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Regional convergence in CEE before and after the Global Financial Crisis

by

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Regional convergence in CEE before and after the Global Financial Crisis

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Abstract

In this study we analyze the convergence of GDP per capita from 2000 to 2013 (current prices and euro exchange rates) for eight countries (Czech Republic, Slovakia, Slovenia, Hungary, Poland, Estonia, Latvia and Lithuania) of the European Union (CEE8). Some convergence indicators are also calculated for the CEE8 as a whole. The main purpose of this study is to shed some light on the impact of the Global Financial Crisis (GFC) on regional convergence in advanced emerging countries, like the CEE8. The main result of random effects panel regressions for unconditional beta-convergence is that significant convergence is found for the whole period from 2000-2013, but not for sub-periods on either end of the sample, except for Hungary and Poland. This means, that convergence in most CEECs is only significant if the GFC is included in the estimation period. The role of capital regions for the convergence process is an item for future research.

Motivation

"Compared to their peak at the beginning of the economic crisis, regional economic differences within countries have started to decline. Since the end of the global financial crisis, regional economic disparities within countries have fallen (Figure 1.1). Comparing all large (TL2) regions of the OECD, regional disparities in GDP per capita remain significant but their nature and composition are changing. In the early 2000s, regional disparities in per capita income across countries clearly surpassed regional differences within countries. In a context of higher growth in low income countries, regional disparities within countries increased between 2000 and 2007 and thus eventually became relatively more important than regional disparities across countries. Since 2011, faster growth in high per capita income countries reversed the trend. As a consequence, the relative importance of within-country discrepancies in 2016 is lower than it was in 2000. Overall, in the 16 years since 2000, total regional discrepancies in the OECD decreased by around 18%." - OECD (2018a), OECD Regions and Cities at a Glance 2018, OECD Publishing, Paris https://doi.org/10.1787/reg_cit_glance-2018-en, pages 20-21.

"Subnational—within-country—regional disparities in real output, employment, and productivity in advanced economies have attracted greater interest in recent years against a backdrop of growing social and political tensions." – IMF (2019).

Figure 1.1 shows the regional disparities across OECD TL2 regions. The overall Theil index indicates a decline of total regional inequality. However, the split in within and between inequality signals a break in

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2008. Up to 2008 inequality between countries declines while inequality within countries increases. After 2008 inequality between countries remains constant, but inequality within countries declines. It may therefore be misleading just to look at the overall development of regional inequality.

1.1. Regional disparities across the OECD, TL2 regions
Theil inequality index of GDP per capita
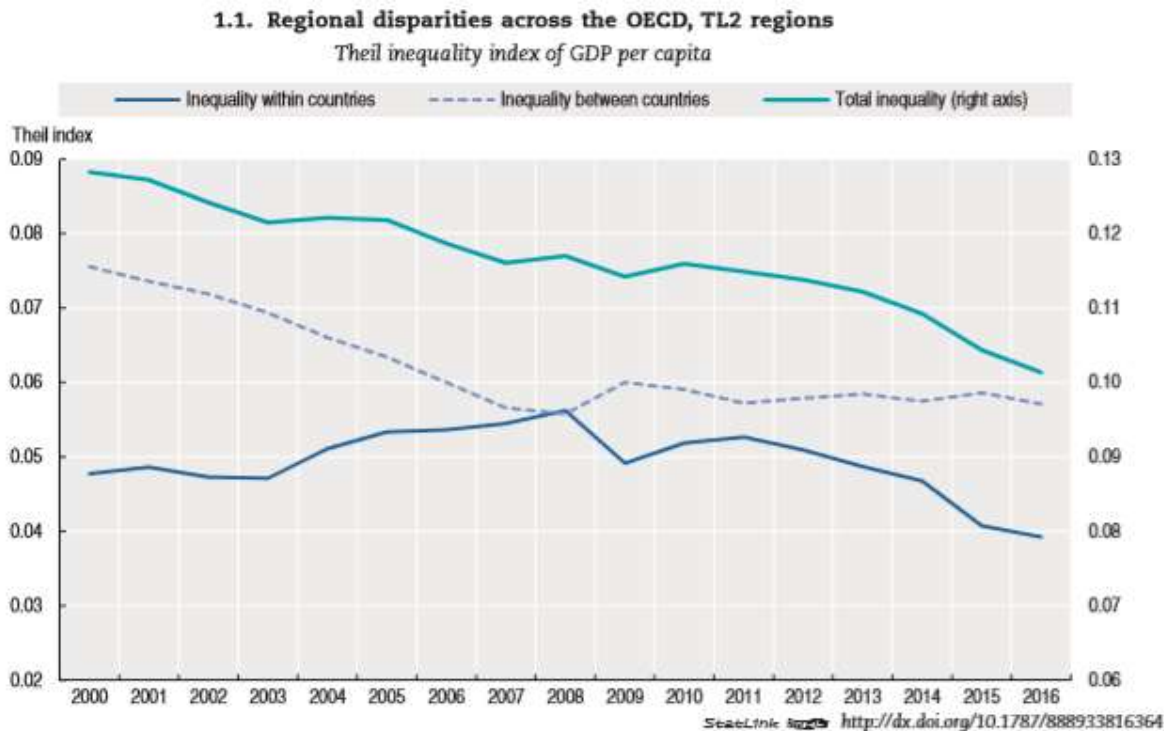
Source: OECD (2018a), OECD Regions and Cities at a Glance 2018, OECD Publishing, Paris
https://doi.org/10.1787/reg_cit_glance-2018-en

Methodology

The concept of convergence study is based on the hypothesis that less developed regions grow faster than developed ones, because of the greater availability of profitable investment opportunities and lower production costs. Both factors contribute to the inflow of capital and higher growth. If this hypothesis is true, then there should be regional convergence of within, as well as between countries, provided that access to technologies is not regionally limited and the regulatory environment is generally conducive to market minded economic decision making. Regional convergence could therefore also be seen as an indicator of a well-functioning market economy, fulfilling the standard assumptions of neoclassical growth about the mobility of capital and labour.

