Tamási, Hajdúhadházi, Gyomaendrődi, Siklósi, Csurgói, Szécsényi, Mórahalmi, Hegyháti, Balmazújvárosi, Jánoshalmi, Derecskei, Mezőkovácsházai, Bácsalmási, Kisteleki
Club 5	Záhonyi, Tiszavasvári, Tiszafüredi, Mátészalkai, Berettyóújfalui, Nyírbátori, Hevesi, Barcsi, Ózdi, Szikszói, Putnoki, Szigetvári, Nyíradonyi, Edelényi, Nagykállói, Mezőcsáti, Kemecsei, Ibrányi, Sarkadi, Baktalórántházai
Club 6	Vásárosnaményi, Encsi, Sellyei, Csengeri, Fehérgyarmati, Gönci, Kunhegyesi, Cigándi

Table A4

Average values of club-forming factors and Kruskal–Wallis test results (2001)

	Club 1	Club 2	Club 3	Club 4	Club 5	Club 6	KW test stat. (η2)
Real income per-taxpayer subject to personal income tax (1,000 HUF)	897.927	837.037	756.799	670.086	652.072	603.198	88.93 (0.50)
Taxable income in neighbouring districts per taxpayer (1,000 HUF)	850.032	795.125	752.542	650.896	625.228	600.850	73.13 (0.40)
Human capital index	0.63	0.60	0.56	0.48	0.34	0.24	75.52 (0.42)
Life expectancy at birth (years)	72.52	72.00	71.99	71.38	70.29	69.64	63.24 (0.35)
Infant mortality rate (‰)	7.96	7.12	8.33	8.42	10.76	13.71	19.29 (0.09)
Average school classes completed (years)	9.57	9.44	9.28	8.91	8.46	8.29	85.81 (0.48)
General fertility rate	18.28	18.79	18.53	20.17	24.41	27.75	64.21 (0.35)
Robin Hood index (%)	32.26	34.07	28.28	24.40	22.12	23.30	29.09 (0.15)
Active enterprises per 10,000 inhabitants in high-tech and medium-high-tech manufacturing and knowledge-intensive services	7.59	6.65	6.50	4.49	2.87	2.15	60.15 (0.33)
Corporate tax benefit per 1,000 inhabitants due to foreign participation in a business enterprise (1,000 HUF)	21.017	10.105	12.759	1.155	1.580	0.000	48.21 (0.26)

Acknowledgements

The research of Zoltán Egri was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences. The authors would like to thank the anonymous reviewers for their advice and suggestions.

REFERENCES

AGINTA, H.–GUNAWAN, A. B.–MENDEZ, C. (2022): Regional income disparities and convergence clubs in Indonesia: new district-level evidence *Journal of the Asia Pacific Economy* 28 (1): 101–132. https://doi.org/10.1080/13547860.2020.1868107

ALEXIADIS, S. (2013): Convergence Clubs and Spatial Externalities Springer, Heidelberg. https://doi.org/10.1007/978-3-642-31626-5

ALPEK, B. L.–TÉSITS, R. (2019): A foglalkoztathatóság mérési lehetőségei és térszerkezete Magyarországon *Területi Statisztika* 59 (2): 164–187. https://doi.org/10.15196/TS590203

ANSELIN, L. (1995): Local indicators of spatial association – LISA *Geographical Analysis* 27 (2): 93–115. https://doi.org/10.1111/j.1538-4632.1995.tb00338.x

AZARIADIS, C.–STACHURSKI, J. (2005): Poverty traps. In: AGHION, P.–DURLAUF, S. (eds.): *Handbook of economic growth* edition 1, volume 1: pp. 296–384., Elsevier.

BALÁS, G.–CSITE, A.–JAKOBI, Á.–KISS, G.–MEGYESI, B.–MAJOR, K.–SZABÓ, P. (2013): *Az EU-s támogatások területi kohézióra gyakorolt hatásainak értékelése* Végső értékelési jelentés. Pannon Elemző – revita Alapítvány – Hétfa Elemző Központ.

