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"A gazdasági teljesítmény és a jóllét területi és térbeli összefüggései Magyarországon" c. posztdoktori kutatás keretében végzett kutatási feladatok - Working Paper

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Bevezetés

A kutatásom középpontjában alapvetően a jóllét (well-being) és a gazdasági teljesítmény kapcsolata állt. A jóllét összefüggéseivel számos szerző foglalkozott (SEN 1988, PATAKI 1998, STANTON 2005, STIGLITZ et al. 2009, OECD 2015), ugyanakkor az utóbbi évtizedekben annak a gazdasági fejlettséggel való konfliktusa is előtérbe került (UNDP 1996, NEMES NAGY 1998, SEN 1998, UNDP 2016). A magyar jóllét területi vizsgálata igen elterjedtnek mondható (NEMES NAGY 2000, OBÁDOVICS-KULCSÁR 2003, CSITE-NÉMETH 2007, BAJMÓCY-LENGYEL 2010, FARKAS 2012, PÉNZES 2014, NAGY-KOÓS 2014), viszont a két jelenség kapcsolata, azok komplex viszonyai eddig nem kerültek kibontásra részleteiben, főként térgazdasági körülmények között nem ismertek a kapcsolódások. (Pl. a sokat citált LENGYEL Imre versenyképességi piramisában (2017), a megvalósult versenyképességet jelző alapkategóriák [GDP/fő, termelékenység, foglalkoztatottság] és a "célok" [életminőség, életszínvonal] összefüggései nem ismertek.) A kutatási téma tehát a Myrdall, Sen, Hirschman és Streeten által megfogalmazott klasszikus kérdésre (PATAKI 1998) keresi a választ mikrotérségi vonatkozásban: "vajon valóban a különféle árujavak és a pénzjövedelem birtoklása, vagyis az egy főre jutó GDP-ben mért gazdasági növekedés a fejlődés végső célja, értéke?"

A posztdoktori kutatás munka- és időbeosztása egy nagy blokkra bontható, a témát kelet-közép-európai keretek között vizsgáltam meg. A kiadvány ezen eredményekről ad számvetést, rendszerbe szedve az eredményeket. A working paper összesen három publikációt közöl.

A kutatás főbb eredményei több magyar és egy idegen nyelvű tudományos konferencián kerültek bemutatásra, ill. lektorált tudományos folyóiratokban és kiadványokban jelentek meg, vagy éppen megjelenés alatt vannak. (Erről információ az egyes dolgozatok után található. A dolgozatok formába öntése a befogadó kiadványok követelményrendszere alapján történt, a tanulmányok ennek megfelelően jelennek meg ezen kiadványban is.)

A KÖZÉP- ÉS KELET-EURÓPAI RÉGIÓK KONVERGENCIÁJÁNAK TERÜLETI RELÁCIÓI

Egri Zoltán – Arany Ferenc – Szabó Csaba

Absztrakt: A régiók közötti konvergencia az Európai Unió politikai céljainak egyike. Tanulmányunkban ezen jelenség területi sajátosságait vesszük górcső alá az általunk definiált közép- és kelet-európai térségben, regionális megközelítésben. Alapvető célunk a konvergencia általános és térbeli viszonyainak feltárása. Elemzésünk módszertanát az abszolút konvergencia-vizsgálat jelenti, kiegészítve a területi sajátosságokkal (szomszédsági relációkkal). A kutatási fő kérdése arra irányul, hogy miként érvényesül a vizsgált térségben a konvergencia, ill. hogyan járulnak hozzá a térbeli interakciók ehhez a jelenséghez?

Abstract: Convergence among regions is one of the political objectives of the European Union. In our study we have studied the territorial features of this phenomenon in the Eastern and Central European macroregion by regional approach (NUTS2). Our basic goal is to explore the general and spatial relationships of convergence. The methodology of our analysis is the absolute (unconditional) convergence test complemented by the spatial features (contiguity relations). The main question of research focuses on whether the convergence is predominant in the examined region? How do spatial interactions contribute to this process?

Kulcsszavak: β-konvergencia, szigma-konvergencia, regionális növekedés

Keywords: β convergence, σ convergence, regional growth

1. Bevezetés

Dolgozatunkban egy általunk definiált absztrakt tér (Közép- és Kelet-Európa, pontosabban EU) konvergenciájának területi sajátosságait, ill. esélyeit taglaljuk. A régiók közötti konvergencia és kiegyenlítődés az Európai Unió politikai céljainak egyike. A Római Szerződés 158. cikke (1957) egyértelműen fogalmaz: „Átfogó harmonikus fejlődésének előmozdítása érdekében a Közösség úgy alakítja és folytatja tevékenységét, hogy az a gazdasági és társadalmi kohézió erősítését eredményezze. A Közösség különösen a különböző régiók fejlettségi szintje közötti egyenlőtlenségek és a legkedvezőtlenebb helyzetű régiók vagy szigetek – a vidéki térségeket is beleértve – lemaradásának csökkentésére törekszik.” Később az Európai Unióról szóló szerződés (2012) a gazdasági és a társadalmi jelző mellé a területit is bevonta, kiemelve a konvergencia térbeli fontosságát.

A konvergencia kétféle értelmezése a fentiekben is kiolvasható: egyrészt egy referenciapont elérésére való törekvésként, másrészt egymáshoz való közelítésként, az egyenlőtlenségek mérsékléseként (Ferkelt-Gáspár 2008, Oblath-Szörfi 2008). Kotosz (2016) a konvergencia-folyamatok tipizálására három kategóriát alkalmazott. Abszolút konvergenciáról beszélhetünk, ha az alacsonyabb fejlettségű terek a fejlettebbekhez tartanak bármiféle egyéb befolyásoló tényezőtől függetlenül, az egyes területi egységek azonos egyensúlyi állapothoz tartanak. Feltételes konvergencia esetén az egyensúlyi állapot elérése egyéb kontrollváltozókhoz köthető, viszont az egyes térségek közötti eltérések állandóak lehetnek. A klubkonvergencia pedig azt jelenti, hogy a területi egységek csoport- vagy klubspecifikus egyensúlyi állapothoz tartanak. A konvergencia-folyamatokat az egyes csoportra vonatkozó kezdeti feltételek határozzák meg.

A konvergencia-vizsgálatok mind a bevont területi egységek, mind a módszertan, mind a függő változók tekintetében igen változatosnak tekinthetők, lásd például Rey-Montouri 1999, Oblath-Szörfi 2008, Szendi 2014, Goecke-Hüther 2016, Kotosz 2016, Yang et al. 2016 munkáit.

Dolgozatunkban az abszolút konvergencia tesztelését választottuk a vizsgált térségben. Az elméleti alapokat Solow (1956) dolgozta ki. Az ún. neoklasszikus növekedési elmélet két termelési tényezőt vesz figyelembe (munka, tőke) a jövedelmek alakulását pedig alapvetően a tőkeállománytól teszi függővé. A tőke mennyisége a népesség növekedésével és az

amortizációval csökken, míg a beruházások egyértelműen növeli. Emellett a tőke csökkenő hozadéka is érvényesül, a fejletlenebb régiókban a tőke egységnyi határterméke magasabb hozadékot realizál, mint egy fejlett régióban. A tőke fejletlen régiókba való befektetése a jövedelmek konvergenciáját indítja meg, és így - az elmélet szerint - előbb-utóbb kialakul a közös egyensúlyi szint. A teóriát számos kritika, módosítás érte (Romer 1986, Mankiw et al. 1992, Lengyel-Rechnitzer 2004), mégis elterjedt vizsgálati keretként alkalmazható a területi konvergenciát érintő elemzésekben (Rey-Montouri 1999, Oblath-Szörfi 2008, Vojinovic et al. 2009, Viegas- Antunes 2013, Bucur-Stangaciu 2015, Goecke-Hüther 2016, Tóth 2016). Emellett a konvergencia-vizsgálatokban a térbeliség szerepe is egyértelműen felértékelődik (Rey-Montouri 1999, Czaller 2016, Benedek-Kocziszky 2017).

Tanulmányunkban az alábbi kutatási kérdések megválaszolását céloztuk meg.

(1) Miként érvényesül Közép- és Kelet-Európában a regionális szintű gazdasági és a társadalmi konvergencia?

(2) Milyen különbségek fedezhetők fel a gazdasági és a társadalmi konvergencia esetében?

(3) Hogyan járulnak hozzá a térbeli interakciók a társadalmi és a gazdasági fejlettség konvergenciájához?

2. Anyag és módszer

Vojinovic et al. (2009) alapján a keresztmetszeti adatokon elvégzett abszolút (β-) konvergencia hipotézis vizsgálata az alábbi regressziós egyenlet alapján történik meg:

$$\frac{1}{T} log \frac{y_{i,T}}{y_{i,0}} = \beta_0 + \beta_1 log y_{i,0} + \varepsilon_i, \qquad (1)$$

ahol $logy_T$ és a $logy_0$ a konvergencia jelenségét indikáló mutató természetes alapú logaritmusa i térségben az első és az utolsó megfigyelt évben; β_0 a konstans, ε_i a hibatag, T a megfigyelés idejét jelzi.

Az alábbi képlet segítségével pedig a β koefficiens becsülhető meg, amely a konvergencia sebességét, ütemét mutatja meg. A képlet jobb oldalán lévő β a fenti regressziós egyenletből származik, ez a függvény meredekségét jelző β_1 paraméter.

$$\beta = -\frac{1}{T} \ln (1 + \beta T) \qquad (2)$$

Ezen érték segítségével a felzárkózás felezési ideje is meghatározható, vagyis az, hogy a vizsgált térségen belüli teljes felzárkózás irányába tartó út feléhez mennyi idő szükséges a konvergencia ütem változatlansága mellett (felezési idő=ln2/β) (Oblath-Szörfi, 2008).

A teljesítménybeli konvergencia elemzését kiegészítjük a fejlettségi változók egyenlőtlenségeinek vizsgálatával. Arra kívánunk rámutatni, hogy a béta-konvergencia a (területi) különbségek csökkenésével (ekkor beszélünk szigma-konvergenciáról), stagnálásával, vagy éppen a növekedésével jár együtt. A szakirodalom egy része (Barro-Sala-i Martin 1990, Oblath-Szörfi 2008, Tóth 2016) szerint a béta- és a szigma-konvergencia kapcsolatban áll egymással, a béta-konvergencia megléte szükséges, de nem elégséges feltétele a szigma-konvergenciának. Quah (1993) ugyanakkor kimutatta, hogy a szigma konvergencia megvalósulhat béta-konvergencia nélkül is. A szigma-konvergencia kimutatása a relatív szórás mutatójával történik.

Mivel a β-konvergencia vizsgálatok hagyományosan nem veszik figyelembe a térbeliséget (Kotosz 2016), ezért a legkisebb négyzetek módszere (OLS: ordinary least squares) regresszió mellett a nem torzított becslés érdekében a térbeli hiba (ML SEM: maximum likelihood spatial error model), a térbeli késleltetés (ML SLM: maximum likelihood spatial lag model) és a térbeli súlyozott legkisebb négyzetek (SWLS: spatially weighted least squares) modelleket alkalmazzuk (Anselin 2005, Kelejian–Prucha 2010, Chasco 2013).

A térbeli függőségének tesztelésére a globális autokorrelációs tesztet használjuk. A globális megközelítéssel a vizsgált régiók növekedésére vonatkozó átlagos mintázatot tárjuk fel. Ezt a Global Moran I segítségével ragadjuk meg.

$$I = \frac{n}{2A} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}\delta_{ij}(y_i-\bar{y})(y_j-\bar{y})}{\sum_{i=1}^{n}(y_i-\bar{y})^2}, \qquad (3)$$

ahol n a területegységek száma, y_i és y_j a vizsgálni kívánt változó értéke az egyes területegységekben, a $\bar{y}$ a vizsgált mutató számtani átlaga, A a szomszédsági kapcsolatok száma, a δ_{ij} együttható értéke pedig 1, ha i és j szomszédosak, egyébként pedig 0 (Tóth 2014).

A vizsgálatokhoz szükséges alapadatokat az Eurostat szolgáltatta. A gazdasági fejlettség mellett (GDP/fő, vásárlőerő-paritáson) a társadalmi fejlettség egyik kiemelt mutatóját (emberi fejlődés indexe, HDI) vontuk be elemzéseinkbe. A regionális jóllétet kifejező HDI-t négy mutató alkotja: az egy főre jutó háztartási jövedelem, a csak alapfokú végzettséggel rendelkezők aránya, a felsőfokú képzettségűek aránya, ill. a születéskor várható élettartam (Bubbico-Dijkstra, 2011). Az indexszerkesztés módszertani sajátosságait Bubbico-Dijkstra (2011) közli, az időbeli összehasonlítás céljából ezt kiegészítettük a szélsőértékek alkalmazásával (lásd Trabold-Nübler, 1991). Vizsgálatainkat a 2004-2014 közötti időszakra végeztük el. A megfigyelés terét az általunk definiált Közép- és Kelet-Európa jelenti, amely Lengyelország, Csehország, Szlovákia, Magyarország, Szlovénia, Románia, Bulgária, Németország és Ausztria NUTS2 régióit tartalmazza. Utóbbi két ország bevonását azért tartottuk fontosnak, mert ezek jelentik az új tagállamok számára a gravitációs központokat, ők a fő gazdasági és pénzügyi partnerek (Kőrösi 2015).

3. Eredmények és értékelésük

Elsőként a β-konvergencia vizsgálatokhoz szükséges adatok korrelációs összefüggéseit ismertetjük a Pearson-féle korrelációs együtthatók alapján. Összehasonlításként közöljük a HDI alkotórészeinek kapcsolatait is. A korrelációs mátrixot az 1. táblázat ismerteti. A mátrix külön a kezdeti állapotokra és külön a növekedési ütemekre mutatja meg az együttmozgások mértékét. A statikus korrelációs koefficiensek (a főátló felettiek) világos egyirányú és szignifikáns kapcsolatokról tanúskodnak a gazdasági és a társadalmi fejlettség, ill. utóbbi alkotórészei között. Vagyis a vizsgált társadalmi és gazdasági jellemzők egymást erősítik, egy kivétellel (GDP/fő és a képzettségi index között) szoros kapcsolat lelhető fel. A dinamikus összefüggések iránya hasonló, az egyik tényező növekedése a másikkal együtt mozog, de a kapcsolatok erőssége diverzebbnek tekinthető. Erős egymást erősítő korreláció jellemzi az esetek többségét, viszont a képzettségi szint és a jövedelmi mutatók dinamikája között csupán gyenge közepes a kapcsolat. Emellett a jövedelmi mutatók és a születéskor várható élettartam növekedése közötti összefüggéseket emeljük ki, az egy főre jutó háztartási jövedelem esetében erősebb kapcsolat figyelhető meg, mint a GDP/fő esetében.