A special feature of the country group under consideration is that their GDP per capita is below the EU average. These countries therefore also have to achieve nominal convergence or – in other words – establish the law of one price. Furthermore, in emerging economies, in particular after a deep systemic transition, it may be more difficult to distinguish relative price changes between regions from changes in real economic activities. This refers to the well-known issue of separating price increases connected with quality improvements from general inflation. For these reasons, we use current prices and current exchange rates in order to capture the Balassa-Samuelson effect, as well as quality improvement related relative price changes, as part of a broader equilibrating convergence process.

To illustrate various aspects of this hypothesis, we applied the concept of sigma (σ) and beta (β) - convergence. In addition, we are interested to explore how the GFC has impacted the convergence and whether the observation for OECD countries mentioned in the quote above - about the relation between growth and convergence - also holds for the 8 New EU Member States (NMS).

On the basis of sigma (σ) - convergence we analyze the variation of regional GDP per capita over the time. A popular indicator for (σ) - convergence is the Gini coefficient. Another indicator is the Theil coefficient. Sigma (σ) - convergence manifests itself in form of falling inequality measures.

Using beta (β) - convergence we check whether there is an accelerated development of poorer regions, which leads to a gradual catch-up. At the same time regions with an already above average GDP per capita should grow below average. The current report only estimates unconditional beta convergence with random effects. This means that we ignore agglomeration effects, spatial heterogeneity and other obstacles to the free flow of goods and factors. As the main focus of this project is the impact of the GFC on convergence, we can justify this approach by the difference of adjustment speed for investment flows (high), agglomeration (low) and spatial characteristics (zero).

Sigma (σ) and beta (β) - convergence are not equivalent. ß-convergence describes the tendency to align the level of economic development of countries in the long term. At the same time, random shocks can lead to short-term growth differences among countries and, consequently, to σ-divergence. In other words, or in a "laboratory", beta convergence measures the endogenous tendencies of an economy to balance out differences once external shocks (contributing to sigma divergence) are taken into account.

Before applying statistical and econometric estimates we carried out some simple descriptive calculations. In the first stage, we compared the average values of GDP per capita by country (Figure 1). We calculated the average values per capita GDP and its decomposition of changes in the space *between* regions and over time *within* regions over time.

We report also the minimum and maximum levels of GDP per capita in regions by country. However, if the minimum value *within* was negative, this does not mean that GDP per capita in regions was also negative. This suggests that the deviation of GDP per capita in some periods was below the average of its values of the regions of a country during the observation period (2000-2013). If the value of the standard deviation *between* is higher than *within*, then a given region differs from other regions more than from itself during the observation time. As a result, the individual effect dominates the effect of time. If deviations *within* are zero (near to zero), then the differences in GDP per capita in the regions of a country do not change over the time.

In the next stage, we estimated sigma (σ)-convergence using statistical methods such as:

- Gini-coefficient and
- Theil index (Theil, 1967).

The Gini-coefficient is a well-known and widely used indicator to characterize the inequality of distribution of GDP per capita – or other (mainly income or wealth) indicators, and is calculated by the formula:

$$G = 0,5 \sum_{i=1}^{n} \sum_{j=1}^{n} x_i x_j \left| \frac{y_i}{x_i} - \frac{y_j}{x_j} \right|, \qquad (1)$$

where n – the number of groups; x_i – the proportion of the population in groups i; y_i – GDP per capita of the corresponding group i.

The Theil index is calculated taking into account the inequalities between countries and within countries:

$$IC = \sum_i y_i \log\left(\frac{y_i}{x_i}\right) = IC_{br} + IC_{wr}$$

$$IC_{br} = \sum_r Y_r \log\left(\frac{Y_r}{X_r}\right), IC_{wr} = \sum_r Y_r \left[\sum_i \frac{y_i}{Y_r} \log\left(\frac{y_i}{Y_r} \bigg/ \frac{x_i}{X_r}\right) \right], \qquad (2-3)$$

where IC – the Theil index, which reflects overall inequality in the distribution of GDP per capita, IC_{br} – the index, which reflects the inequality between countries, IC_{wr} – the index, which reflects the inequality within countries, y_i and x_i – share of GDP and population of country in time i, Y_r and X_r - share of GDP and population for country r (average for the observation period).

To analyze the convergence of countries in terms of economic development, we used a model of unconditional beta (β)-convergence, which is based on the neoclassical growth theory (Solow 1956, Swan 1956).