BARRO, R. J.–SALA-I-MARTIN, X. (1995): *Economic Growth Theory* McGrawHill, Boston.

BARTKOWSKA, M.–RIEDL, A. (2012): Regional convergence clubs in Europe: identification and conditioning factors *Economic Modelling* 29 (1): 22–31. https://doi.org/10.1016/j.econmod.2011.01.013

BAUMOL, W. J. (1986): Productivity growth, convergence and welfare: what the long run data show? *The American Economic Review* 76 (5): 1072–1085.

BAUMOL, W. J.–WOLFF, E. N. (1988): Productivity growth, convergence, and welfare: reply *American Economic Review* 78 (5): 1155–1159.

BORSI, M. T.–METIU, M. (2015): The evolution of economic convergence in the European Union *Empirical Economics* 48: 657–681. https://doi.org/10.1007/s00181-014-0801-2

CAPELLO, R.–PERUCCA, G. (2013): Do Eastern European regions move towards an endogenous growth pattern? A diachronic perspective of regional success factors *GRINCOH Working Paper Series*, Paper No. 1.15.

CASTELLÓ-CLIMENT, A.–DOMÉNECH, R. (2021): Human capital and income inequality revisited *Education Economics* 29 (2): 194–212. https://doi.org/10.1080/09645292.2020.1870936

CHO, D. (1996): An alternative interpretation of conditional convergence *Results Journal of Money, Credit and Banking* 28 (4): 669–681. https://doi.org/10.2307/2078077

CUTRINI, E. (2019): Economic integration, structural change, and uneven development in the European Union *Structural Change and Economic Dynamics* 50: 102–113. https://doi.org/10.1016/j.strueco.2019.06.007

CZALLER, L. (2016): Agglomeráció, regionális növekedés és konvergencia *Területi Statisztika* 56 (3): 275–300. https://doi.org/10.15196/TS560302

CSITE, A.–NÉMETH, N. (2007): Az életminőség területi differenciái Magyarországon: a kistérségi szintű HDI becslési lehetőségei *Budapest Working Papers On The Labour Market* BWP – 2007/3.

DIEMER, A.–IAMMARINO, S.–RODRÍGUEZ-POSE, A.–STORPER, M. (2022): The regional development trap in Europe *Economic Geography* 98 (5): 487–509. https://doi.org/10.1080/00130095.2022.2080655

DURLAUF, S. N.–JOHNSON, A. P. (1995): Multiple regimes and cross-country growth behaviour *Journal of Applied Econometrics* 10 (4): 365–384. https://doi.org/10.1002/jae.3950100404

EGRI, Z. (2017): Regional health inequalities in the European macroregion from the East Central European perspective *Regional Statistics* 7 (1): 197–224. https://doi.org/10.15196/RS070111

EGRI, Z. (2020): A területi jövedelemegyenlőtlenségek változása Békés megyében, 1988–2017 *Területi Statisztika* 60 (4): 477–512. http://doi.org/10.15196/TS600404

EGRI, Z. (2022): A hazai települési jövedelemegyenlőtlenségek sajátosságai a földrajzi közelhatások alapján, 2012–2019 *Területi Statisztika* 62 (6): 625–662. https://doi.org/10.15196/TS620601

EGRI, Z.–KŐSZEGI, I. R. (2016): Az egészségi állapot szerepe hazánk területi gazdasági fejlődésében *Területi Statisztika* 56 (5): 520–548. https://doi.org/10.15196/TS560502

EUROPEAN COMMISSION [EC] (2017): *Competitiveness in low-income and low-growth regions: the lagging regions report* Publications Office of the European Union, Brussels.