1. táblázat: **A kezdeti fejlettségi szint és a növekedési ütemek korrelációs kapcsolatai**

	HDI	Jövedelem/fő	Várható élettartam	Képzettség	GDP/fő
HDI	-	+0,939**	+0,935**	+0,880**	+0,895**
Jövedelem/fő	+0,876**	-	+0,947**	+0,705**	+0,948**
Várható élettartam	+0,826**	+0,740**	-	+0,734**	+0,884**
Képzettség	+0,705**	+0,431**	+0,587**	-	+0,691**
GDP/fő	+0,739**	+0,895**	+0,651**	+0,382**	-

Megjegyzés: a korrelációs mátrix főátló feletti része a statikus mutatók (kezdeti szint), a főátló alatti része pedig a dinamikus mutatók (növekedési ütem) korrelációs koefficienseit közli. A ** 0,05 szintű szignifikanciát jelez.
Forrás: A szerzők saját szerkesztése (2017)

A következő táblázatokban (2.-3.) az abszolút konvergencia vizsgálati eredményeit közöljük. A konvergencia összefüggéseit a legkisebb négyzetek módszerével lefuttatott

regresszióval kezdjük, majd a hibatag térbeli függőségének tesztelése (Moran I) után a megfelelő specifikációval bíró térbeli jegyekkel kerülnek kiegészítésre az egyes regressziók. Ezt követően a konvergencia főbb mutatóit ismertetjük. (A konvergencia üteme, a teljes felzárkózás feléhez szükséges felezési idő.) Minden térökonometriai vizsgálat elején definiálnunk kell a vizsgált tér struktúráját: meg szükséges adnunk, hogy a régióink mely más régiókkal szomszédosak (Váry 2017). A megfelelő térbeli súlymátrix megválasztását a következőképpen értük el. A függő változók (növekedési ütemek) esetében a Moran I indexet lefuttattuk többféle távolságmátrix alkalmazásával. Az első- és másodrendű királynő és bástya-; a 4, 5, 6 legközelebbi szomszéd-; valamint a 175, 200, 225 km-es távolságalapú súlymátrixokat alkalmaztuk. Elemzéseink során azt tapasztaltuk, hogy az elsőrendű királynő-szomszédság ragadja meg a térbeliséget a legjobban, a Moran I érték itt a legmagasabb: a HDI növekedés esetében 0,830, míg a GDP/fő esetében 0,694.

A magas Moran I értékek rámutatnak a térbeli autokorreláció erőteljes jelenségére, vagyis a hasonló növekedéssel bíró terek klaszterekké állnak össze a vizsgált térben. A további elemzések során ezzel a súlymátrixszal dolgoztunk. Több egyéb mátrixszal is elvégeztük a regressziós elemzéseket, ezek azonban érdemi változást nem eredményeztek a főbb paraméterekben.

A 2.-3. táblázatból kiolvasható eredményeink szerint a vizsgált időszakban a közép- és kelet-európai térségben érvényesült az abszolút konvergencia. A konvergenciát indikáló regressziós béta együttható mindkét mutató esetében negatív előjelet vesz fel. Vagyis az alacsonyabb fejlettségi szinten lévő régiók magasabb növekedési ütemmel bírnak, ill. vica versa. Az összefüggések erőssége jelentősen különbözik az OLS regressziók esetén (48,9 és 90,5 százalék), a HDI esetében erőteljesebb a függvény meredeksége, vagyis a konvergencia jelensége. A hibatagokon lefuttatott globális autokorrelációs teszt (Moran I) szerint még jelentős mértékű információ maradt a modellekben. A térbeli jegyekkel kiegészített regressziók megválasztásához a Lagrange multiplikátor ad információt. Eszerint a társadalmi fejlettség változása esetében az OLS regresszió térben késleltetett hibatagjaival, a GDP/fő növekedés esetében pedig a függő változó szomszédos értékeivel kerültek kiegészítésre a regressziók. Vagyis előbbi esetben a térbeli hiba- (SEM), utóbbinál a térbeli késleltetés (SLM) modellt alkalmaztuk. A modellek alkalmasságáról a maximum likelihood regressziónál már nem csak az R^2, hanem a Log likelihood és az Akaike információs kritérium is tájékoztat. Előbbinél a nagyobb, utóbbinál pedig a kisebb érték a kedvezőbb. Eszerint mindkét függő változó esetében a szomszédsági értékek bevonása javítja a modellek magyarázóerejét. A likelihood ratio teszt a térbeli függőséget teszteli (az alkalmazott súlymátrixot), eszerint a két jelenség növekedésére szignifikáns hatással van a szomszédos régiókban lezajló folyamatok. A HDI konvergencia esetében a hibatagok heteroszkedasztikusan viselkednek, így itt a kovarianciamátrix robusztus becslést alkalmaztunk (SWLS HET, Kelejian–Prucha 2010, Chasco 2013). A térbeliséggel kiegészített modellek kiegyenlítettebb képet adnak a magyarázóerő tekintetében. (Az SWLS esetében már csak az R^2 ad információt a megfelelő illeszkedésről.) Vagyis kijelenthetjük, hogy a konvergencia nemcsak a kezdeti állapot függvénye, hanem a szomszéd régiókban lejátszódó tevékenységek (spill-over hatások) is egyértelműen befolyásolják azt. Kocziszky (2013) a szubnacionális területi egységek közötti kölcsönhatásokat a termelési, szolgáltatási, infrastrukturális folyamatok több régióra kiterjedő érintettségére, ill. a különböző fejlettségű térségek közötti munkaerő-, vásárlóerő- és tőkemozgására vezeti vissza. Ezen jelenségek vélhetően nemcsak a gazdasági konvergenciát érintik, befolyásolják a társadalmi fejlettség alakulását is.

2. táblázat: **A HDI abszolút β-konvergenciájának hagyományos és térbeli regressziói**

	OLS	ML SEM	SWLS (HET)
konstans	0,201*** (35,336)	0,185*** (21,354)	0,187*** (12,831)
HDI (ln, 2004)	-0,044*** (-30,447)	-0,040*** (-18,415)	-0,040*** (-11,186)
lambda	-	0,735*** (9,821)	0,741*** (7,986)
R-squared	0,905	0,947	0,906
Log likelihood	370,069	390,575	-
Akaike info criterion	-736,137	-777,15	-
Breusch-Pagan test	4,002**	23,837***	-
Likelihood Ratio Test	-	41,013***	-
Lagrange Multiplier (error)	45,151***	-	-
Lagrange Multiplier (lag)	23,628***	-	-
Moran I (res.)	0,455***	0,018	-
A konvergencia üteme (%)	5,83	5,08	5,16
Felezési idő (év)	11,89	13,64	13,43

Megjegyzés: *** szignifikáns 0,01 szinten, ** szignifikáns 0,05 szinten. A térbeli súlymátrix az elsőrendű királynő-szomszédságon alapul. Zárójelben a t- és z-score értékek láthatók. Forrás: A szerzők saját szerkesztése (2017)

3. táblázat. **Térbeli jegyekkel bővített abszolút konvergencia a GDP/fő (PPS) esetén**

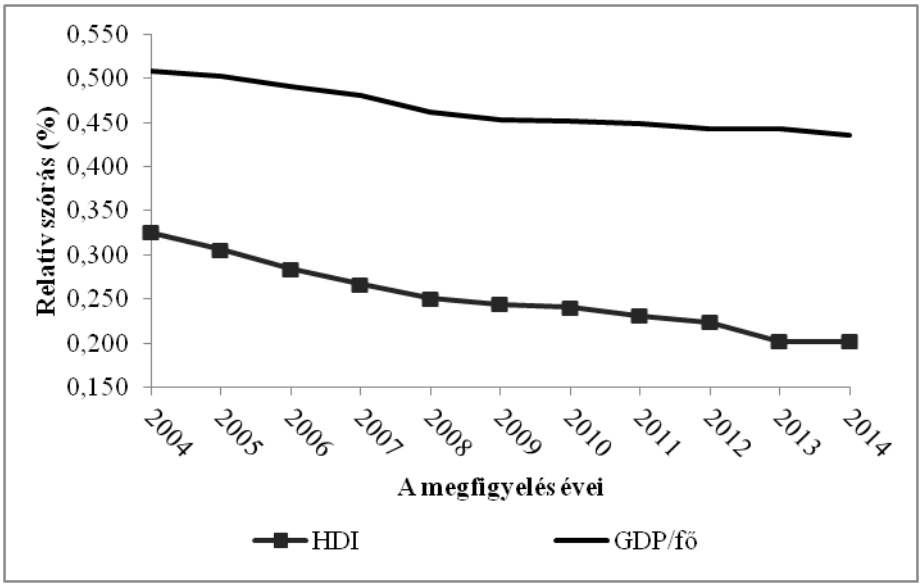
	OLS	ML SLM
konstans	0,206*** (11,503)	0,059*** (3,253)
GDP/fő (ln, 2004)	-0,018*** (-9,586)	-0,005*** (-2,995)
W	-	0,729*** (10,248)
R-squared	0,489	0,704
Log likelihood	313,561	333,163
Akaike info criterion	-623,121	-660,326
Breusch-Pagan test	5,073*	6,068
Likelihood Ratio Test	-	39,205***
Lagrange Multiplier (lag)	28,108***	-
Lagrange Multiplier (error)	9,230***	-
Moran I (res.)	0,207***	-0,021
A konvergencia üteme (%)	1,95	0,52
Felezési idő (év)	35,62	132,79

Megjegyzés: *** szignifikáns 0,01 szinten, ** szignifikáns 0,05 szinten, * szignifikáns 0,10 szinten. A térbeli súlymátrix az elsőrendű királynő-szomszédságon alapul. Zárójelben a t- és z-score értékek láthatók. Forrás: A szerzők saját szerkesztése (2017)

A 2. és a 3. táblázatban a konvergencia évenkénti üteme, ill. a felezési idő követhető az egyes modellekben kalkulált regressziós béták alapján. A regressziós béták ugyan negatív előjelet vettek fel, de a konvergencia ütemek, ill. az abból számított felezési idők eltérő mintákat nyújtanak. A társadalmi fejlettség mutatója kedvezőbb képet ad, az éves konvergencia-ütem 5% fölötti minden esetben, a felezési idő nem haladja meg a 15 évet. A gazdasági teljesítmény jóval alacsonyabb konvergencia-ütemmel rendelkezik (2% körül), a térbeliség beemelésével viszont a negyedére esik vissza. (Hasonlóképpen, a felezési idő ennek megfelelően emelkedik.) A szomszédsági hatások mindkét esetben lefelé korrigálják az eredeti OLS modellt, a gazdasági fejlettség esetén számottevőbbek a közvetlen környezetben

lévő régiókban zajló folyamatok. Részletesebb vizsgálat során feltételezzük, hogy konvergenciaklubok is fellelhetők a vizsgált térségben.

1. ábra: **Szigma konvergencia a fejlettségi mutatók esetében**



Forrás: A szerzők saját szerkesztése (2017)

Végül, de nem utolsósorban területi kiegyenlítődés figyelhető meg a két fejlettségi mutató alapján, vagyis a β-konvergencia a területi különbségek csökkenésével járt együtt 2004 és 2014 között. A szigma-konvergencia a GDP/fő esetében nagyobb szóródási értékek mellett jellemző, a HDI-nél egyértelműen alacsonyabb, vagyis utóbbi mutatónál a területi különbségek kisebb mértékűek. Az 1. ábráról leolvasható az is, hogy 2008-ig erőteljes csökkenés tapasztalható, majd a görbék meredeksége jelentősen visszaesik. Ezen jelenség vélhetően a gazdasági válságnak tudható be.

4.Összefoglalás

Dolgozatunkban a kelet- és közép-európai NUTS2 régiók gazdasági és jólléti teljesítményének konvergenciáját vizsgáltuk meg 2004 és 2014 között. Mind a hagyományos, mind a térbeli vizsgálatok megerősítik az abszolút konvergencia hipotézisét, vagyis a kevésbé fejlett térségek a fejlettekhez tartanak, minden egyéb magyarázó tényezőtől, feltételtől függetlenül. A térbeliség aktív szereplőként járul hozzá a növekedéshez mindkét fejlettségi mutató esetében. A gazdasági teljesítmény (GDP/fő) tekintetében a szomszédsági hatások erőteljesebben befolyásolják a konvergenciát, a humán fejlődés indexénél pedig a gyorsabb konvergencia ütem emelhető ki. Felhívjuk a figyelmet arra, hogy a matematikai-statisztikai elemzések ugyan szignifikáns összefüggéseket eredményeztek, a tényleges spill-over hatások részletes elemzése javasolt a vizsgált jelenség relációjában.

További kutatási irányként a konvergencia és a felzárkózás lokális sajátosságainak kimutatása indokolt. Tanulmányunk ugyan rámutat a tér szerepére, de alapvetően globális mutatók (Global Moran I, térbeli jegyekkel bővített regressziók) alapján értékeltük a konvergenciát. Ilyen vizsgálat lehet például a területi súlyozású regresszió, vagy az egyes régiók egyedi pályáinak kiszámítása (konvergencia ütem, felezési idő). Ugyan a vizsgálat időszaka viszonylag rövidnek tekinthető, célszerű lehet megosztani a megfigyelés időszakát a gazdasági válság kezdetének figyelembevételével.

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Spatial Relations of the Convergence in the Central and Eastern European Regions

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SPATIAL RELATIONS OF THE CONVERGENCE IN THE CENTRAL AND EASTERN EUROPEAN REGIONS

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Abstract: *Convergence among regions is one of the political objectives of the European Union. In our study we have studied the territorial features of this phenomenon in the Central and Eastern European macroregion by regional approach (NUTS2). Our basic goal is to explore the general and spatial correlations of social and economic convergence. The methodology of our analysis is the absolute convergence test complemented by the spatial features (contiguity relations). The main question of research focuses on whether the convergence is predominant in the examined region? How do spatial interactions contribute to the convergence process?*

Key words*: β convergence, σ convergence, regional growth, social and economic inequalities*

INTRODUCTION

In our study we describe the territorial features and chances of the convergence in an abstract space (Central and Eastern Europe, exactly EU) defined by us. The convergence among regions is one of the main political objectives of the European Union. Article 130a of the Single European Act clearly stated that "in order to promote its overall harmonious development, the Community shall develop and pursue its actions leading to the strengthening of its economic and social cohesion. In particular the Community shall aim at reducing disparities between the various regions and the backwardness of the least-favoured regions" [1]. Later the Treaty on European Union [2] involved next to the economical and social marker the territorial too, highlighting the spatial importance of the convergence.

There are two kinds of interpretations, which can be read above: on the one hand, the intention to reach a reference point, on the other hand, as the approaching to each other, as the reducing of the inequalities [3], [4]. Kotosz [5] and Paas et al. [6] applied three categories for the typing of the convergence-processes. In the *absolute convergence* hypothesis, the per capita incomes of countries or regions converge with one another in the long-term regardless of the initial conditions. Poorer countries and regions grow faster than richer ones and there is a negative relationship between average growth rates and initial income levels even if no other variables are included in the regression models as explanatory factors. It is assumed that all economies converge to the same unique and globally stable steady-state equilibrium. According to the conditional convergence hypothesis, the per capita incomes of countries or regions converge with one another in the long-term provided that their structural characteristics (e.g. technologies, human capital, institutions, population growth rates, infant mortality rates, etc.) are identical. In the case of conditional convergence, equilibrium differs by economy, and each particular economy approaches its own but unique equilibrium. The club convergence means that, the territorial units belong to group or club-specified balance condition. The convergence-processes are specified by the initial conditions concerning certain groups. The club convergence hypothesis allows multiple and only locally stable steady-state equilibriums.

The convergence analyzes can be considered diverse both the involved territorial units, the method and the dependent variables, see for example [7], [4], [8], [5], [9].