Formally the model of unconditional convergence is as follows:

$$g_T = a + by_0 + \varepsilon \qquad \varepsilon \approx N(0, \sigma^2 I) \ , \tag{4}$$

where g_T - the logarithm of the average growth rate for the period T, y_0 - the initial value of the logarithm of GDP per capita, a - parameter describing the level of technological progress in the country, b - convergence coefficient, ε - random component. The analysis of the convergence process was carried out on the basis of the calculation of the speed of convergence (β), on the basis of estimated values (b) (formula 4), as follows:

$$b = \frac{1 - e^{-\beta T}}{t} \tag{5}.$$

The speed convergence has been calculated for different time periods in 2000-2013 cutting off successive observations at the beginning and end of the observation period while keeping the end (2013) and beginning (2000) constant. The results show that the speed of regional convergence of countries is changing in the short and long term, as well in different periods (before the economic crisis, during and after economic crisis).

Literature Survey

This Survey covers the time period until 2015 and focuses on investigations including emerging economies. Most studies find conditional regional convergence, although not at a very high speed, which is in line with earlier surveys of the topic (Sala-i-Martin, 1996). This is also confirmed by OECD (2009). Remaining inequalities are documented between old and new EU member countries (Borsi and Metiu, 2015; Fulterer and Lungu, 2018).

Most reviewed studies look at larger (TL2) or smaller (TL3) regions (Arnold and Blöchliger, 2016; Crespo Cuaresma, Doppelhofer and Feldkircher, 2014; Badinger et al, 2004)). Some studies look at the degree of fiscal decentralisation (Bartolini, Stossberg and Blöchliger, 2016), international (Huber and Tondl, 2012) and national migration (Kırdar and Saracoğlu, 2007 for Turkey; Toya, Hosono and Makino, 2004 for Philippines), cohesion policy (Montfort, 2008), the availability of natural resources (Turganbayev, 2016 for Kazakhstan). For the advanced, new EU member countries as a whole (which form the sample of our beta and sigma convergence estimates) clear signs of convergence are found for the time up to 2005 (Rapacki and Prochniak, 2009). For the same country group (CEE8) it is also found for the time period 1995-2005 where convergence with EU15 is progressing (Matkovski and Prochniak, 2007). This result is also confirmed with an application of Bayesian averaging and conditioning on a large number of underlying growth factors for the longer observation period 1960-2009 and also a larger group of transition countries, including CIS countries (Prochniak and Wirkovski, 2014). Nevertheless, the pace of convergence is generally found to be slow.

The structure of regional convergence in the European Union is not homogenous (Crespo Cuaresma, Doppelhofer and Feldkircher, 2014). This study finds that regional convergence across countries is driven by catching-up new EU member states, while within-country regional convergence is mainly taking place in old EU member countries. While beta-convergence is found for the EU regions as a whole, sigma-convergence is reversing in 2009 (Goecke and Hüther, 2016). Before 2008 structural factors dominate unconditional income convergence in new EU member countries (Mikulic et al, 2013). Ignoring spatial dependence leads to significant under-estimation of regional convergence speed (Badinger, Müller and Tondl, 2004). However, other studies show the opposite (Feldkircher, 2006). For the OECD it is also found that between country differences decline over time, but on the contrary, within country differences increase in the majority of countries (Arnold and Blöchliger,

2016). An important part of regional convergence is coming from spatial spillovers (Crespo Cuaresma and Feldkircher (2013). Regional divergence is associated with pockets of high productivity, often the agglomeration of capitals (Lengyel and Kotosz, 2018). Income convergence before the GFC is driven by high income growth of top earners in low income countries (Vacas-Soriano and Fernández-Macías, 2018).

Fiscal decentralization is found to support regional convergence (Bartolini, Stossberg and Blöchliger, 2016; Arnold and Blöchliger, 2016), mainly because of opportunities of better targeting local public goods to more growth-enhancing uses.

EU-cohesion policy is found to contribute to regional convergence (Arnold and Blöchliger, 2016). Regional income differences have been found to have a small but significant effect on internal migration (Barro and Sala-i-Martin, 1992). The relation between migration and regional growth may however be reversed for developing countries like Turkey (Kırdar and Saracoğlu, 2007) and the Philippines (Toya, Hosono and Makino, 2004).

The global financial crisis is found to have had a serious impact on catching up economies (Forgó and Jevčák, 2015). These negative effects were particularly large in countries that have experienced an unbalanced, domestic demand-driven and external loan-financed boom before the crisis. For the EU28 Dvorokova (2014) finds that beta convergence prevailed through the global financial crisis, but sigma convergence (lower dispersion) shows a break during and after the crisis. Before the crisis dispersion was increasing. After the crisis dispersion was falling. Also, exposure to resource price boom and bust cycles interferes negatively with convergence (Turganbayev, 2016).

A bottom line of the reviewed studies is that regional convergence is a common underlying phenomenon with an uneven and heterogenous realization over time and space. One and the same factor can have a different impact on convergence, depending on time and space. For instance, in the case of migration whether high- or low-skilled workers shift or move to high- or low-income regions makes a difference. For all combinations, an economic setting could be found which either increases or reduces regional inequality. In this context, the interaction between institutions, shocks and policies plays a decisive role (Blanchard, 1999).

Data and descriptive statistics

GDP per capita data (at current market prices and euro exchange rates) are from 151 NUTS3 regions of 8 advanced new European Union Member States (Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Hungary and Slovenia) for the years 2000 to 2013. Table 1 provides descriptive statistics about average values and their evolution over time and regions.