EZCURRA, R.–DEL VILLAR, A. (2021): Globalization and spatial inequality: does economic integration affect regional disparities? *The Annals of Regional Science* 67 (2): 335–358. https://doi.org/10.1007/s00168-021-01050-5

FAGERBERG, J.–VERSPAGEN, B. (1996): Heading for divergence? Regional growth in Europe reconsidered *Journal of Common Market Studies* 34 (3): 431–448. https://doi.org/10.1111/j.1468-5965.1996.tb00580.x

FRIEDRICH-ECKEY, H.–TÜRCK, M. (2007): Convergence of EU-regions a literature report *Investigaciones Regionales – Journal of Regional Research* 10: 5–32.

GÁL, Z.–LUX, G. (2014): ET2050 *Territorial scenarios and visions for Europe volume 8 – Territorial scenarios and visions for Central and Eastern Europe* Final Report, ESPON, Luxembourg.

GALOR, O. (1996): Convergence? Inferences from theoretical models *The Economic Journal* 106 (437): 1056–1069.

GORZELAK, G. (2020): Regional policies in East-Central Europe. In: FISCHER, M.–NIJKAMP, P. (eds.): *Handbook of regional science* 2nd edition, pp. 1087–1114., Springer-Verlag Berlin Heidelberg. https://doi.org/10.1007/978-3-662-60723-7

GYŐRI, R. (2006): Bécs kapujában Területi fejlettségi különbségek a Kisalföld déli részén a 20. század elején *Korall Társadalomtörténeti folyóirat* 24-25: 231–250.

GYŐRI, R.–MIKLE, G. (2017): A fejlettség területi különbségeinek változása Magyarországon, 1910–2011 *Tér és Társadalom* 31 (3): 144–164. https://doi.org/10.17649/TET.31.3.2866

HAJDÚ, D.–KONCZ, G. (2022): Employment data of participants in supported adult training for jobseekers and their territorial pattern in Hungary, 2010–2020 *Regional Statistics* 12 (2): 117–148. https://doi.org/10.15196/RS120205

IAMMARINO, S.–RODRÍGUEZ-POSE, A.–STORPER, M. (2017): Why regional **d**evelopment matters for Europe's economic future *Working papers DG for Regional and Urban Policy* Publications Office of the European Union, Luxembourg.

IAMMARINO, S.–RODRÍGUEZ-POSE, A.–STORPER, M.–DIEMER, A. (2020): *Falling into the middle-income trap? A study on the risks for EU regions to be caught in a middle-income trap* Publications Office of the European Union, Luxembourg. https://doi.org/10.2776/02363

JENEINÉ GERŐ, H. E.–KINCSES, Á.–TÓTH, G. (2021): A hazai mikro-, kis- és középvállalkozások térbeli jellegzetességei *Területi Statisztika* 61 (6): 769–796. https://doi.org/10.15196/TS610604

KARBOWSKI, A. (2017): Institutional underpinnings of the development of knowledge subsystems in Central and Eastern Europe *Ekonomista* 1: 30–46.

KINCSES, Á.–TÓTH, G. (2019): A Magyarországon élő külföldi kötődésű népesség térbeli autokorreláltsága *Területi Statisztika* 59 (6): 579–606. https://doi.org/10.15196/TS590601

KOTOSZ, B. (2016): A konvergencia területisége és lokális szintű mérése: elméleti áttekintés *Területi Statisztika* 56 (2): 139–157. https://doi.org/10.15196/TS560203

KOTOSZ, B.–LENGYEL, I. (2018): Térségek konvergenciájának vizsgálata a V4-országokban *Statisztikai Szemle* 96 (11–12): 1069–1090. https://doi.org/10.20311/stat2018.11-12.hu1069

KRUGMAN, P. (1991): *Geography and trade* MIT Press, Cambridge.

KUZNETS, S. (1955): Economic Growth and Income Inequality *The American Economic Review* 45 (1): 1–28.

LE GALLO, J. (2001): *Space-time analysis of GDP disparities among European regions: a Markov chains approach* [Research Report] Laboratoire d'analyse et de techniques économiques (LATEC).