In our study the absolute convergence was tested in the CEE region, according to the standard neoclassical growth model of Solow [10]. Convergence occurs because of lower and diminishing returns to investment in more developed and capital abundant countries and

sectors. Capital investment spreads to new, less-capital abundant countries and sectors, where returns to investment are higher; likewise, labour migrates to the more developed countries where wages are higher. Nevertheless, capital accumulation merely cannot sustain growth in the long term, while growth in total factor productivity can. The Solow model does not predict absolute convergence, but it does predict that per capita income in an economy converges to its steady-state value. It also predicts convergence in factor prices and the standard of living [11]. The theory got several critics and modifications [12], [13], still it can be applied as a spread examination frame in the analyzes of the territorial convergence [7], [8], [11], [14], [15], [8]. Besides this, the role of the spatiality is clearly appreciating in the convergence analyzes [7], [16], [17].

In our study we are looking for answers to the following research questions:

- Can we observe economic and social convergence at regional level in Central and Eastern Europe?
- What kinds of differences can be found in the cases of the economic and social convergence?
- How can the spatial interactions contribute to the convergences of the economic and social growth and development?

MATERIALS AND METHODS

According to [7] the examination of the absolute (β-) convergence hypothesis based the cross-section data, we estimate regression equation in the following form:

$$\frac{1}{T} log \frac{y_{i,T}}{y_{i,0}} = \beta_0 + \beta_1 log y_{i,0} + \varepsilon_i$$

where $\log y_T$ and $\log y_0$ are the natural logarithms of development variables in region i in the last and the first year of the period under analysis, respectively β_0 coefficient is a constant, β_1 is the slope of the regression line, ε is the error term, T indicades the duration of the period. With the help of the following formula (below) we can measure the β coefficient, which shows the speed of convergence. β on the right side of the formula, comes from the above mentioned regression equation, this is the β_1 parameter signing the slope of the regression line.

$$\beta = -\frac{1}{T} \ln (1 + \beta T)$$

With the speed of convergence the half-life convergence can be calculat, that is how much time takes it to reach the half-way to the direction of the full-convergence in the examined region while the speed doesn't change (half-life convergence = ln2/β) [4].

The β-convergence analysis can be completed with the examinations of the inequalities of the development variables. Sigma (σ) convergence occurs when income (or any other development indicator) differentiation between the regional units decreases over time [7]. According to [18] and [4] the beta and sigma convergence are in connection with each other, the existence of beta-convergence is necessary, but it's not sufficient condition of the sigma-convergence. Sigma-convergence can be realized without beta-convergence as well [19]. The measurement of the sigma-convergence is calculated with the indicator of the coefficient of variation. (CV=standard deviation/mean)

Traditionally the β-convergence examinations doesn't take into consideration the spatiality [5]. That's why besides the method of the ordinary least squares (OLS) regression we apply in favour of the inconsistent estimation the maximum likelihood spatial error (ML SEM), maximum likelihood spatial lag (SLM) and the spatially weighted least squares models (SWLS) [20], [21], [22].

The global spatial autocorrelation test (Moran's I) is applied for the spatial dependence. The average spatial pattern of the growth variables is explored by the global approach. The formula of Moran's I:

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

where n is the number of the spatial units indexed by i and j, y is the variable of interest, $\bar{y}$ is the mean of y, A means the numbers of the neighborhood relations, the value of δ_{ij} coefficient is 1, if the i and j are neighbors, anyway it is 0 [23].

The required database was provided by the Eurostat. In addition to the economic development (GDP per capita, purchasing power parity) the Human Development Index (HDI) was also included into our analyzes. The HDI, which express the regional well-being is created by four indicators: the per capita income of households, the rate of those who completed less than primary and primary and lower secondary education, the rate of those who graduated in the tertiary education and the life expectation at birth [24]. The methodological particularity of the index editing is published by Bubbico-Dijkstra [24], for the purpose of the temporal comparison we completed it defined the minimum and maximum values [25]. We made our examinations for the period of 2004-2014. The observation area is Central and Eastern Europe, which contains the NUTS2 regions of Poland, Czech Republic, Slovakia, Hungary, Slovenia, Romania, Bulgaria, Germany and Austria. The involvement of the last two countries was important, because these counties means the gravity centres for the new member states, they are the main economical and financial partners [26].

RESEARCH RESULTS

First of all, we explored the pairwise correlation relationships of the development variables using the Pearson's correlation coefficient. By comparison we run the coefficients of the HDI components, too. The table 1 figures the correlation matrix. The matrix shows the extent of the correlation separated for the initial conditions and separated for the growth rates. The correlation coefficients of the static (initial) variables (above the diagonal) describe clear, one-way and significant relations between the economic and the social development and between its components respectively. So the examined social and economical features strengthen each other, excepting one (between the GDP per capita and the education index) there are close correlations. The direction of the dynamic interactions (growth rates) is similar, (synergisting correlations exist), but regarding the strength of the relationships are more diverse (below the diagonal).

Table 1.

Correlational relationships (Initial level of development/Growth rates)

	HDI	Household income	Life expectation	Education	GDP per cap
HDI	-	.939**	.935**	.880**	.895**
Household income	.876**	-	.947**	.705**	.948**
Life expectation	.826**	.740**	-	.734**	.884**
Education	.705**	.431**	.587**	-	.691**
GDP per cap	.739**	.895**	.651**	.382**	-

*Note: above the diagonal the pairwise correlation coefficients of the static variables can be seen, below the diagonal the correlational relationships of growth rates are shown. The ** means significance at .01 level. Source: own editing, 2017*

Most of the pairwise correlations are strong, but between the dynamics of educational level and the income indicators there are only medium weak relation. In addition, we highlight the connections between the increase of the income indicators and the life expectancy at birth, in the case of the per capita income of the household there is a stronger correlation, than in the case of the GDP per capita.

In the following tables (2., 3.) are the results of the absolute β-convergence. In order to get the correlations we use the ordinary least square method to run the regression, than after the test of the spatial dependence of the error terms (Moran I), the regressions will be completed by the spatial features having appropriate specification. Than the main indicators of the convergence will be calculated. (The convergence rate, the half-life convergence.)

We have to definate the spatial structure of the examined space: we have to give, which are the regions who are neighbors to our region [27]. The choice of the appropriate spatial weight matrix was achieved as it follows. In the case of the dependent variables (growth rates) the Moran I index was running more kinds of distance matrices. The first and second order queen and rook-, the 4, 5, 6 nearest neighbors-, and the 175, 200, 225 km distance-based weight matrices were applied. During our analyzes we experienced that the queen weight matrix (with first order of contiguity) seizes the spatiality the best. The Moran's I value is here the highest: in the case of the HDI growth 0,830, while in the case of the GDP per capita growth is 0,694.

The high and significant Moran I values show the strong importance of the spatial autocorrelation, so the regions having similar growth are in the same cluster in CEE. During the following analyzes we worked with the usage of this weight matrice. We made the regression analyzes with more other matrices, but they had no meaningful changes in the main parameters.

Table 2.

Absolute convergence of the HDI by different regression models

	OLS	**ML SEM**	**SWLS (HET)**
intercept	.201*** (35.336)	.185*** (21.354)	.187*** (12.831)
HDI (ln, 2004)	-.044*** (-30.447)	-.040*** (-18.415)	-.040*** (-11.186)
lambda	-	.735*** (9.821)	.741*** (7.986)
R-squared	.905	.947	0.906
Log likelihood	370.069	390.575	-
Akaike info criterion	-736.137	-777.15	-
Breusch-Pagan test	4.002**	23.837***	-
Likelihood Ratio Test	-	41.013***	-
Lagrange Multiplier (error)	45.151***	-	-
Lagrange Multiplier (lag)	23.628***	-	-
Moran I (res.)	.455***	.018	-
Speed of convergence (%)	5.83	5.08	5.16
Half-life convergence (ys)	11.89	13.64	13.43

*Note: *** significant at 0.01, ** significant at 0.05, * significant at 0.10. The spatial weight matrix is based on first oder queen contiguity. See the t- (OLS) and z-score (ML, SWLS) values in parentheses. Source: own editing, 2017*

According to our results, in the table 2 and 3 we show that in the examined period in the CEE region the absolute convergence has prevailed. The regression β-coefficient – indicating the convergence – has negative sign. So the regions with lower development levels have higher growth rates and vice versa. The strengths of the coefficients of determination are significant different in the OLS regressions (0.489 and 0.905). In the case of the HDI the slope of the regression line is more powerful, that’s why we can observe the major phenomenon of the convergence. According to the global autocorrelation test run on the error terms (Moran I), significant information left in the models. The Lagrange multiplier gives the information to choose the regression completing with spatial characteristics. The regressions

were completed in the case of the change of the HDI with the OLS regression's spatial lagged error terms, in the case of the GDP per capita growth with the neighbor values of the dependent variable. So in the first case we used the spatial error model (SEM), in the other case the spatial lag model (SLM) was used.

Table 2.

Absolute β-convergence of GDP per capita by OLS and ML regressions

	OLS	ML SLM
intercept	.206*** (11.503)	.059*** (3.253)
GDP per capita (ln, 2004)	-.018*** (-9.586)	-.005*** (-2.995)
W	-	.729*** (10.248)
R-squared	.489	.704
Log likelihood	313.561	333.163
Akaike info criterion	-623.121	-660.326
Breusch-Pagan test	5.073*	6.068
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Speed of convergence (%)	1.95	.52
Half-life convergence (ys)	35.62	132.79

*Note: *** significant at .01, ** significant at .05, * significant at .10. The spatial weight matrix is based on first oder queen contiguity. See the t- (OLS) and z-score (ML, SWLS) values in parentheses. Source: own editing, 2017*

About the fit of the models in the maximum likehood regression give information not only the R-squared values, but also the Log likehood and the Akaike information criterion, too. In the first case the higher, in the last case the lower value is more favourable. In the case of both variables, the involvement of the spatially lagged values optimizes the explanatory power. The spatial dependence is tested by the likehood ratio test (the applied weight matrix), according to this, the processes taking place in the neighbor regions have a significant influence on the increase of both HDI and GDP per capita. In the case of the HDI convergence the residuals has not constant variance (heteroskedasticity can be seen), so here the robust estimation of covariance matrix was used (SWLS HET, [21], [23]). The models completed with spatiality, give a more balanced figure about the determination. So it can be state that the regional convergence depends not only on the initial levels, but also the activities in the neighbor regions have obviously influence (spill-over effects). Kocziszky [28] leads back the interactions between the subnational territorial units to the producing-, service- and infrastructural processes involving more regions, and the movement of the human capital-, purchasing power- and capital among the different developed regions. These phenomena touch not only the economic convergence, but also have an influence on the growth of the social development. The tables 2 and 3 show the yearly rates of the convergence speed and the half-life convergences calculated by the regression betas. Although the regression betas have negative signs, but the speed of the convergence and the half-life convergence show different patterns. In case of HDI the yearly speed of convergence rate is over 5% in all cases, the half-life convergence doesn't exceed the 14 years. The regional economic performance has much lower speed of convergence (about 2 %), taking the spatiality into consideration it falls back to its quarter level. (It is similar as the half-life convergence increases). In both cases the spatial effects lower the regression betas of the original OLS models (and the calculated indicators, too). Examining the economic development the ongoing processes in

the neighbor regions are more considerable. During a more deeper examination we suppose that convergence clubs can be found in the examined space.

Last but not least, the territorial income and HDI differentiation between the regions decreased over the examined 10 years. So, the β-convergence met the σ-convergence between 2004 and 2014. We can see higher variability in case of GDP per capita, while the HDI has lower regional inequality in the CEE region. On figure a powerful decrease of the coefficient of variation can be seen until 2008, later the slope of the curves relapse significantly. This phenomenon is because of the economic recession probably.

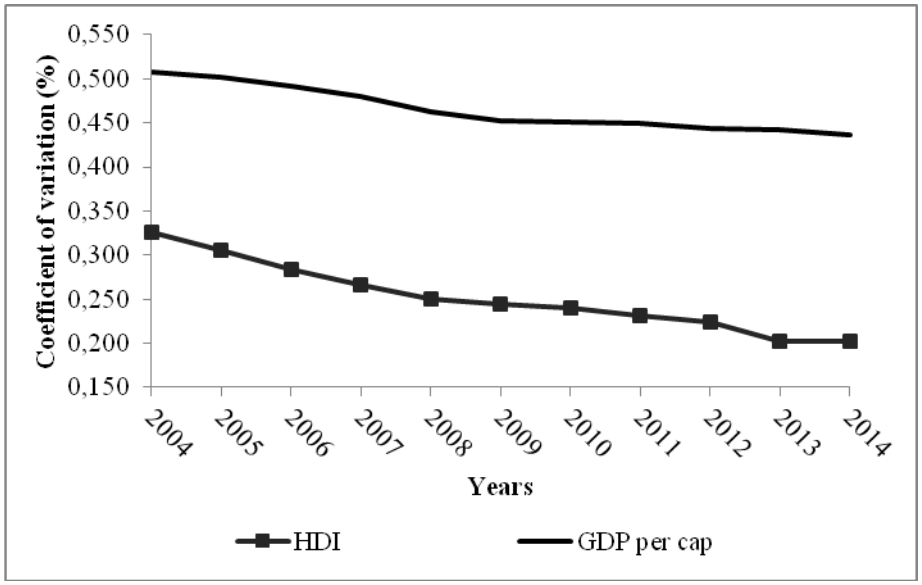

Figure 1. Sigma-convergence of HDI and GDP per capita

Source: own editing, 2017

CONCLUSIONS

In our study, the convergence of the GDP per capita and the Human Development Index was examined in the Central and Eastern European NUTS2 regions, from 2004 to 2014. Both traditional and spatial analyzes strengthen the absolute convergence hypothesis, which means that the less developed regions grow faster than the well developed regions, independent on any other explanatory factors.

The spatiality contributes as an active factor to the growth in the case of both development indicators. For the economic performance (growth of GDP per capita) the spatial effects have more powerful influence on the convergence than the initial level, in case of the human development index the faster speed of convergence can be highlighted. We have to draw the attention, though the mathematical-statistical analyzes resulted significant outcomes, the deeper analysis of the real spill-over effects is suggested in the relation of the examined phenomenon.

As a further research direction the statement of convergence and of the local features of the catch-up is justified. Although, our study highlights the role of the spatiality, but basically the convergence analyzes are evaluated by the global indicators (Global Moran's I, regressions completed with spatial features). So kind of examination can be for example the geographically weighted regression or the calculation of the unique paths of the certain regions (speed of convergence, half-life convergence). Whereas the period of the examination is quite short, but it’s expedient to share the observation-period with the consideration of the beginning of the economic recession.

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The spatial peculiarities of economic and social convergence in Central and Eastern Europe

Zoltán Egri

Introduction

Our paper discusses the spatial peculiarities or chances of convergence regarding an abstract area (Central and Eastern Europe i.e. EU) defined by us. Convergence and equalisation between regions strongly impacts, and is clearly associated with, the main political goals of the European Union. Article 158 of the Treaty of Rome (1957) clearly states that "In order to promote its overall harmonious development, the Community shall develop and pursue its actions leading to the strengthening of its economic and social cohesion. In particular the Community shall aim at reducing disparities between the various regions and the backwardness of the least-favoured regions". This statement was confirmed later in the Single European Act (1987). Then, in 2012, the Treaty on European Union added a new attribute (territorial) to the already existing ones (economic and social), highlighting the importance of territorial convergence.