The average level of GDP per capita in these eight EU countries for the whole period of 2000-2013 was equal to euro 8,013.94. It was above this average in Slovenia (€13,699.61), the Czech Republic (€11,090.44) and Slovakia (€9,433.90). In the remaining five countries (Estonia: €7,921.90; Hungary: €7,537.74; Poland: €6,866.00; Latvia: €6,406.45; Lithuania: €6,368.14) analyzed, it was below average. The average ranking changes when looking at the overall minimum and maximum levels. While Slovenia has the highest income level in its poorest region (€7,736.00) its richest region is only fourth behind Slovakia, Czech Republic and Poland. This indicates that Slovenia is a country with relatively low regional per capita GDP differences.

The "between" Min and Max levels indicate the on average lowest and highest GDP per capita levels over time. Again, Slovenia and Czech Republic enjoy the highest level of GDP per capita in their poorest region, while Latvia and Lithuania occupy the lowest ranks in this respect. It is noteworthy that Slovakia has the highest GDP per capita of the richest region, while its poorest region is the third poorest among the covered countries. This indicates that Slovakia is a country with a relatively high degree of regional inequality.

The "within" Min and Max levels show the deviations from the average GDP per capita level for a region over time.

The time effect differs in the regions of eight countries differently. During 2000-2013 in the regions of some countries (Slovenia, Estonia, Lithuania) GDP per capita differences from the average level increase. This means that regional differences increase over time in these countries. And in the regions of other countries (Czech Republic, Slovakia, Hungary, Poland, Latvia) it can be observed that the deviation of GDP per capita from its average level goes downwards (see Table 1). This means that regional differences in these countries become smaller.

Table 1. Descriptive statistics for GDP per capita in CEE8 EU countries regions 2000-2013

Countries		Mean	Std. Dev.	Min	Max	Observations	
Total	overall	8013,94	4407,49	1786,00	33883,00	N =	2114
	between		3750,30	3953,93	25216,29	n =	151
	within		2334,05	-4776,63	19935,37	T =	14
Slovenia	overall	13699,61	3905,61	7736,00	27207,00	N =	168
	between		3354,34	9729,43	22486,07	n =	12
	within		2208,64	6647,54	18420,54	T =	14
Czech Republic	overall	11090,44	5070,54	4995,00	33624,00	N =	196
	between		4125,38	8859,07	25216,29	n =	14
	within		3134,67	-1345,85	19498,15	T =	14
Slovakia	overall	9433,90	6424,16	2523,00	33883,00	N =	112
	between		5166,18	5341,79	21784,57	n =	8
	within		4207,87	-3356,67	21355,33	T =	14
Hungary	overall	7537,74	3652,73	2784,00	23677,00	N =	294
	between		3359,45	4230,36	18765,43	n =	21
	within		1599,14	-1167,69	12449,31	T =	14
Poland	overall	6866,00	3335,11	2966,00	30278,00	N =	1050
	between		2686,72	4453,14	21539,07	n =	75
	within		1998,48	-1165,07	15604,93	T =	14
Estonia	overall	7921,90	4164,41	2842,00	21037,00	N =	70
	between		3380,95	6091,43	13952,14	n =	5
	within		2839,91	526,76	15006,76	T =	14
Latvia	overall	6406,45	3907,69	1786,00	18906,00	N =	84
	between		3206,60	3992,29	12735,64	n =	6
	within		2568,71	-240,19	12576,81	T =	14
Lithuania	overall	6368,14	3063,99	1793,00	17097,00	N =	140
	between		2056,70	3953,93	11176,86	n =	10
	within		2356,61	466,28	12288,28	T =	14

Source: Eurostat

During 2000-2013 in most countries, the average level of GDP per capita *between* regions varied more (Std. Dev. = 3750.30) than *within* regions of these countries (Std. Dev. = 2334.05). This is the case for seven countries and only in Lithuania differences *between* regions were smaller (Std. Dev. = 2056.70) than in *within* regions (Std. Dev. = 2356.61). This means that over the 2000-2013 observation period regions in seven countries differ from each other more than over time for each region. Accordingly, in the regions of seven countries the individual (between) effect dominated the time (within) effect. The exception was Lithuania, where the time effect dominated the individual effect.

The calculated values for the CEE8 as a whole indicate how different the regions in the CEE8 are. The GDP per capita in the richest region (Bratislava in Slovakia) in 2012 is nearly 20 times higher than in the poorest region (Latgale, Latvia) in 2000.

Figure 1 shows the development of GDP per Capita for the countries in question and the European Union as a whole (EU28). The impact of the global financial crisis in 2008/9 is visible for each country, although with varying degree. There are two groups of countries, one which recovered relatively rapidly (Estonia, Latvia, Lithuania, Slovakia) while the other did not reach the pre-crisis level of 2008 until 2013 (Poland, Czech Republic, Hungary and Slovenia). For all country's convergence to the EU28 average is visible only until 2008. Afterwards divergence prevails because the income loss during the crisis was larger than for the EU28 on average and income growth afterwards was insufficient to compensate the loss during the crisis. Particularly severe is divergence for Slovenia, the Czech Republic, Hungary and Poland. It is interesting to note that this group comprises high (Slovenia and Czech Republic) and low (Hungary and Poland) income countries.