LE GALLO, J.–FINGLETON, B. (2013): Regional growth and convergence empirics. In: FISCHER, M. M.–NIJKAMP, P. (eds.): *Handbook of regional science* pp. 291–316., Springer, Heidelberg–New York–Dordrecht–London.

LENGYEL, B. (2012): *Tudásalapú regionális fejlődés* L'Harmattan Kiadó, Budapest.

LENGYEL, I.–VARGA, A. (2018): A magyar gazdasági növekedés térbeli korlátai – helyzetkép és alapvető dilemmák *Közgazdasági Szemle* 65 (5): 499–524. http://dx.doi.org/10.18414/KSZ.2018.5.499

LEONIDA, L.–MONTOLIO, D. (2001): Convergence and inter-distributional dynamics among the Spanish provinces. A non-parametric density estimation approach *Working Papers* 2001/7, Institut d'Economia de Barcelona (IEB).

LI, F.–GUANGDONG, L.–WEISHAN, O.–JING, O.–HAITAO, M. (2018): Identifying economic growth convergence clubs and their influencing factors in China *Sustainability* 10: 2588. https://doi.org/10.3390/su10082588

LŐCSEI, H. (2010): *Területi Növekedési Pályák Magyarországon, 1990–2008* Doktori disszertáció ELTE TTK Földtudományi Doktori Iskola, Budapest.

MAJOR, K. (2007): Markov láncok használata a regionális jövedelemegyenlőtlenségek előrejelzésében *Tér és Társadalom* 21 (1): 53–67. https://doi.org/10.17649/TET.21.1.1093

MANKIW, N. G.–ROMER, D.–WEIL, D. N. (1992): A contribution to the empirics of economic growth *The Quarterly Journal of Economics* 107 (2): 407–437. http://dx.doi.org/10.2307/2118477

MASTRONARDI, L.–CAVALLO, A. (2020): The spatial dimension of income inequality: an analysis at municipal level *Sustainability* 12 (4): 1622. https://doi.org/10.3390/su12041622

MCKELVEY, R. D.–ZAVOINA, W. (1975): A statistical model for the analysis of ordinal level dependent variables *The Journal of Mathematical Sociology* 4 (1): 103–120. https://doi.org/10.1080/0022250X.1975.9989847

MONFORT, P. (2020): Convergence of EU regions redux recent trends in regional disparities *Working Papers* 2/2020, Publications Office of the European Union, Brussels.

MORAN, P. A. P. (1948): The interpretation of statistical maps *Journal of the Royal Statistical Society B* 10 (2): 243–251. https://doi.org/10.1111/j.2517-6161.1948.tb00012.x

MAULANA, M. R.–AGINTA, H. (2022): Testing for convergence clubs in real wage across Indonesian provinces from 2008 to 2020 *Regional Statistics* 12 (3): 104–130. https://doi.org/10.15196/RS120305

MYRDAL, G. (1957): *Economic theory and underdeveloped regions* Gerald Duckworth & Co Ltd, London.

NEMES NAGY, J. (2009): *Terek, helyek, régiók: A regionális tudomány alapjai* Akadémiai Kiadó, Budapest.

NÉMETH, N.–KISS, J. P. (2007): Megyéink és kistérségeink belső jövedelmi tagoltsága *Területi Statisztika* 47 (1): 20–45.