The different interpretations of convergence are, at least partly, evident from the foregoing: on one hand, it is considered as a set of efforts to reach a reference point and, on the other hand, it is perceived as a set of attempts for approximation and for the reduction of inequalities (Ferkelt-Gáspár 2008, Oblath-Szörfi 2008). Kotosz and Lengyel (2017) and Paas et al (2007) used three categories for the characterisation of convergence processes. In the *absolute convergence* hypothesis, less developed regions tend to converge with more developed ones, regardless of any other influencing factor, and all individual regional units converge to the same equilibrium. The steady-state equilibrium is a reasonable assumption in the case of a homogeneous sample of countries or regions (e.g. EU regions, USA states, OECD countries, etc.) (Mankiw et al. 1992). According to the *conditional convergence* hypothesis, reaching the equilibrium may be linked to other control variables (e.g. human capital, institutions, population growth rates, health status, etc.), although the differences between individual regions may remain constant. In other words, equilibrium differs by region and each particular economy approaches its own income level. The *club convergence* (based on Baumol 1986) hypothesis means that the territorial units belong to a particular group- or club-specific equilibrium. For instance, regions of the European Union converge with the EU average, while other regions approach other averages, if at all. The convergence processes are determined by the initial conditions of each individual group.

As far as the relevant territorial units, the applied methods and the indicators are concerned, convergence studies vary considerably, e.g. Rey-Montouri 1999, Oblath-Szörfi 2008, Goecke-Hüther 2016, Kotosz 2016, Yang et al. 2016.

The primary focus of our paper is to test the hypothesis of absolute convergence in the study region. The starting point of neoclassical theories is the paper published by Solow in 1956. His model expresses output as a function of capital, labour and technology under the assumption of diminishing returns of capital. According to his theory, equilibrium is defined on the basis of three components: savings, population growth and technological development (the latter component became part of his model only later), which were considered exogenous for modelling purposes. His theory can be used to arrive at the β-parameter, which measures the catch-up speed of a country. Based on absolute β-convergence, the countries involved in the study differ only in their initial capital stocks and income levels. In this context, convergence takes place when poorer countries grow faster than richer ones. The reason for the assumption of diminishing returns of capital is that poorer countries have less capital and achieve higher returns than richer ones. Capital movements to underdeveloped regions induce income convergence and, according to the theory, sooner or later lead to a common level of equilibrium. Despite its numerous critics and amendments (Romer 1986, Mankiw et al. 1992, Lengyel-Rechnitzer 2004), but the theory describes an existing phenomenon (and has been still widely used as a study framework for territorial catch-up and convergence analyses (Rey-Montouri 1999, Konya-Guisan 2008, Oblath-Szörfi 2008, Vojinovic et al. 2009, Viegas-Antunes 2013, Bucur-Stangaciu 2015, Goecke-Hüther 2016, Tóth 2016).

The role of spatiality has clearly gained importance for the convergence studies (Rey-Montouri 1999, Baumont et al. 2001, Paas et al 2003, Kocziszky 2013, Czaller 2016, Benedek-Kocziszky 2017). In other words, authors tend to abandon the theories of an economy that is closed and independent of its surrounding regions and to account for interactions taking place between the regional economic actors. The resulting models assume that the impact of externalities between regions is similar to that of the diffusion of technology, while the regional transmission of accidental shocks plays only a negligible role in the long-term growth process (Kocziszky 2013). The notion of external impacts, as referred to in economics and territorial economics literature, can be clearly attributed to Marshall (1920). The external economic impacts, caused by agglomeration, result from the division of input and labour markets and from knowledge spillover (Varga 2005). The new economic geography provides a framework for the interpretation of spatiality and economic growth; accordingly, the location of a region plays a major role in its economic activity. In other

words, the economic situation of a region greatly depends on its actual location and neighbours. Therefore, poorer regions are better positioned to develop when they are located adjacent to richer regions (Baumont et al. 2001). The theory highlights the role of agglomeration externalities deriving from the spillover effects and interactions previously described by Marshall. However, as far as the new economic geography is concerned, there is a general pessimism with regard to convergence and, in the meantime, the phenomenon of core-periphery seems to emerge as a result of increasing returns (Paas et al 2007).

Spatial interactions and convergence, mostly in the CEE countries

In the CEE region (Czech Republic, Poland and Hungary), Herz and Vogel (2003) could not find any evidence of absolute convergence at NUTS2 level between 1991 and 2002. According to their study, economic catch-up was explained only with certain conditions (unemployment, sectoral employment) at the initial development level. Spatiality is expressed by country-specific factors (dummy variables) which are responsible for institutional and political impacts. In the ten new CEE member states, Smętkowski and Wójcik (2012) demonstrated unconditional convergence at NUTS3 level between 1998 and 2005. Although this finding is supported by the observation of catch-up at macro level, there is also a clear evidence of polarisation within the individual countries. Spatial autocorrelation confirms the theory of growth poles for this period. It means that city regions and their immediate vicinity represent growth centres but, at the same time, regional inequalities are also widening. The poorest regions also show convergence, but at a very low speed, and a clear backwardness is indicated by the distance of economic catch-up. These two region types form a separate convergence club in the study period. Hegerty (2016) studied, along the main economic sectors, the catch-up chances of the eleven new CEE member states at NUTS3 level between 2000 and 2013. Performed with the involvement of industrial, construction, finance, insurance and real estate sectors as well as gross value added, the absolute beta-convergence analysis produced significant results only in exceptional cases. Although convergence could be found in agriculture and construction (Hungary), in construction and industry (Croatia and Slovenia) and in construction (Baltic states), no overall convergence could be identified in the studied territory consisting of 233 NUTS3 regions. High growth hot spots, identified with Getis-Ord local G statistics, were present in the Baltic states, Bulgaria and Romania, while cold spots could be detected in Poland and Croatia. Using the σ-method, Kotosz (2016) studied local convergence in the V4 countries at NUTS3 level between 2000 and 2013. According to his conclusion, the areas of permanent divergence occur most frequently, while the areas of

permanent convergence occur most rarely. As evidenced by the analysis of Kotosz and Lengyel (2017), the V4 countries show no significant beta-convergence at NUTS2/3 level between 2000 and 2014, while national divergence is present, again, in terms of growth. The positive impact of agglomeration benefits on economic growth was clearly proved by the authors and the twin-peaks phenomenon of convergence clubs can observed in the study area. Benedek and Kocziszky (2017) also studied the convergence trends of the V4 countries at NUTS level in terms of economic and social well-being performance. According to their findings, the convergence or divergence trends are strongly linked with regional polarisation and peripheralisation. Their calculations proved the emergence of convergence clubs. In lack of sigma- and beta-convergence, local convergence can be shown to exist within the clubs of the NUTS2 regions. The findings confirm that peripheral regions are stuck in a lower development phase: they show convergence within the convergence club but their position has not improved considerably in the long run.

Study questions

It is time to specify our study questions. As the importance of reaching economic and social cohesion was laid down already in the Treaty of Rome, our study deals with convergence along the lines of these two dimensions. Apart from the politically declared dual-target scheme, the separate treatment of economic cohesion and social cohesion is justified also by the fact that there is no straightforward relationship between economic and social development (UNDP 2010, Rodrigez-Pose - Tselios 2015). Furthermore, our study abandons the theory of closed economies and focuses on regional correlations including spatial interactions.

In view of the foregoing, our study questions are as follows:

- How do economic convergence and social convergence take place at regional level in Central and Eastern Europe?
- How do spatial interactions contribute to the convergence of social and economic development?
- What are the differences between economic convergence and social convergence?
- What are the local peculiarities of catch-up for the two dimensions?

Materials and methods

The mathematical-statistical framework of our study relies on the absolute convergence test. Based on Barro - Sala-i-Martin (1990) and Vojinovic et al. (2009), the study of cross-section data through the absolute (β-) convergence hypothesis is performed with the following regression equation:

$$\frac{1}{T} log \frac{y_{i,T}}{y_{i,0}} = \beta_0 + \beta_1 log y_{i,0} + \varepsilon_i, \qquad (1)$$

where $logy_T$ and $logy_0$ is the natural logarithm of the convergence index in region i during the first and last study year; β_0 is the constant, ε_i is the residual and T is the time of observation. The following formula is used to produce an estimate of the β coefficient which shows the speed of convergence. β seen on the right side of the formula comes from the above regression equation and indicates the steepness of the function curve (β_1).

$$\beta = -\frac{1}{T} \ln (1 + \beta_1 T) \qquad (2)$$

This value can also be used to determine the half-life of convergence i.e. the time required to cover half the road leading to full convergence within the study region if the speed of convergence remains unchanged (half-life = ln2/β) (Oblath-Szörfi, 2008).

The performance convergence test is supplemented with an analysis of the inequalities of development variables. Our purpose with that is to demonstrate that beta-convergence is coupled with a decrease (sigma-convergence), stagnation or increase of (territorial) differences. Certain authors (Barro and Sala-i-Martin 1990, Oblath-Szörfi 2008) claim that beta-convergence and sigma-convergence are interrelated and that beta-convergence is a necessary but not sufficient condition for sigma-convergence. However, as evidenced by the findings of Quah (1993), sigma-convergence may emerge even without the presence of beta-convergence. Sigma-convergence is shown through the population-weighted coefficient of variation.

As traditionally β-convergence tests fail to take spatiality into consideration (Kotosz 2016), our analyses are supplemented with this aspect. We use the global autocorrelation test for the study of spatial dependence. The global approach is used to reveal the average performance and growth patterns of the study regions. It is expressed with the help of Global Moran's I.

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

where n is the number of spatial units, y_i and y_j are variables in the individual spatial units, $\bar{y}$ is the arithmetic mean of the relevant variable, A is the number of contiguities, while δ_{ij} is 1 when i and j are neighbours but otherwise it equals 0 (Tóth 2014).

In order to avoid inconsistent estimates, we use the OLS (ordinary least squares) regression as well as the ML SEM (maximum likelihood spatial error), ML SLM (maximum likelihood spatial lag) and SWLS (spatially weighted least squares) models for our absolute convergence tests (Anselin 2005, Kelejian–Prucha 2010, Chasco 2013).

Based on the average convergence of the overall study territory, we also wish to show the individual routes of the various regions. The speed of convergence can be calculated and interpreted not only for the overall study territory but also for each region (Oblath-Szörfi 2008). First we describe the narrowing of the development gap (i.e. the rate of progress of the relevant region towards the established target value) for the period of 2004-2014 and then we determine the individual half-life values. After that we calculate the catch-up time in terms of economic development and social development. Assuming the regional growth values as constant, we provide information on how much time would be required for catching up with the development status of the reference region.

The narrowing of individual development gaps (i.e. the annual speed of convergence) is measured as follows:

$$\beta = \frac{ln[(1-RY_{t1})/(1-RY_{t0})]}{T},$$

where $RY_t = (TD_{t,i})/(TD_{t,j})$. *TD* (territorial development) is the regional development index, while *i* is the given region and *j* is the reference region. *0* and *t* stand for the base period and current period, respectively, while *T* indicates the number of years (Oblath 2014). The catch-up time is estimated on the basis of Oblath (2014) with the following formula:

$$T = lg\frac{TD_0^j}{TD_0^i}/lg\frac{1+g_i}{1+g_j},$$

where *g* is the growth rate. The rest is the same as described for the above formula.

The base data needed for the tests were made available by Eurostat. For our analyses we use economic development (GDP per capita, PPP) and HDI (human development index) considered as one of the main indicators of social development. HDI, which is also a tool for expressing regional well-being, consists of four indices: household income per capita (expressed as PPCS), mean years of schooling, expected years of schooling and life expectancy at birth (Bubbico-Dijkstra, 2011). The methodological know-how of index editing is published by Bubbico-Dijkstra (2011); we supplement this know-how with the use of extreme values in order to create the possibility of time-based comparisons (see Trabold-Nübler, 1991). Our choice is justified by the fact that the applied base dimensions have

different content and that the minima and maxima applied in global analyses cannot be used in more developed regions.[1]

Our tests concern the period of 2004-2014. The observation area is Central and Eastern Europe (as defined by us) including the NUTS2 regions of Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Romania, Bulgaria, Germany and Austria. The reason for involving the last two countries is that they act as the gravity centres and main economic and financial partners for the new member states (Kőrösi 2015). Furthermore, as stated by Tagai (2004, 2011), Germany has an outstanding role with regard to the interactive processes of Central and Eastern Europe. Due to its vicinity to the region, Germany has such a compelling economic weight – perceived as outstanding from the CEE's point of view – in the modelled system of spatial interrelations, which rarely concedes its primacy to local actors.

Within the framework of our study, the EU membership represents, at least partly, the requirement of "homogeneous spatial units". Furthermore, the group treatment of the study region is justified by the common history, the resulting current relationships and the spatial structure links (Gorzelak 2001, 2006, Rechnitzer-Smahó 2011) as well as the joint opportunities for transnational development projects (Strategy for the Danube Region and Central Europe programmes [Interreg VB]).

Results

First we analysed the economic and well-being interrelations prevailing in the first and last year of the study period (Figure 1). In both years there is a strong and positive relationship between the economic and social dimensions, with the coefficients of determination ranging from 81.1% to 82.5%[2]. It means that a higher GDP per capita is associated with a similarly high social development value. As the shrinking range for 2014 is shown at higher levels in Figure 1, a catch-up can be assumed for both variables. Based on our preliminary results, we may as well accept the criticism of McGillivray (1991), published among the first ones, challenging the usefulness of HDI on grounds that it was in close relationship, among others, with GDP per capita (which was still included in the index back then). The author claims that

[1] Applied extreme values:

- household income per capita: 2500-25000 PPCS;
- population share of only primary education: 2.0-40.0%;
- population share of tertiary education: 5.0-40.0%;
- life expectancy at birth: 65-85 years.

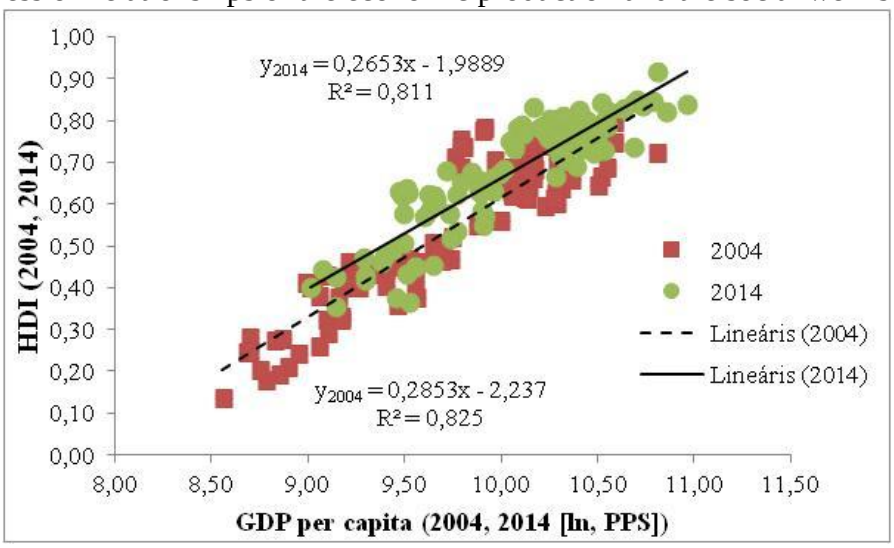
HDI calculation was performed with the use of geometric mean based on UNDP (2016).

[2] The coefficient of determination of pooled regression was 79.9 %. The regression equation can be written as follows. HDI $= 0{,}278 \ln GDP - 2{,}149$; $t_{\ln GDP\ per\ cap} = 65{,}53$; $t_{constant} = -51{,}11$.

the well-being index is just another redundant index that is unable to produce a more refined picture of development than the one obtained with the traditionally applied economic performance index.