Within the country's income developments look very similar before the crisis. Only the Czech Republic sticks out as a high-income country with a high and even accelerating growth rate before the global financial crisis. After the crisis, Poland and Hungary fall behind, while Slovakia, Estonia, Latvia and Lithuania catch up towards the higher (but stagnating) incomes of Slovenia and the Czech Republic.

It is worthwhile to note that with current exchange rates the performance of Poland looks much less impressive than by just looking at national growth rates of real GDP per capita. Poland is even battling with Hungary for the last place among the CEE8 after the crisis.

Figure 1. GDP per capita in 8 new EU countries in 2000-2013
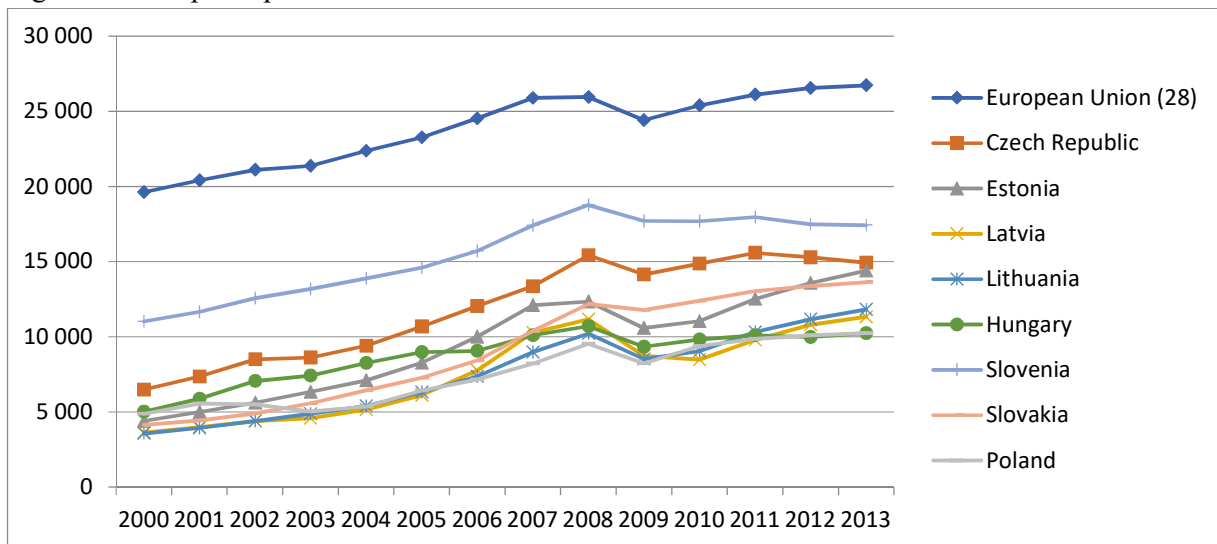
Source: Eurostat

Tables 2 and 3 contain information about sigma convergence. Table 2 provides information about the calculated Gini coefficients of GDP per capita from 2000 to 2013. A visualization of the evolution of Gini coefficients for the covered countries, regions and years is provided by Figure 2. The Gini coefficient shows a relatively uniform pattern: Before the crisis inequality increases (most in Slovakia, Slovenia, Hungary, Lithuania, Czech Republic). After the crisis income differences between regions stay mostly constant or increase a notch (Czech Republic, Estonia, Latvia, Hungary, Poland, Slovakia) or fall slightly (Lithuania, Slovenia).

Regional inequality is mostly smaller than for the CEE8 overall. This is because the CEE8 is not a group of homogenous countries. The only exception in our country sample is Slovakia in the final years of the observation period with inequality measured by the Gin coefficient outpacing the CEE8.

Regional differences were increasing in all covered countries with the exception of Latvia. In Hungary and Slovakia, two countries with a well-documented record of regional inequality between Western and Eastern parts of the country, regional inequality increased further. Particularly low is regional inequality in Slovenia and the Czech Republic. Relatively constant is regional inequality over time in Estonia.

Table 2. Regional disparities (Gini coefficient) by 8 new EU countries (NMEs)

Countries	2000-2013	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Czech Rep	0,21	0,11	0,11	0,12	0,12	0,12	0,12	0,13	0,13	0,13	0,13	0,13	0,12	0,12	0,13
Estonia	0,27	0,16	0,17	0,17	0,17	0,18	0,18	0,18	0,17	0,16	0,17	0,15	0,15	0,16	0,17
Latvia	0,31	0,23	0,23	0,23	0,23	0,23	0,24	0,24	0,22	0,21	0,20	0,20	0,19	0,20	0,21
Lithuania	0,26	0,14	0,15	0,17	0,16	0,15	0,16	0,17	0,18	0,16	0,17	0,16	0,15	0,15	0,16
Hungary	0,23	0,18	0,17	0,19	0,19	0,19	0,20	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21
Poland	0,23	0,17	0,16	0,16	0,16	0,17	0,17	0,17	0,17	0,17	0,18	0,19	0,19	0,19	0,19
Slovenia	0,15	0,10	0,10	0,11	0,12	0,12	0,12	0,13	0,13	0,13	0,13	0,13	0,12	0,12	0,12
Slovakia	0,32	0,19	0,19	0,19	0,20	0,20	0,23	0,23	0,23	0,22	0,23	0,23	0,24	0,23	0,23
Total CEE8	0,28	0,25	0,24	0,25	0,26	0,26	0,25	0,24	0,24	0,23	0,25	0,24	0,23	0,23	0,22

Source: Own calculations

Apart from an unfavorable geography (Slovakia, Hungary and Poland) the presence of ethnic minorities (Estonia, Latvia, Hungary and Slovakia) seems to contribute to high regional inequality. The two effects apparently re-enforce each other in Hungary and Slovakia.