ŐRI, P.–SPÉDER, ZS. (2020): Folytonos átmenet: Magyarország népesedése 1920 és 2020 között *Statisztikai Szemle* 98 (6): 481–521. https://doi.org.10.20311/stat2020.6.hu0481

PEETERS, L. (2008): Selective in-migration and income convergence and divergence across Belgian municipalities *Regional Studies* 42 (7): 905–921. https://doi.org/10.1080/00343400701541839

PÉNZES, J. (2020): The impact of the Trianon Peace Treaty on the border zones – an attempt to analyse the historic territorial development pattern and its changes in Hungary *Regional Statistics* 10 (1): 60–81. https://doi.org/10.15196/RS100102

PÉNZES, J.–KISS, J. P.–DEÁK, A.–APÁTI, N. (2018): Térségi sokszínűség és stabilitás: Az iskolázottság települési szintű egyenlőtlenségeinek változása Magyarországon 1990–2011 között *Területi Statisztika* 58 (6): 567–594. https://doi.org/10.15196/TS580602

PHILLIPS, P. C.–SUL, D. (2007): Transition modeling and econometric convergence tests *Econometrica* 75 (6): 1771–1855. https://doi.org/10.1111/j.1468-0262.2007.00811.x

PHILLIPS, P. C.–SUL, D. (2009): Economic transition and growth *Journal of Applied Econometrics* 24 (7): 1153–1185. https://doi.org/10.1002/jae.1080

QUAH, D. (1993): Galton's fallacy and test of the convergence hypothesis *Scandinavian Journal of Economics* 95 (4): 427–443. https://doi.org/10.2307/3440905

QUAH, D. (1996): Empirics for economic growth and convergence *European Economic Review* 40 (6): 1353–1375. https://doi.org/10.1016/0014-2921(95)00051-8

RATTSØ, J. (2008): *Puzzles of convergence and catching up: regional income growth in Norway* mimeo, Department of Economics, Norwegian University of Science and Technology.

RATTSØ, J.–STOKKE, E. (2010): Migration and dynamic agglomeration economies: time-series evidence from Norway *Working Paper Series* No.: 11111, Department of Economics, Norwegian University of Science and Technology, Oslo.

RESENDE, G. M.–DE CARVALHO, A. X. Y.–SAKOWSKI, P. A. M.–CRAVO, T. A. (2016): Evaluating multiple spatial dimensions of economic growth in Brazil using spatial panel data models *The Annals of Regional Sciences* 56:1–31. https://doi.org/10.1007/s00168-015-0706-9

RODRÍGUEZ-POSE, A.–TSELIOS, V. (2015): Toward inclusive growth: is there regional convergence in social welfare? *International Regional Science Review* 38 (1): 30–60. https://doi.org/10.1177/0160017613505201

RODRÍGUEZ-POSE, A.–WILKIE, C. (2017): Innovation and competitiveness in the periphery of Europe. In: HUGGINS, R.–THOMPSON, P. (eds.): *Handbook of regions and competitiveness contemporary theories and perspectives on economic development* pp. 351–380., Edward Elgar Publishing, Cheltenham.

SICHERA, R.–PIZZUTO, P. (2019): ConvergenceClubs: a package for performing the Phillips and Sul's club **c**onvergence clustering procedure *The R Journal* 11 (2): 142–151.

SMĘTKOWSKI, M. (2015): Spatial patterns of regional economic development in Central and Eastern European countries *Geographia Polonica* 88 (4): 539–555. https://doi.org/10.7163/GPol.0033

SMĘTKOWSKI, M. (2018): The role of exogenous and endogenous factors in the growth of regions in Central and Eastern Europe: the metropolitan/non-metropolitan divide in the pre- and post-crisis era *European Planning Studies* 26 (2): 256–278. https://doi.org/10.10)80/09654313.2017.1361585

SZAKÁLNÉ KANÓ, I. (2017): A gazdasági aktivitás térbeli eloszlásának vizsgálati lehetőségei. In: LENGYEL, I. (szerk.): 2017: *Két évtizedes a regionális tudományi műhely Szegeden:1997–2017* pp. 357–378., JATEPress, Szeged.