Figure 1

The regression relationships of the economic production and the social well-being in CEE



Looking for more detailed relationships, we describe the correlation coefficients of the base data required for β-convergence tests on the basis of Pearson coefficients. We supplement them with the components of HDI. The matrix shows the extent of joint movements both for the initial development levels and for the growth rates. The static correlation coefficients (above the main diagonal) show clearly significant and unidirectional relationships between economic and social development and the components of the latter. It means that the social and economic characteristics under review strengthen each other and that there is a strong relationship between them, except between GDP per capita and schooling index.

The dynamic relationships show similar directions; the growth of one factor moves together with that of another but the strength of relationships is more diverse and can produce a more sophisticated picture. There is a strong synergic correlation in most of the cases, although there is only a weak/average dynamic link between schooling and income indicators. We must highlight the relationship between income indicators and life expectancy at birth growth. Also, the household income per capita shows a stronger relationship than GDP per capita. This confirms the findings of Stiglitz-Sen-Fitoussi (2009) claiming that household income is a better proxy for quality of life than GDP.

Table 1

The correlational relationships between the initial development levels (2004) and the growth rates (2014/2004)

	HDI	Income per capita	Life expectancy	Schooling	GDP per capita
HDI	-	.939**	.935**	.880**	.895**
Income per capita	.876**	-	.947**	.705**	.948**
Life expectancy	.826**	.740**	-	.734**	.884**
Schooling	.705**	.431**	.587**	-	.691**
GDP per capita	.739**	.895**	.651**	.382**	-

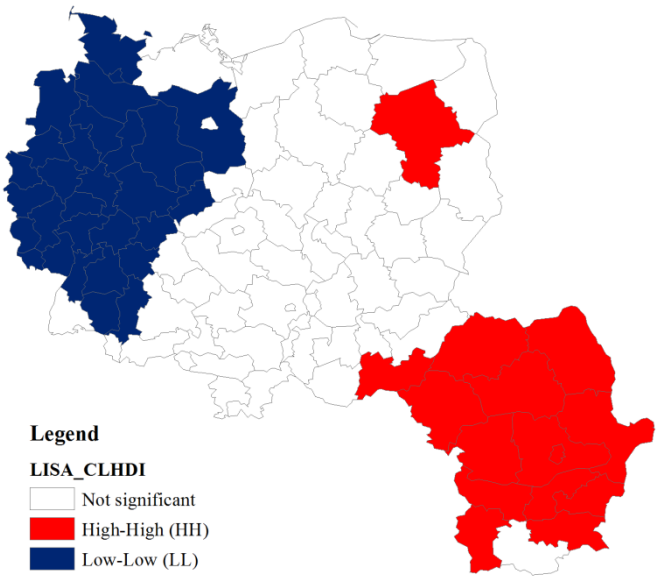
Note: the correlation coefficients of the static indicators (initial level) are shown in the part above the main diagonal, while those of the dynamic indicators (growth rate) are displayed in the part below the main diagonal of the correlation matrix. ** stands for a significance level of 0.01.

Now we are going to lay down the foundation for the findings of our absolute convergence tests. We start to analyse the convergence relationships by running an OLS regression; once the spatial dependence of random errors has been tested (Moran's I), each regression is supplemented with spatial features of the required specification. At the start of our spatial econometric assessment, we need to define the structure of the CEE territory. In particular, we must specify the regions and their direct neighbours (Váry 2017). The following method is used to select the appropriate spatial weight matrix. In the case of dependent variables (growth rates) we run Moran's I index with the use of various distance matrices. Actually, we apply first- and second-order queen and rook; 4, 5, 6 nearest neighbour; and 175, 200, 225 km distance spatial weight matrices.

According to our analyses, spatiality is best described by the first-order queen contiguity as Moran's I shows the highest value here: 0.830 for HDI and 0.694 for GDP per capita growth. The high values of Moran's I confirm the strong nature of spatial autocorrelation, which means that spaces of similar growth rates form clusters within the territory under review. Figure 2 and Figure 3 show the spatial growth relationships between HDI and GDP per capita. Based on the growth indices, the figures indicate the phenomenon of East-West dichotomy. As to HDI, consistently continuous and significant LL spaces are seen, representing mostly the German regions. The eastern part of the territory under review displays a similarly continuous HH cluster consisting of Romania as a whole, Bulgaria excluding Yuzhen Tsentralen (South-Central Planning Region), the Southern Great Plain of Hungary and the Mazowieckie (Warsaw region) of Poland.

Figure 2

The local autocorrelation pattern of the HDI growth in CEE



The picture is similar in the case of economic growth as well: the East-West division is evident. Western spaces are less homogeneous: Germany's northern, central and southern regions are displayed as an independent cluster centre joined by several Austrian spatial units and two Slovenian regions. The eastern part shows a HH cluster consisting of Romania as a whole, Severoiztochen and Severen Tsentralen of Bulgaria, Poland excluding Zachodnio-Pomorskie, Lubuskie, Dolnoslaskie, Podkarpackie and Pomorskie, and Střední Morava of the Czech Republic. Having the lowest community GDP per capita (29% of EU average at PPP), Severozapaden (Northwestern) is a LH spatial outlier i.e. it has low economic growth, while its direct neighbours show high economic growth. This phenomenon indicates a halt of the catch-up process in the study period.

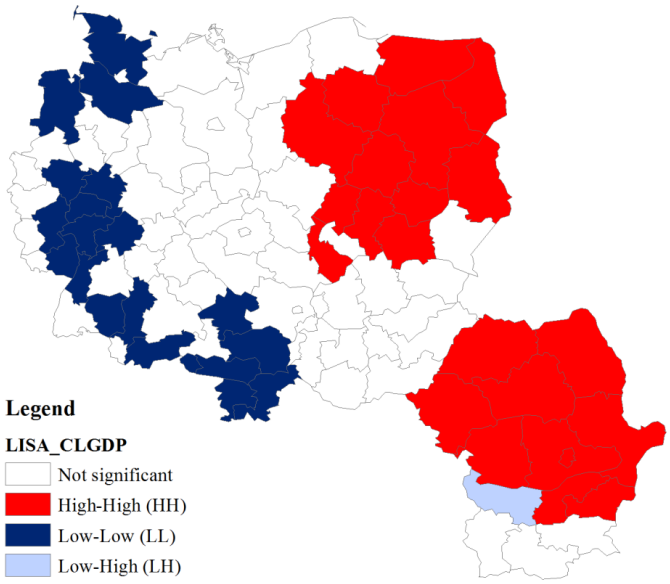
A similar study by Rodríguez-Pose-Tselios (2015), dealing with social well-being in the regions of Western Europe, explains the significant spatial autocorrelation with the "traditional" social-economic interactions taking place between the regions (knowledge and information technology spillover, trade, movement of labour and capital, economies of scale, transfer payments, etc.). According to the same study, the strong congruity may be further explained by such other factors as the roles played by national cultures, institutions and macrolevel policies. The spatial characteristics of these roles are evident also in the results of our spatial analyses regarding the growth of the economy and social development. It means

that, under the conditions of our current analyses, we may also calculate with the differentiating impacts that national factors have on convergence spatiality.

We continued our analyses with the use of this first-order queen weight matrix. Although we tried to run our regression analyses with several other matrices, they did not lead to any real change in the main parameters. According to our results listed in Table 2 and Table 3, the CEE region shows unconditional convergence during the study period.

Figure 3

The spatial configuration of the GDP per capita growth (Local Moran's I)



The regression beta coefficient, indicating convergence, is negative in the case of both indices. It means that the less developed regions show higher growth rates and vice versa. The strength of the relationships varies greatly for the OLS regressions (48.9% vs. 90.5%). As to HDI, the slope is steeper and, consequently, the convergence is stronger. According to the findings of our global autocorrelation test (Moran's I) performed on residual errors, the models still hold a lot of information. The method of Lagrange multipliers is used to provide information for the regressions supplemented with spatial characteristics. Accordingly, the regressions were supplemented with the spatial lag errors of the OLS regression for social development change and with the congruity values of the dependent variable for GDP per capita. In other words, we used the spatial error model (SEM) for the former and the spatial lag model (SLM) for the latter.

Table 2

Absolute convergence of HDI by the traditional (OLS) and spatial regressions

	OLS	**ML SEM**	**SWLS (HET)**
constant	.201*** (35.336)	.185*** (21.354)	.187*** (12.831)
HDI (ln, 2004)	-.044*** (-30.447)	-.040*** (-18.415)	-.040*** (-11.186)
lambda	-	.735*** (9.821)	.741*** (7.986)
R-squared	.905	.947	.906
MCN	20.07	-	-
Log likelihood	370.069	390.575	-
Akaike info criterion	-736.137	-777.15	-
Breusch-Pagan test	4.002**	23.837***	-
Likelihood Ratio Test	-	41.013***	-
Lagrange Multiplier (error)	45.151***	-	-
Lagrange Multiplier (lag)	23.628***	-	-
Moran's I (res.)	.455***	.018	-
Speed of convergence (%)	5.83	5.08	5.16
Half-life (year)	11.89	13.64	13.43

Note: *** significant at 0.01, ** significant at 0.05, * significant at 0.10. The spatial weight matrix is based on first–order queen contiguity. See the t- (OLS) and z-score (ML, SWLS) values in parentheses.

In the case of maximum likelihood regressions we can obtain information on model suitability not only from R^2 but also from the log likelihood (higher values are better) and Akaike info criterion (lower values are better). Accordingly, the involvement of congruity values improves the explanatory power of models for both dependent variables. The likelihood ratio test, which is used for testing spatial dependence (i.e. the applied weight matrix), demonstrates that the processes taking place in neighbouring regions significantly impact the strengthening of the two phenomena. Due to the heteroscedasticity of residuals in the case of HDI convergence, a robust estimation of the covariance matrix is used here (SWLS HET, Kelejian–Prucha 2010, Chasco 2013). When supplemented with spatiality, the models provide a more balanced picture in terms of explanatory power. (In the case of SWLS regression only R^2 provides information on the best fit.) Therefore it can be concluded that convergence does not depend only on the initial conditions. In fact, it is also clearly influenced by phenomena occurring in the neighbouring regions or in the countries encompassing a given region (spillover effects). These phenomena affect not only economic convergence but have an obvious impact on social development as well.

Table 3

Absolute convergence completed with spatial features in case of GDP per capita

	OLS	**ML SLM**
constant	.206*** (11.503)	.059*** (3.253)
GDP per capita (ln, 2004)	-.018*** (-9.586)	-.005*** (-2.995)
W	-	.729*** (10.248)
R-squared	.489	.704
MCN	15.55	-
Log likelihood	313.561	333.163
Akaike info criterion	-623.121	-660.326
Breusch-Pagan test	5.073*	6.068
Likelihood Ratio Test	-	39.205***
Lagrange Multiplier (lag)	28.108***	-
Lagrange Multiplier (error)	9.230***	-
Moran's I (res.)	.207***	-.021
Speed of convergence (%)	1.95	.52
Half-life (year)	35.62	132.79

Note: *** significant at .01, ** significant at .05, * significant at .10. The spatial weight matrix is based on first-order queen contiguity. See the t- (OLS) and z-score (ML, SWLS) values in parentheses.

Table 2 and Table 3 list the annual speeds of convergence and half-life figures based on the regression beta values calculated for the individual models. Although the regression beta values are displayed with negative sign, the speeds of convergence (and the half-life figures computed from them) show different patterns. The average growth of social development looks better, the annual speed of convergence always exceeds 5% and the half-life never exceeds 15 years. Economic performance is coupled with a much lower speed of convergence (approx. 2%, which is almost the same as the estimate obtained with the same methodology by Mankiw et al. [1992] for the OECD countries, or the estimate of Dedák and Dombi [2009] for the CEE counties) but it drops to one quarter of its original value (while half-life increases in parallel) when spatiality comes into the picture. The neighbourhood effects lead to a downward adjustment of the original OLS model in both cases, while in the case of economic development the phenomena occurring in the direct neighbour regions are more pronounced.

Several former studies highlight the presence of national differentiation in the CEE convergence process (Herz-Vogel 2003, Hegerty 2016, Kotosz-Lengyel 2017) and, in particular, the great differences that can be seen both between and within the countries in this regard. Our study focuses on nine countries. However, the introduction of that many (or, to be precise, eight) convergence club dummy variables produced severe multicollinearity. That is why we created two dummy variables (d_2004, d_2007), indicating the accession date, in the EU accession function, and we used Germany and Austria as references.

Table 4

Institutional club convergence in CEE

	HDI	**GDP per capita**
constant	.175*** (12.609)	.085*** (2.640)
TD (ln, 2004)	-.038*** (-11.626)	-.006* (-1.858)
d_2004	.005** (2.406)	.010*** (3.162)
d_2007	.007* (1.798)	.022*** (4.655)
R-squared	.908	.572
MCN	55.250	78.543
Log likelihood	373.005	323.79
Akaike info criterion	-738.011	-639.581
Breusch-Pagan test	13.641***	47.336***
Lagrange Multiplier (error)	43.126***	23.876***
Lagrange Multiplier (lag)	25.998***	27.363***
Moran's I (res.)	.445***	.331***
Speed of convergence (%)	4.78	.62
Half-life (year)	14.50	111.80

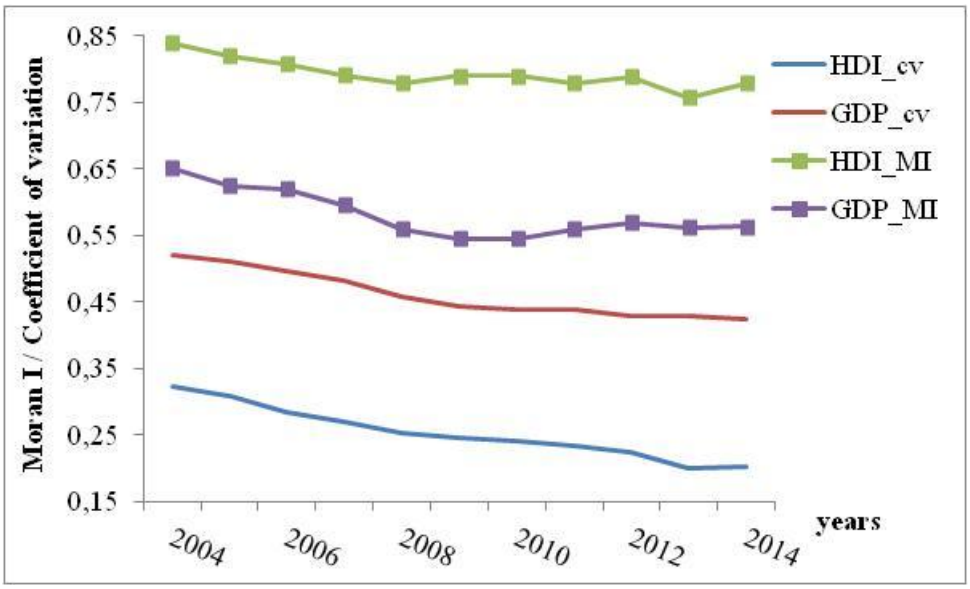
Note: *** significant at 0.01, ** significant at 0.05, * significant at 0.10. See the t-score values in parentheses. A TD refers to territorial development.