Fig. 2. Regional disparities (sigma convergence) by CEE8 countries (Gini coefficient)
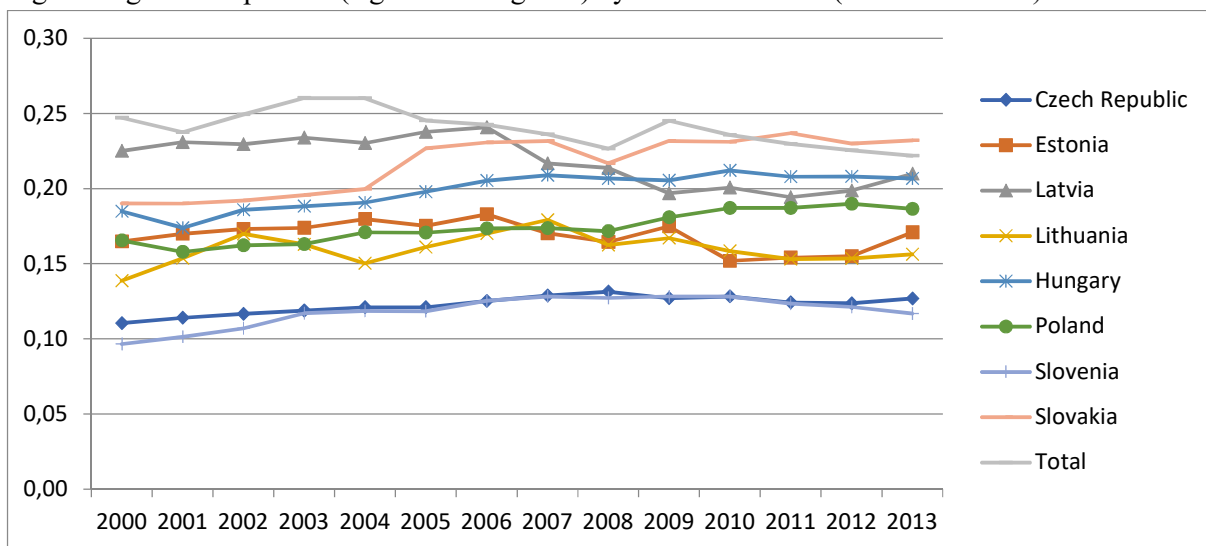
Source: Own calculations

Table 3 (Theil index) allows to decompose inequality in a contribution from the differences between countries and within countries. Overall the Theil Index declines, but only because of the between effect, which more than halves between 2000 and 2013. On the contrary, the within effect (representing the consequences of the evolution of regional income developments within countries) stays about constant. This means that regional inequality in the CEE8 countries is decreasing, because on average the difference between high income and low-income countries is becoming smaller. In other words, there is convergence of the CEE8 countries, but no convergence of regions within countries.

There are two marked deviations of the overall pattern (Figure 3). First, in the run-up to EU entry in 2004 differences between countries increased slightly. This effect, however, was only temporary and in 2005 the between effect was already about the same as in 2001. Second, the global financial crisis of 2009 again temporarily increased differences among CEE8 countries. Although it is clear

(Figure 3) that this increase of inequality was again temporary, it however took longer (two years) until this increase in income differences was reversed.

Table 3. Regional disparities (sigma convergence) by 8 NMEs (Theil index of GDP per capita)

Years	Theil's Index	Theil between	Theil within
2000	0,11	0,049	0,061
2001	0,10	0,043	0,058
2002	0,11	0,049	0,061
2003	0,12	0,058	0,061
2004	0,12	0,055	0,062
2005	0,10	0,042	0,063
2006	0,10	0,038	0,064
2007	0,10	0,033	0,063
2008	0,09	0,029	0,060
2009	0,10	0,040	0,065
2010	0,10	0,031	0,066
2011	0,09	0,028	0,064
2012	0,09	0,024	0,064
2013	0,09	0,022	0,063
2000-2013	0,13	0,033	0,098

Source: Own calculations

Regional inequality during the observation period 2000-2013 within countries – measured by Theil's Index - remained approximately on the same level.