SZAKÁLNÉ KANÓ, I.–LENGYEL, I. (2021): Convergence clubs of NUTS 3 regions of the V4 Group *E&M Economics and Management* 24 (4): 22–38. https://doi.org/10.15240/tul/001/2021-4-002

TIPAYALAI, K.–MENDEZ, C. (2022): Regional convergence and spatial dependence in Thailand: global and local assessments, *Journal of the Asia Pacific Economy* 29 (2): 693–720. https://doi.org/10.1080/13547860.2022.2041286

TÓTH, G.–KINCSES, Á.–KOVÁCS, M. (2024): A termékenység térbelisége Magyarországon, 2021 *Területi Statisztika* 64 (1): 30–50 https://doi.org/10.15196/TS640102

VIDA, GY. (2022): A regionális megvalósult versenyképesség néhány szempontjának területi jellemzői Magyarországon 2010 és 2019 között *Területi Statisztika* 62 (5): 538–569. https://doi.org/10.15196/TS620503

VON LYNCKER, K.–THOENNESSEN, R. (2016): Regional club convergence in the EU: evidence from a panel data analysis *Empirical Economics* 52 (2): 525–553. https://doi.org/10.1007/s00181-016-1096-2

VÖLLMECKE, D.–MAREK, P.–JINDRA, B. (2014): Regional growth dynamics in the new EU member states – the role of FDI and human capital *GRINCOH Working Paper Series* Paper No. 2.12.

WILLIAMSON, J. G. (1965): Regional inequality and the process of national development: a description of the patterns *Economic Development and Cultural Change* 4 (2): 3–84. https://doi.org/10.1086/450136

INTERNET SOURCES

AYOUBA, K.–LE GALLO, J. (2020): *D2.5. Report on spatiotemporal ESDA on GDP, income and educational attainment in European regions, 2019* ffhal-02789469ff. https://hal.inrae.fr/hal-02789469 (downloaded: September 2021)

DUSEK, T. (2006): Regional income differences in Hungary: a multi-level spatio-temporal analysis *Conference Paper, 46th Congress of the European Regional Science Association* Volos. http://www-sre.wu.ac.at/ersa/ersaconfs/ersa06/papers/284.pdf (downloaded: August 2012)

EUROPEAN UNION [EU] (1957): *Treaty establishing the European community (consolidated version)* Rome Treaty, 25 March 1957. https://www.refworld.org/docid/3ae6b39c0.html (downloaded: September 2020)

KÖZPONTI STATISZTIKAI HIVATAL [KSH] (2012): *A gyermekvállalás társadalmi-gazdasági hátterének területi jellemzői.* https://www.ksh.hu/docs/hun/xftp/idoszaki/regiok/szegedgyermekvallalas.pdf (downloaded: September 2020)

LE GALLO, J.–DALL'ERBA, S. (2005): *Spatial econometric analysis of the evolution of the European regional convergence process, 1980–1999* Technical report, EconWPA. https://econwpa.ub.unimuenchen.de/econ-wp/urb/papers/0311/0311001.pdf (downloaded: October 2020)

OFTK – NEMZETI FEJLESZTÉS 2030 (2013): Országos Fejlesztési és Területfejlesztési Koncepció *Magyar Közlöny* 2014/1. sz. https://regionalispolitika.kormany.hu/download/a/c9/e0000/MK14001.pdf (downloaded: September 2021)

PÉNZES, J. (2019): *A hazai területi egyenlőtlenségek alakulása jövedelmi mutatók tükrében* A Magyar Regionális Tudományi Társaság XVII. Vándorgyűlése Területi kutatások Közép-Európában, Sopron, 2019. október 11. http://www.mrtt.hu/vandorgyulesek/2019/07/penzes.pdf (downloaded October 2020)

DATABASES/WEBSITES

[1] NATIONAL SPATIAL DEVELOPMENT AND PLANNING INFORMATION SYSTEM: https://www.oeny.hu/oeny/teir/#/ (downloaded: December 2021)

[2] HUNGARIAN CENTRAL STATISTICAL OFFICE: https://www.ksh.hu/?lang=en (downloaded: November 2021)