The convergence club approach provides an opportunity also for the testing of institutional impacts. Zeghni and Fabry (2008) and Zeghni (2011) studied the role of institutions for human development in the transitional economies of Central and Eastern Europe. The authors found a significant impact in the case of those countries that joined the Community in 2004 and 2007. They attributed the improvement of human development, achieved through market (creation and regulation) and political institutions (democracy and state federalism), to the application of the "acquis communautaire" criterion. Therefore the EU accession date may be considered as an institutional development variable, the impact of which is also tested. Our results confirm the existence of convergence, and the dummy variables (i.e. institutional clubs) have a significant impact on the growth of our development variables. According to the t-scores, this impact is more stable for HDI and GDP in the regions of countries that joined the Community in 2004 and 2007, respectively. Regardless of the significant presence of explanatory variables, the models present several errors. The high level of multicollinearity should be mentioned first. It actually demonstrates that the dummy variables are "superfluous" because the convergence clubs are basically inherent in the static (initial) and dynamic data. This reinforces the summary statement of Váry (2017, p. 262), according to which "as all potentially decisive development factors (institutional quality, cultural attitudes,

human capital, geographical aspects, etc.) correlate and interact with each other in a complex manner, it is difficult to identify the individual impacts of each explanatory variable on development". Furthermore, the heteroscedasticity of residuals compromises the reliability of regression estimates. As to social well-being, the regional dummy variables reduce the speed of convergence and increase half-life. In the case of economic performance the values are slightly better than those obtained formerly with the spatial lag model.

Figure 4

Sigma convergence and spatial autocorrelation of the development variables



Note: MI - Moran's I, cv - population-weighted coefficient of variation

Last but not least, the population-weighted coefficients of variation (CV) of the two development indices indicate territorial leverage i.e. sigma-convergence is coupled with declining regional differences between 2004 and 2014 (Figure 4). As to GDP per capita, sigma-convergence shows greater variation and it is clearly lower than in the case of HDI, leading to smaller regional inequalities and more balanced conditions. It is also evident in Figure 4 and from the data that there is a considerable decrease until 2008, followed by a sudden drop in the steepness of the curves, which may be the result of the economic crisis. Regression trend calculations are used for both variables in order to find out whether the direction of regional differences can be considered reliable. We apply a logarithmic estimation for both HDI and GDP per capita to explain the trends that decrease with the highest speed/certainty. The coefficients of determination amount to 96.4% (HDI) and 91.5%

(GDP per capita), the regression parameters (constant, β_1) are significant[3] and the equations reasonably explain the phenomenon of decreasing variation (leverage). In addition to the population-weighted CV, the global regional autocorrelation of development variables is also analysed to see how the effect of leverage may change the average spatial pattern and how the study area may become separated into regions consisting of several sub-regions with different characteristics. The values of Moran's I move together with the CV values in so far as where a variable shows a lower coefficient of variation, there is a higher level of clusterisation (HDI) and vice versa (GDP per capita). In addition, there is another similarity: both CV and significant regionalisation tend to decrease until the start of the economic crisis but after that the CV decreases, while the spatial autocorrelation shows stagnation. It is somewhat contradictory to former findings (Benedek-Kocziszky 2017) claiming that convergence and divergence are strongly related to regional polarisation. That is why we continue our study with local convergence analyses.

Local convergence and catch-up analyses without the use of spatial parameters

The local analyses are suitable for describing the individual routes of the various regions as well as for showing the annual speed of convergence (the narrowing of the development gap), the half-life value and the catch-up time. Prior to such analyses, it is necessary to define a (reference) region for the catch-up target. Instead of choosing a NUTS2 region, we selected Austria's national performance as the catch-up target to be achieved. (Austria is a leader in the study region with regard to both dimensions.) (The main results can be seen in the Appendix.)

Table 5 and Table 6 list, by NUTS2 region, the annual speed of convergence for HDI and economic performance and the resulting half-life values. The tables contain the extreme values (maxima and minima) of the various countries, organised according to annual speed of catch-up. (The tables do not include the regions that have already caught up with the reference region.) Figure 5 and Figure 6, linked with the calculations, give a better understanding of the spatial peculiarities.

[3] $HDI_{CV} = 180{,}43 - 23{,}69\ years$
$t_{constant} = 15{,}45$; $t_{years} = -15{,}43$;
$GDP_{CV} = 155{,}09 - 20{,}33\ years$
$t_{constant} = 9{,}81$; $t_{years} = -9{,}77$.

The annual catch-up speeds, required to reach Austria's level, vary greatly for both HDI and GDP per capita; based on the growth realised in 2004-2014, the individual regions can be grouped into either the "catch-up completed" category or the "catch-up failed" category. Just like in the case of global and spatial convergence analyses, the former indicator displays a stronger narrowing of the development gap. As to the study region, the Mazowieckie territorial unit (including Warsaw) of Poland shows the highest annual speed of convergence (11.6%) and the Jihozapad territorial unit of the Czech Republic displays the lowest value (0.7%).

Table 5

The maximum and the minimum values of local speed of convergence and the half-life of convergence (HDI)

	Regions	Annual speed of convergence, %	Half-life, years
Bulgaria	Yugozapaden	-4.9	14.06
	Yugoiztochen	-1.5	45.91
Czech Republic	Strední Cechy	-4.5	15.51
	Jihozápad	-.7	103.91
Hungary	Southern Great Plain	-2.6	26.27
	Central Hungary	-	catch-up failed
Poland	Mazowieckie	-11.6	6.00
	Kujawsko-Pomorskie	-3.0	23.25
Romania	Bucuresti - Ilfov	-9.8	7.10
	Sud-Est	-2.4	28.42
Slovenia	Vzhodna Slovenija	-3.0	22.99
	Zahodna Slovenija	-	catch-up failed
Slovakia	Východné Slovensko	-3.1	22.36
	Západné Slovensko	-2.0	33.98
Germany	-	-	-
	Saarland	-	catch-up failed
Austria	Burgenland	-10.2	6.80
	Steiermark	-	catch-up failed

Note: the table lists the maxima and minima of the countries in the study region on the basis of their respective speed of convergence.

With regard to HDI catch-up, a clear East-West dichotomy can be seen. As to Central and Eastern Europe, the eastern part is basically characterised with convergence, while the western part typically shows developed spaces categorised either as "catch-up completed" or "catch-up failed". The new member states, with two exceptions, experience a strong trend of catch-up mostly in the capitals or in the neighbouring regions of the capitals. The Prague region and the Bratislava region exceeded the average Austrian quality of life in 2011 and 2014, respectively. The annual narrowing of the development gap is fairly strong in the

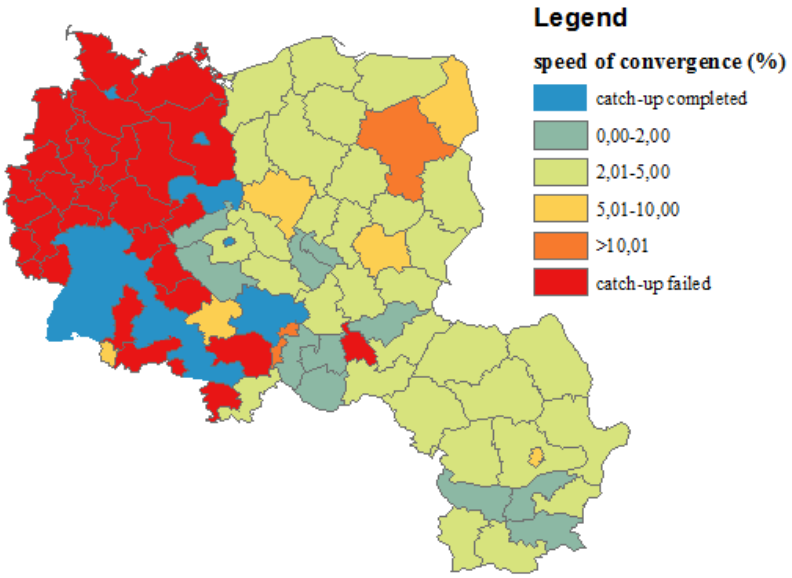
Warsaw (11.6%) and Bucharest (9.76%) regions[4]. With its annual speed of almost 5%, the Sofia region (Yugozapaden) excels among the other regions, while a Polish region including three big hubs other than the capital city (Malopolskie, Dolnoslaskie, Podlaskie) shows an annual speed above 5%. The higher catch-up rate of the more developed urban areas in the above countries indicates a process of divergence.

The "catch-up failed" category can also be found in the new member states; despite a slight increase, the basic trend is represented by a downward adjustment from the reference value in Central Hungary and Zahodna Slovenija (Ljubljana). (In 2004 the former stood at 90% of, while the latter nearly reached the Austrian average but by 2014 the former dropped to 83% and the latter increased to 98% of the reference value.) A similar but somewhat different process can be seen in Germany and Austria as well. The German and Austrian regions in the "catch-up failed" and "catch-up completed" categories exceeded the reference value in 2004 but showed a decline in social development in 2014. This phenomenon is typical in some 90% of the territorial units of the German-speaking countries. The only exceptions are Burgenland, Niederösterreich, Oberösterreich and Vorarlberg; these are the only regions where convergence can be seen.

[4] It is worth examining the delineation of the two regions. The Mazowieckie region represents the classic example of aggregation information loss: seven NUTS3 units are established in the vicinity of a fairly developed capital city. Actually, three out of the eight sub-regions exceed the GDP per capita value of the EU28 average (Miasto Warszawa: 198%; Warszawszki Zachodni: 101%; Plocki: 86%), and the remaining ones vary between 50% and 60%. However, Bucharest forms a NUTS2 region only with the sub-region located in its immediate vicinity (Bucharest-Ilfov). That is why the position of the Mazowieckie region is noteworthy.

Figure 5

Local speed of convergence by the HDI in CEE



Furthermore, the speed of convergence shows a clear-cut differentiation at national level. This indicates, again, the importance of country-specific effects and convergence clubs. The narrowing of the development gap averages 2% in Poland (4.6%), Slovakia (2.5%) and Romania (4.18%). The Czech Republic, Hungary, Bulgaria and Slovenia show various catch-up trends. As to the first three, the speed of convergence is low, which strengthens the divergence process, in the less developed/depressed regions (Northern Hungary, Southern Transdanubia, Severozapaden [Bg], Severen Tsentralen, Severozápad [Cz]). The phenomenon of club formation is obvious also in Germany: most southern provinces (Baden-Württemberg, Bavaria) show downward adjustment but still keep their pace. The regions of Berlin, Hamburg, Dresden and Leipzig are in a similar situation. There is a highly performing but relatively lagging convergence club in the central and northern part of Germany. The reference region is not uniform either: Burgenland, Oberösterreich and Vorarlberg are strongly catching up, while there is a downward adjustment in the Vienna region.

The speed of convergence of GDP per capita also shows both extremes (catch-up completed, catch-up failed) but their ratio differs from the HDI figures. The catch-up failed category is particularly small, which is an evident sign of the division between the two dimensions. When comparing the two figures, this phenomenon becomes especially spectacular in the central and northern part of Germany.

Table 6

The local convergence features of GDP per capita in CEE

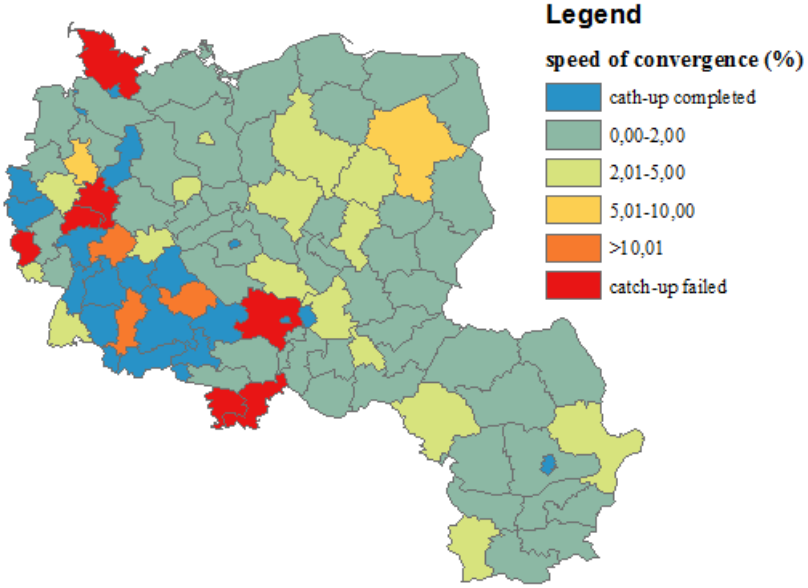
	Regions	Annual speed of convergence, %	Half-life, years
Bulgaria	Yugozapaden	-3.5	19.66
	Severozapaden	-.3	256.29
Czech Republic	Jihovýchod	-2.0	34.39
	Severozápad	-.3	catch-up failed
Hungary	Central Hungary	-2.1	32.41
	Southern Transdanubia	-.2	450.45
Poland	Mazowieckie	-9.9	7.00
	Swietokrzyskie	-1.0	66.56
Romania	Vest	-2.1	33.23
	Nord-Est	-1.0	68.61
Slovenia	Vzhodna Slovenija	-	catch-up failed
	Zahodna Slovenija	-	catch-up failed
Slovakia	Západné Slovensko	-2.9	24.11
	Východné Slovensko	-1.2	55.66
Germany	Niederbayern	-11.1	6.24
	Trier	-	catch-up failed
Austria	Steiermark	-1.9	36.45
	Burgenland	-.0	1774.1

Note: the table lists the maxima and minima of the countries in the study region on the basis of their respective speed of convergence.

A Hungarian region (Southern Transdanubia) produces the lowest positive value (0.7%) and, again, the Polish capital region (Mazowieckie) is the best performer (9.9%) in the CEE area under review. The two phenomena are synergistic and moving together in both regions. Just like in the case of human development, Prague and Bratislava exceed the Austrian average also in terms of economic performance. However, the two dimensions are not balanced in Bucharest, with the HDI slightly lagging behind.

Figure 6

Unique speeds of convergence by the GDP per capita

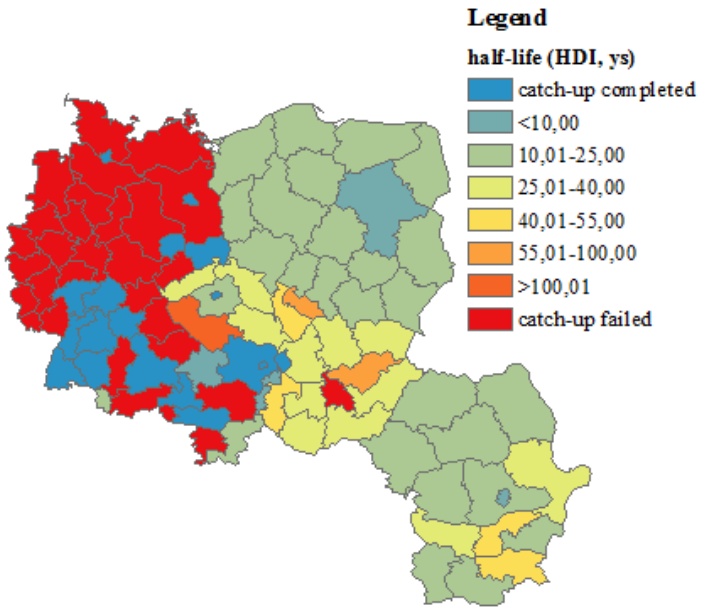


Central Hungary displays an opposite trend: the speed of convergence is positive for GDP per capita but negative for HDI. In the latter two cases the issue of efficiency is also raised as the one-sided process of complex catch-up seems to have favoured only the dimension of GDP per capita. In view of the growth rates of the 10-year period under review, Zahodna Slovenija fails to reach the reference region (just like in the case of HDI). In the Yugozapaden region of Bulgaria economic performance and human development walk hand in hand. In the eastern territory the main spaces for economic catch-up, in addition to capital cities, are the regions that include developed cities. In particular, the regions of Poznan, Wroclaw, Katovice or Lódz (Wielkopolskie, Dolnoslaskie, Slaskie, Lódzkie) in Poland, the region of a major Brno sub-centre (Jihovichod) in the Czech Republic and the region of Západné Slovensko (Trnava, Trencin, Nitra) adjacent to the capital city in Slovakia show high-level convergence with Austria. Romania's second largest growth pole is the Vest region, which includes MEGA (Timişoara, Arad) known to have European implications, and the strategically positioned Sud-Est region that attracts a huge amount of foreign working capital Sud-Est (Allen & Overy 2011). Apart from these regions, the eastern territory displays only low catch-up speeds (0-2% per year). In terms of economic performance it means the presence of divergence within the countries. Slovenia is an exception as even Vzhodna Slovenija shows a downward adjustment. This region is an exception also in that HDI displays a moderate catch-up speed but GDP is relatively lagging behind the Austrian average. It is, again, a one-sided progress but this time it is in favour of HDI convergence.