Fig. 3. Regional disparities by 8 new EU countries (Theil index of GDP per capita)
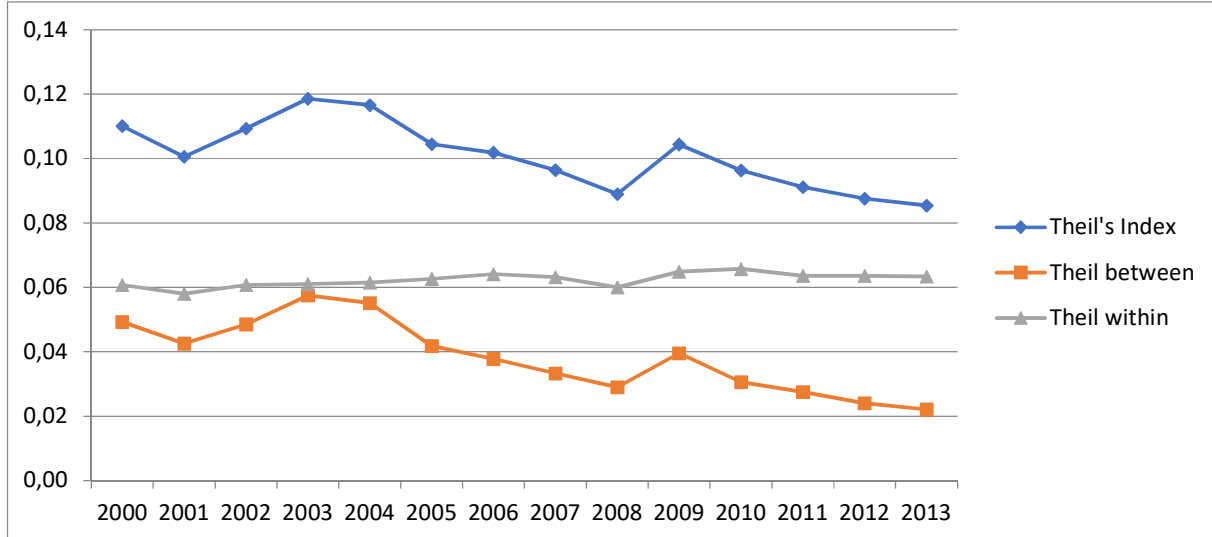
Source: Own calculations

Figure 3 and Figure 1.1 (at the beginning of this report) are based on different levels of disaggregation. Figure 3 is calculated from smaller Nuts3 regions compared with the larger TL2 regions underlying Figure 1.1. The divergent trends of Theil'a within and between index is also confirmed for the EU, using equivalized household incomes (Vacas-Soriano and Fernández-Macías, E., 2018).

Estimates of unconditional beta convergence of CEE8 NUTS3 regions in 2000-2013

For the whole sample (2000-2013) estimates of unconditional beta convergence are highly significant (at a 1% level) except for Estonia and Latvia where the significance level is intermediate. The estimated adjustment speed beta is highest in the Czech Republic, followed by Hungary, Estonia, Latvia,

Lithuania, Slovenia, Poland and Slovakia. The adjustment speed is generally low (below 1%) and of similar magnitude as estimated by Kirchweger (2006).

Table 4a reports the estimates of unconditional convergence for all possible subsamples ending in 2013. A common feature of these results is that the beta coefficient tends to become smaller, insignificant or changing signs the more pre-crisis and crisis years are cut-off. In other words, information from after the crisis regional GDP per capita developments indicates no beta-convergence. The only exemption is Poland, which shows regional convergence for all years until 2010.

Table 4b reports the estimates for all sub-samples starting in 2000. In most countries the regional convergence coefficient is either insignificant or has the wrong sign if estimated on the basis of observations from the pre-crisis period. Exceptions are Hungary and Poland.

Considering both results could indicate that convergence for the whole sample period may be the effect of some misspecification. Table 4c reports the estimates from split sub-samples. Only for Hungary (one case) and Poland (in 6 cases) a split sample generates a significant beta convergence speed estimator with the correct sign for both subsamples. This result casts some doubts on the validity of significant convergence speed estimates for the whole sample.

The econometric results point to the conclusion that regional convergence in the 8 new EU member countries during the period 2000 to 2013 is only significant if the global financial crisis is included in the sample. This could be related to higher-income regions having been hit harder by the GFC. If confirmed, this would mean that EU accession has generated unsustainable growth before the GFC. The GFC would then be rather characterized as a Hayekian mal-investment crisis instead of a Keynesian under-consumption crisis. Taking this conclusion serious has major implications for the assessment of the appropriate policy response.

Figure 4 compares the estimated convergence speed for the whole sample for the CEE8 countries. (same numbers, different presentation as bar-graph and spider graph). The differences of regional convergence among CEE8 countries are large, which could be related to differences in initial conditions at the beginning of the transition from central planning to a market economy.

The top position of the Czech Republic with respect to regional convergence could be related to the favorable position close to high income economies as well as a compact geography with few natural mobility barriers. In addition, the Czech Republic was committed to market friendly structural reforms from the beginning of the transition process in the early nineties.

On the other hand, Slovakia is converging as a country, although with the lowest regional beta convergence speed. This is because its richest region, Bratislava, is also growing rapidly, which points to a regionally imbalanced growth pattern. Economic growth in Slovakia has been mainly driven by large greenfield investments in the automotive and consumer electronics sectors for exports into the EU. The location of such plants was therefore biased in favor of Western Slovakia where efficient transport connections to the main export markets were available. The difference in regional convergence is also reflected in regional unemployment differentials, which are multiples larger in Slovakia than the Czech Republic (Figure 4).

The paradoxically low rate of beta convergence in Slovenia, despite low regional unemployment rate differences could be related to the hysteresis of industrial structures inherited from former Yugoslavia.

In Poland and Lithuania, the intermediate rate of regional convergence could be related to the lack of transport infrastructure and an unfavorable geographical location.