The southern provinces of Germany form, again, a well-performing convergence club including regions with “catch-up completed” status, downward adjustment or high speed of convergence. The German representatives of the “catch-up failed” category (Trier, Schleswig-Holstein, Giessen, Kassel) greatly differ from the same categorisation made for HDI. Although most of the cases are also about downward adjustment (when compared to Austria, Kassel’s position is the same in 2004 as in 2014), unlike in the case of well-being, these regions fail to reach the initial value of the reference region in 2004. In Germany, the behaviour of central and northern regions is similar to that of the majority of eastern regions where, apart from a few exceptions, the narrowing of the development gap is 0-2% per year, typically coupled with the relative lagging of social well-being. Austria is still not uniform: the GDP per capita values of several regions (Wien Oberösterreich, Salzburg, Tirol, Vorarlberg) are higher than the average already in 2004 but, except for Vienna, there is continuous convergence without any downward adjustment. In the territory under review, the lowest speed of convergence is present in Burgenland (0.036% per year) located in the periphery of Austria. When compared to HDI, progress is one-sided here again, the growth of social development may be attributed to state interventions. Steiermark and Kärnten also show some one-sided catch-up taking place, again, in favour of HDI.

Figure 7

Half-life of convergence (HDI)

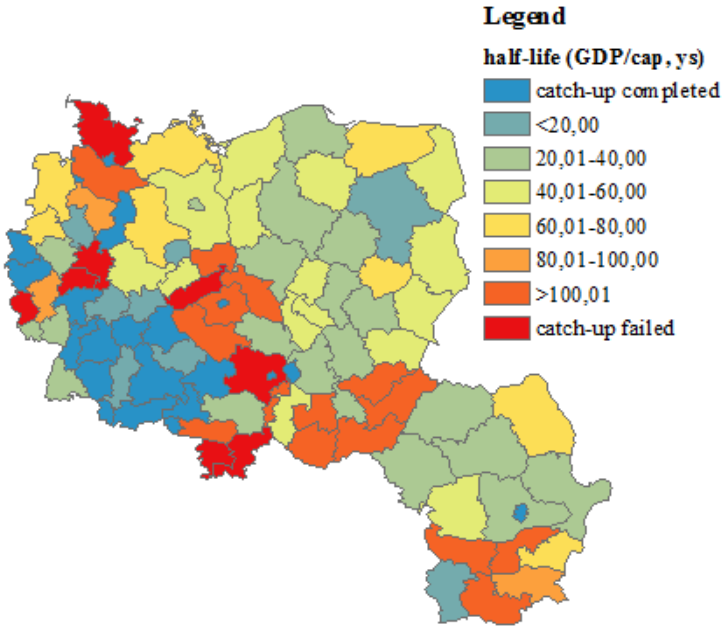


Resulting from the speed of convergence, half-life shows here – just like for the entire CEE territory – the number of years that would be required, upon assuming a constant speed of convergence for the 10-year period under review, to cover half of the way leading to catch-up. As in the case of HDI the vast majority of the regions show a higher speed of convergence, it can be detected in half-life values as well. A diverse half-life picture is obtained when the non-converging or "catch-up completed" regions are omitted from the analyses (Figure7). It takes 6 years for the best-performing Mazowiecki region and as many as 104 years for the Jihozápad region, which has the lowest speed of convergence, to catch up with half of Austria's average social well-being. As to the eastern capital cities that are not lagging, Warsaw and Bucharest would catch up (assuming constant growth) with the reference level within a relatively short time (12-14 years), while the Sofia region would need almost 30 years to do the same. The short half-life of Strední Cechy, the region round Prague, is presumably attributable to the positive effects of neighbourhood with the Czech capital city. When put on the map, half-life values – just like catch-up speeds – positively confirm the phenomenon of national convergence clubs, completed with the presentation of gradual progress. Except for one or two regions, Poland and Romania would catch up with half of Austria's social well-being within 10-25 years, while Slovakia would need 25-40 years to do the same. In Hungary, most regions are also expected to reach the Austrian HDI within 25-40 years, with the relatively developed Western Transdanubia needing 43.5 years and the most

backward Northern Hungary requiring 58 years for it. The situation is similar in the Czecz Republic, where the catch-up target represents an inconceivably long period for the relatively developed Jihovychod region located in the western part of the country, while the Ostrava region (formerly involved in heavy industry) faces the same half-life as Northern Hungary (which is a not too optimistic perspective for such kind of regions). Except for the above region and the capital city region, the rest of the country would reach half of the catch-up target within 25-40 years. The spatial pattern of Bulgaria and Slovenia is in line with the respective speeds of convergence; only Yugoiztochen and Severen Trentsalen (Bulgaria) excel with a half-life of 40-55 years.

Figure 8

Half-life of convergence by the GDP per capita



When analysing the time requirement for economic catch-up (Figure 8), clusterisation and club formation can be seen again – although not as clearly as for social development – in the case of a continuous area, excluding the central and western regions of Hungary, having a half-life above 100 years (Western Transdanubia excels with its 450.5 years); similar features can be found in the western part of the Czech Republic (Bohemia) and the entire territory of Slovenia. The one-sided development is striking mostly in Strední Cechy with a half-life of 15.5 years for HDI and 226.9 years for GDP per capita. In Poland, the regions including the already mentioned big hubs are accompanied by regions such as Malopolskie (Krakow) and Pomorskie (Trójmiejski) where the relatively short half-life is the result of the better initial

conditions. Slovakian regions also show divergence and the East-West dichotomy is present again but, unlike in the case of HDI, the catch-up of western regions is expected to be quicker. Except for the capital city region, Bulgaria needs an inconceivably long time to catch up with half of Austria's performance level. (Severozapaden, which has the lowest GDP per capita, would need 256.3 years to do that.) The subtle interrelations between social and economic development are exemplified by the case of Burgenland and Kärnten. In the former region the half-life is 6.8 years for HDI and, upon assuming a constant speed of convergence for the 10-year period under review, 1774 years for GDP per capita. The latter region shows a downward adjustment in terms of social development, while its half-life for economic convergence amounts to 465 years. Half-life varies widely in the northern part of Germany but the provinces of the former East Germany are not necessarily worse off than the West German regions. The poorest values belong to Hannover (85.2 years), Dresden (193.1 years) and Lüneburg (438.6 years).

As part of our local convergence tests, we also provide catch-up time estimates. For such purpose, we assume constant growth rates both for the reference region and for all other regions (excluding Germany) on the basis of the average values of the 10-year period under review. As to HDI and GDP per capita, we use 2.8% and 2.7% for Austria and 5.4% and 5.5% for the other regions, respectively. Catch-up time varies from 0.0 to 32.67 years (Nord Est [Ro]) for social development and from 0.0 to 54.85 years (Severozapaden [Bg]) for economic development. When assessing the results, we focus mainly on spatial differences (Figure 9 and Figure 10). Economic catch-up is in line with the East-West division: the fast growing regions take the spatial structure of a new Central European banana (SIC! 2006) and even the eastern wall can be identified. In Poland, some traditional historical inequalities can also be detected (Gorzelak 2001, 2011), although this spatial feature cannot be seen for HDI. Most of the eastern regions display better growth performance – mostly when examined along non-income dimensions – than their western counterparts; this finding is confirmed (in static approach) also by some former studies (Tridico 2007). The regions of the former East Germany show similar differences: GDP per capita is severely lagging behind, while HDI presents a more balanced country picture. The poorly developed regions show a similar spatial image in the southern and southeastern peripheries. As to HDI, Romania's Nord-Est, Sud-Est and Sud-Muntenia represent the highest catch-up values, while Bulgaria without the capital city region, Northern Hungary and Northern Great Plain and Romania's Nord-Est and Sud-Vest Oltenia excel in terms of GDP per capita.

Figure 9

Catch-up time for HDI in CEE

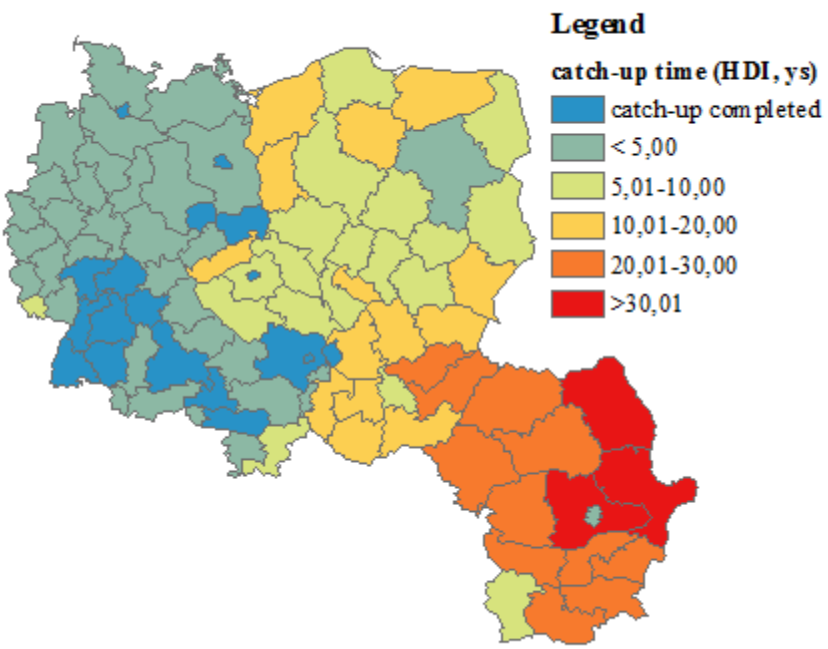
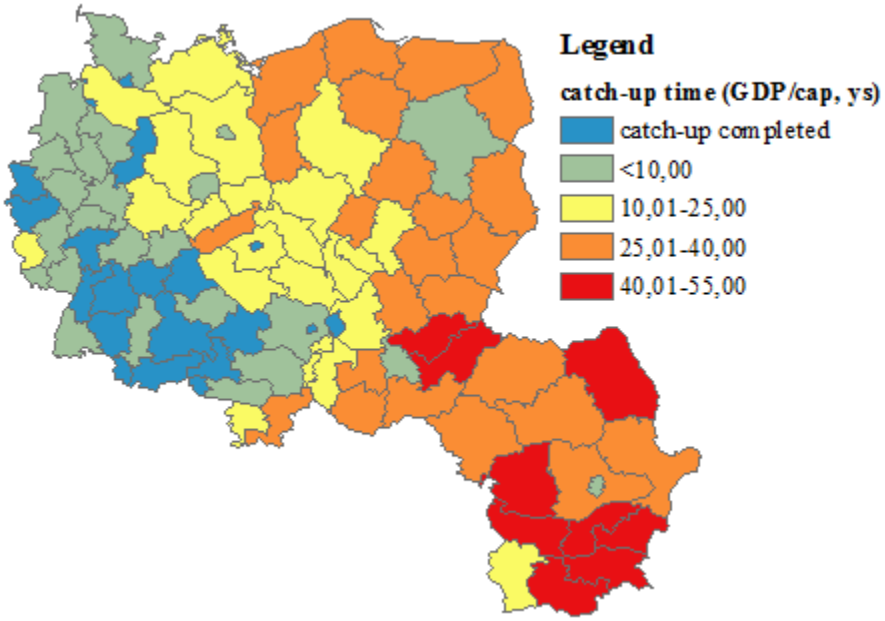


Figure 10

Catch-up time for GDP per capita in CEE



Summary

Our paper discusses the convergence of economic and well-being performance in the Central and Eastern European NUTS2 regions for the period between 2004 and 2014.We have abandoned the theory of closed economies and, as a result, used spatial interactions and spillover effects for our study. We drafted four research questions in connection with this theme.

The question for the existence of convergence in CEE has been strengthened, there is a significant absolute convergence in the case of the economic (GDP / capita) *and of the social development (HDI)* between 2004 and 2014 in the study area. Regarding the regional economic performance, the annual speed of convergence of around 2%, corresponding to the literature and conditional convergence studies was estimated, while the human development index was much higher by nearly 6%. So, regardless of any other explanatory factor, less developed regions tend to converge with more developed ones.

The spatiality, its dependence and the different interactions can be considered as the phenomena that can be clearly understood in the context of the convergence and the catch-up. The spatial dependence of growth rates can be considered really strong, and the spatial divisions are heavily tied to the national boundaries, especially in the case of the HDI. So, similarly to Rodríguez-Pose-Tselios' study (2015) about the western european regions, we can assume that in the Central and Eastern European regions there is also the effect of national institutions and impact of culture, not only on the traditional neighborhood relations, interactions (knowledge, technology, movement of production factors, etc.) can be attributed to spatial similarity. This is proved and shaded in part, the regression analyzes with the involvement of variables of institutional development are also tinged, in their case, the role of multicollinearity is significant. That is why, both static (initial development) and dynamic data (growth rate) carry the institutional characteristics (convergence clubs). Global regression models have contributed significantly to the incorporation of neighbourhood characteristics. There is a significant and positive neighborhood effect, in the case of both regression of the developmental variables, the growth of the two phenomena has a reliable impact on the processes in neighboring regions. The spatial regression models explain the convergence of the area with really good efficiency, the main indices (R2, Log likelihood, Akaike info criterion) take up more favorable values, than in the case of the OLS regression.

The differences are clear between the economical and social convergence. On the one hand, in the case of social well-being there are much more balanced relations (spatial autocorrelation, population-weighted coefficient of variation), than it appears in the case of

the GDP/capita. In addition, there is a closer correlation between initial development and growth rate, and the annual convergence rate is considerably faster. (It is nearly three times more of the OLS' result, than it was experienced in the case of GDP). That is why, the time what we need to achieve the full convergence within the area under investigation, in the case of the HDI it is on average 11.9 years and 35.6 years in the case of GDP. The neighborhood effects downplay the main indicators of convergence, the effects of the processes are more significant in the surrounding region, than the economical performance, the annual convergence rate falls to the value of its one-quarter, and HDI has only 12-13 percent relapse. These results highlight the two phenomena, the two development dimensions, which means that the redundant nature of the indicators doesn't stand in a dynamic approach.

The global and spatial regressions provide only an average picture of the phenomenon that is being studied and therefore the presentation of the individual paths of each region (narrowing of the development gap, half-life and the time needed to reach it) was made and as a target region to be achieved we chose the whole Austria. Local results basically shine the information provided by global regressions, pointing to a number of unique features. The indicators described in the regression studies (the annual speed of convergence, so the narrowing of the development gap and the half-lives) are moving on a much wider scale, the values of the "catch-up completed" and the "catch-up failed" category are experienced. There are significant differences in the social and economical development too, similarly to the regression results, social development provides a more favourable picture of catch-up. At the same time, which was not indicated by mathematical-statistical methods, downward adjustment can be referred to as a very characteristic process, especially for HDI. Local convergence and catch-up analyses without the use of spatial parameters strenghten the national character of catching up, the club formation (club convergence) and the preferences of urban spaces.

Based on our results, it is important to highlight that these studies don't necessarily mean that economical and social convergence and catching up are hand in hand. The one-sided development is experienced in many regions (eg.: Közép-Magyarország, Vzhodna Slovenija, Burgenland, the northern and central-german regions), which deals with the efficiency of economical performance.

In our study, we also estimated the cath-up - time. The experiments also show a significant period for the less developed southern and eastern regions by calculating a relatively higher constant growth rate. That is why, the large-spatial fragmentation will last for a long time in the case of a longer optimal growth too.

Our analysis can not be considered as it hadn't criticism, because a relatively short period of time has been investigated, which is also burdened by an economical crisis. At the same time, this period clearly points to the cynolized relationships between economical and human development in the examined region.

Acknowledgements

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Appendix 1. The main results of local HDI catch-up calculations

GEO	Speed of convergence	Half-life of convergence	Catch-up time
BG31 - Severozapaden	-0,019	-35,563	27,621
BG32 - Severen tsentralen	-0,016	-42,752	25,298
BG33 - Severoiztochen	-0,031	-22,173	21,161
BG34 - Yugoiztochen	-0,015	-45,906	25,989
BG41 - Yugozapaden	-0,049	-14,058	8,179
BG42 - Yuzhen tsentralen	-0,030	-23,437	23,640
CZ01 - Praha	-0,026	catch-up completed	0,000
CZ02 - Strední Cechy	-0,045	-15,511	6,934
CZ03 - Jihozápad	-0,007	-103,912	9,522
CZ04 - Severozápad	-0,018	-37,922	15,947
CZ05 - Severovýchod	-0,021	-33,638	9,487
CZ06 - Jihovýchod	-0,025	-27,947	6,312
CZ07 - Strední Morava	-0,014	-51,098	9,815
CZ08 - Moravskoslezsko	-0,012	-58,329	12,641
HU10 - Közép-Magyarország	0,052	catch-up failed	7,327
HU21 - Közép-Dunántúl	-0,018	-38,912	17,502
HU22 - Nyugat-Dunántúl	-0,016	-43,504	14,992
HU23 - Dél-Dunántúl	-0,018	-37,721	19,636
HU31 - Észak-Magyarország	-0,012	-58,026	22,121
HU32 - Észak-Alföld	-0,026	-26,327	20,949
HU33 - Dél-Alföld	-0,026	-26,266	18,286
PL11 - Lódzkie	-0,040	-17,540	10,074
PL12 - Mazowieckie	-0,116	-5,996	2,104
PL21 - Malopolskie	-0,054	-12,856	6,490
PL22 - Slaskie	-0,044	-15,674	7,730
PL31 - Lubelskie	-0,047	-14,717	9,472
PL32 - Podkarpackie	-0,046	-15,081	10,167
PL33 - Swietokrzyskie	-0,037	-18,892	9,760
PL34 - Podlaskie	-0,053	-12,974	9,066
PL41 - Wielkopolskie	-0,044	-15,605	8,173
PL42 - Zachodniopomorskie	-0,031	-22,449	10,184
PL43 - Lubuskie	-0,030	-23,100	10,913
PL51 - Dolnoslaskie	-0,051	-13,497	7,495
PL52 - Opolskie	-0,039	-17,714	10,012
PL61 - Kujawsko-Pomorskie	-0,030	-23,246	12,216
PL62 - Warminsko-Mazurskie	-0,033	-21,148	13,117
PL63 - Pomorskie	-0,041	-16,937	8,080
RO11 - Nord-Vest	-0,037	-18,854	24,575
RO12 - Centru	-0,033	-21,008	23,029
RO21 - Nord-Est	-0,034	-20,475	32,674
RO22 - Sud-Est	-0,024	-28,423	31,185
RO31 - Sud - Muntenia	-0,030	-23,368	30,284

GEO	Speed of convergence	Half-life of convergence	Catch-up time
RO32 - Bucuresti - Ilfov	-0,098	-7,103	3,998
RO41 - Sud-Vest Oltenia	-0,037	-18,659	25,019
RO42 - Vest	-0,029	-23,553	22,780
SI03 - Vzhodna Slovenija	-0,030	-22,987	6,779
SI04 - Zahodna Slovenija	0,280	catch-up failed	0,732
SK01 - Bratislavský kraj	#SZÁM!	catch-up completed	0,000
SK02 - Západné Slovensko	-0,020	-33,977	13,425
SK03 - Stredné Slovensko	-0,024	-28,672	13,128
SK04 - Východné Slovensko	-0,031	-22,362	13,631
DE11 - Stuttgart	-0,115	catch-up completed	0,000
DE12 - Karlsruhe	-0,176	catch-up completed	0,000
DE13 - Freiburg	-0,313	catch-up completed	0,000
DE14 - Tübingen	-0,127	catch-up completed	0,000
DE21 - Oberbayern	-0,067	catch-up completed	0,000
DE22 - Niederbayern	#SZÁM!	catch-up failed	3,456
DE23 - Oberpfalz	#SZÁM!	catch-up failed	1,458
DE24 - Oberfranken	#SZÁM!	catch-up failed	1,329
DE25 - Mittelfranken	-0,404	catch-up completed	0,000
DE26 - Unterfranken	-0,501	catch-up completed	0,000
DE27 - Schwaben	#SZÁM!	catch-up failed	0,147
DE30 - Berlin	-0,197	catch-up completed	0,000
DE40 - Brandenburg	#SZÁM!	catch-up failed	0,461
DE50 - Bremen	#SZÁM!	catch-up failed	3,331
DE60 - Hamburg	-0,120	catch-up completed	0,000
DE71 - Darmstadt	-0,153	catch-up completed	0,000
DE72 - Gießen	#SZÁM!	catch-up failed	1,507
DE73 - Kassel	#SZÁM!	catch-up failed	2,533
DE80 - Mecklenburg-Vorpommern	#SZÁM!	catch-up failed	2,602
DE91 - Braunschweig	#SZÁM!	catch-up failed	2,273
DE92 - Hannover	#SZÁM!	catch-up failed	2,073
DE93 - Lüneburg	#SZÁM!	catch-up failed	3,438
DE94 - Weser-Ems	#SZÁM!	catch-up failed	4,365
DEA1 - Düsseldorf	#SZÁM!	catch-up failed	3,707
DEA2 - Köln	#SZÁM!	catch-up failed	0,928
DEA3 - Münster	#SZÁM!	catch-up failed	3,492
DEA4 - Detmold	#SZÁM!	catch-up failed	3,229
DEA5 - Arnsberg	#SZÁM!	catch-up failed	5,078
DEB1 - Koblenz	#SZÁM!	catch-up failed	3,361
DEB2 - Trier	#SZÁM!	catch-up failed	0,799
DEB3 - Rheinhessen-Pfalz	#SZÁM!	catch-up failed	0,907
DEC0 - Saarland	0,229	catch-up failed	5,813
DED2 - Dresden	-0,187	catch-up completed	0,000
DED4 - Chemnitz	#SZÁM!	catch-up failed	0,903

GEO	Speed of convergence	Half-life of convergence	Catch-up time
DED5 - Leipzig	-0,389	catch-up completed	0,000
DEE0 - Sachsen-Anhalt	#SZÁM!	catch-up failed	3,011
DEF0 - Schleswig-Holstein	#SZÁM!	catch-up failed	2,109
DEG0 - Thüringen	#SZÁM!	catch-up failed	0,717
AT11 - Burgenland (AT)	-0,102	-6,799	1,692
AT12 - Niederösterreich	0,321	catch-up completed	0,000
AT13 - Wien	-0,062	catch-up completed	0,000
AT21 - Kärnten	-0,068	catch-up completed	0,000
AT22 - Steiermark	0,088	catch-up failed	0,850
AT31 - Oberösterreich	-0,082	-8,449	0,800
AT32 - Salzburg	-0,044	catch-up completed	0,000
AT33 - Tirol	#SZÁM!	catch-up failed	0,258
AT34 - Vorarlberg	-0,067	-10,299	0,666

Appendix 2. The main results of local GDP per capita catch-up calculations

GEO/TIME	Speed of convergence	Half-life of convergence	Catch-up time
BG31 - Severozapaden	-0,003	-256,289	54,849
BG32 - Severen tsentralen	-0,006	-107,374	50,169
BG33 - Severoiztochen	-0,009	-79,506	44,610
BG34 - Yugoiztochen	-0,008	-90,286	44,268
BG41 - Yugozapaden	-0,035	-19,662	20,785
BG42 - Yuzhen tsentralen	-0,004	-167,638	52,649
CZ01 - Praha	0,012	catch-up completed	catch-up completed
CZ02 - Strední Cechy	-0,003	-226,856	18,499
CZ03 - Jihozápad	-0,004	-171,077	19,537
CZ04 - Severozápad	0,003	catch-up failed	26,667
CZ05 - Severovýchod	-0,006	-110,221	22,454
CZ06 - Jihovýchod	-0,020	-34,387	17,656
CZ07 - Strední Morava	-0,015	-45,867	22,076
CZ08 - Moravskoslezsko	-0,013	-53,966	21,889
HU10 - Közép-Magyarország	-0,021	-32,412	7,634
HU21 - Közép-Dunántúl	-0,003	-222,200	27,964
HU22 - Nyugat-Dunántúl	-0,014	-48,846	21,517
HU23 - Dél-Dunántúl	-0,002	-450,453	39,176
HU31 - Észak-Magyarország	-0,002	-303,372	41,318
HU32 - Észak-Alföld	-0,003	-264,771	40,693
HU33 - Dél-Alföld	-0,005	-133,739	36,870
PL11 - Lódzkie	-0,022	-31,096	26,667
PL12 - Mazowieckie	-0,099	-7,003	6,753
PL21 - Malopolskie	-0,020	-35,468	28,630
PL22 - Slaskie	-0,020	-34,414	22,835
PL31 - Lubelskie	-0,012	-56,139	37,718
PL32 - Podkarpackie	-0,012	-56,643	37,150
PL33 - Swietokrzyskie	-0,010	-66,563	36,040
PL34 - Podlaskie	-0,013	-52,858	36,315
PL41 - Wielkopolskie	-0,027	-25,303	21,703
PL42 - Zachodniopomorskie	-0,013	-53,062	30,940
PL43 - Lubuskie	-0,015	-47,054	30,702
PL51 - Dolnoslaskie	-0,038	-18,203	20,066
PL52 - Opolskie	-0,013	-51,947	32,151
PL61 - Kujawsko-Pomorskie	-0,013	-54,480	31,905
PL62 - Warminsko-Mazurskie	-0,011	-65,335	36,870
PL63 - Pomorskie	-0,020	-34,897	26,035
RO11 - Nord-Vest	-0,018	-38,122	36,315
RO12 - Centru	-0,019	-36,414	34,698
RO21 - Nord-Est	-0,010	-68,606	50,169
RO22 - Sud-Est	-0,021	-33,656	35,768
RO31 - Sud - Muntenia	-0,019	-36,802	38,294

GEO/TIME	Speed of convergence	Half-life of convergence	Catch-up time
RO32 - Bucuresti - Ilfov	#SZÁM!	0,000	0,266
RO41 - Sud-Vest Oltenia	-0,012	-60,181	44,268
RO42 - Vest	-0,021	-33,230	31,419
SI03 - Vzhodna Slovenija	0,007	catch-up failed	23,806
SI04 - Zahodna Slovenija	0,039	catch-up failed	10,409
SK01 - Bratislavský kraj	0,220	0,000	0,000
SK02 - Západné Slovensko	-0,029	-24,110	21,333
SK03 - Stredné Slovensko	-0,018	-39,047	28,185
SK04 - Východné Slovensko	-0,012	-55,656	33,149
DE11 - Stuttgart	0,013	catch-up completed	catch-up completed
DE12 - Karlsruhe	-0,015	catch-up completed	catch-up completed
DE13 - Freiburg	-0,022	-31,244	2,861
DE14 - Tübingen	0,124	catch-up completed	catch-up completed
DE21 - Oberbayern	-0,004	catch-up completed	catch-up completed
DE22 - Niederbayern	-0,111	-6,240	2,195
DE23 - Oberpfalz	#SZÁM!	catch-up completed	catch-up completed
DE24 - Oberfranken	-0,049	-14,107	4,815
DE25 - Mittelfranken	0,020	catch-up completed	catch-up completed
DE26 - Unterfranken	-0,111	-6,243	1,649
DE27 - Schwaben	-0,108	-6,390	1,758
DE30 - Berlin	-0,032	-21,768	3,312
DE40 - Brandenburg	-0,012	-56,713	14,310
DE50 - Bremen	-0,022	catch-up completed	catch-up completed
DE60 - Hamburg	-0,021	catch-up completed	catch-up completed
DE71 - Darmstadt	-0,034	catch-up completed	catch-up completed
DE72 - Gießen	0,029	catch-up failed	7,634
DE73 - Kassel	0,000	catch-up failed	4,346
DE80 - Mecklenburg-Vorpommern	-0,009	-78,213	16,507
DE91 - Braunschweig	#SZÁM!	catch-up completed	catch-up completed
DE92 - Hannover	-0,008	-85,237	3,539
DE93 - Lüneburg	-0,002	-438,059	15,550
DE94 - Weser-Ems	-0,010	-68,290	6,753
DEA1 - Düsseldorf	-0,013	catch-up completed	catch-up completed
DEA2 - Köln	-0,036	catch-up completed	catch-up completed
DEA3 - Münster	-0,009	-78,898	7,128
DEA4 - Detmold	-0,075	-9,251	2,638
DEA5 - Arnsberg	-0,025	-27,220	5,651
DEB1 - Koblenz	-0,008	-88,198	7,634
DEB2 - Trier	0,002	catch-up failed	10,822
DEB3 - Rheinhessen-Pfalz	-0,018	-38,556	3,539
DEC0 - Saarland	-0,023	-30,666	3,653
DED2 - Dresden	-0,004	-193,073	12,092
DED4 - Chemnitz	-0,012	-59,004	15,080

GEO/TIME	Speed of convergence	Half-life of convergence	Catch-up time
DED5 - Leipzig	-0,035	-20,019	8,929
DEE0 - Sachsen-Anhalt	-0,009	-76,624	15,550
DEF0 - Schleswig-Holstein	0,023	catch-up failed	9,061
DEG0 - Thüringen	-0,016	-42,217	14,310
AT11 - Burgenland (AT)	0,000	-1774,140	14,007
AT12 - Niederösterreich	0,006	catch-up failed	7,507
AT13 - Wien	-0,042	catch-up completed	catch-up completed
AT21 - Kärnten	-0,001	-465,342	6,382
AT22 - Steiermark	-0,019	-36,446	4,114
AT31 - Oberösterreich	0,205	catch-up completed	catch-up completed
AT32 - Salzburg	0,019	catch-up completed	catch-up completed
AT33 - Tirol	0,033	catch-up completed	catch-up completed
AT34 - Vorarlberg	0,032	catch-up completed	catch-up completed

Megjelenés alatt:
Regional Statistics c. folyóirat