Most difficult to explain is the relatively high rate of beta-convergence despite high regional unemployment rate differentials in Hungary. Maybe EU structural funds play a role improving the income situation in disadvantaged regions while unemployment stays relatively high.

Fig. 4. ß-convergence of GDP per capita in NMEs in 2000-2013 and unemployment differentials
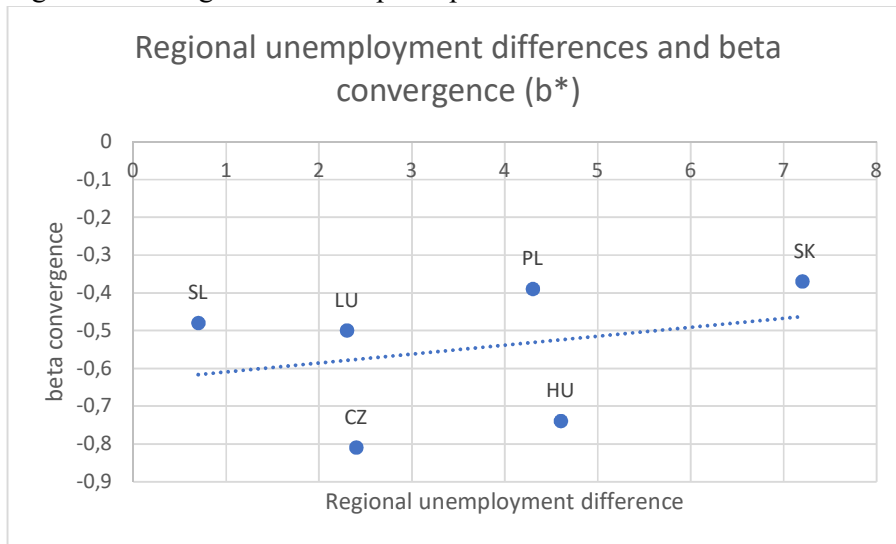
Source: Own calculations
Source: Eurostat for regional unemployment differences in countries with sub-national unemployment statistics and Table 4a, first line for beta convergence (CZ-Czech Republic, HU-Hungary, LU-Lithuania. PL-Poland, SL-Slovenia)

Table 5 provides a confirmation of the role of the crisis years for significant beta convergence. The estimates are the coefficients of lagged gdp per capita in convergence equations for every year and country, for which a significant estimate is found.

Table 5: Significant b* coefficients for convergence regressions[2] with initial gdp per capita from previous year.

	01/00	02/01	04/03	06/05	07/06	08/07	09/08	10/09
Czech R.		0,04*						
Estonia								
Latvia						-0,15*		
Lithuania		0,07**	-0,06**	0,05**	0,06**	-0,04*		
Hungary	-0,07*							
Poland	-0,05***	-0,08***		-0,03**	0,01*		-0,11***	-0,08**
Slovenia		0,05**	0,05**	0,03**	0,05**			
Slovakia						-0,04*		

Source: Own calculations

Significant negative coefficients are only found for the crisis years (2008-2010) in Latvia, Lithuania, Poland and Slovakia, before in Lithuania (2004) and Poland (2001, 2002, 2005) and none after the GFC.

The Figures 5 (a-h) show the dynamics of regional economic activity dependent on the initial level of gdp per capita in 2000 for all countries under investigation (Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovenia and Slovakia).

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[2] The specification of the unconditional convergence equations is as in (4) with the exception that y_0 is replaced by y_{-1}, the lagged level of gdp per capita.

Table 4a. ß-convergence of GDP per capita in regions of 8 NMEs over the time until 2013

| Time	Slovenia		Czech Republic		Slovakia		Hungary		Poland		Estonia		Latvia		Lithuania	
	b*	ß-conv.	b*	ß-conv.	b*	ß-conv.	b*	ß-conv.	b*	ß-conv.	b*	ß-conv.	b*	ß-conv.	b*	ß-conv.
2001-2013	-0,048***	0,41	-0,081***	0,7	-0,037***	0,32	-0,074***	0,64	-0,039***	0,33	-0,060**	0,51	-0,058**	0,5	-0,050***	0,43
2002-2013	-0,050***	0,47	-0,079***	0,74	-0,047***	0,44	-0,052***	0,49	-0,024**	0,22	-0,065**	0,61	-0,068**	0,64	-0,064***	0,6
2003-2013	-0,045**	0,46	-0,063***	0,65	-0,057***	0,58	-0,031**	0,31	-0,038***	0,39	-0,075**	0,78	-0,079**	0,82	-0,084***	0,88
2004-2013	-0,055***	0,63	-0,091***	1,06	-0,058***	0,66	-0,028*	0,31	-0,075***	0,87	-0,087***	1,01	-0,108***	1,27	-0,094***	1,1
2005-2013	-0,055**	0,71	-0,101***	1,33	-0,055***	0,71	-0,019	0,24	-0,096***	1,27	-0,104**	1,37	-0,126***	1,68	-0,098***	1,29
2006-2013	-0,054**	0,79	-0,087***	1,29	-0,067***	1	-0,018	0,26	-0,071***	1,06	-0,091*	1,36	-0,139**	2,14	-0,103**	1,55
2007-2013	-0,051*	0,87	-0,068**	1,18	-0,059**	1,02	-0,026	0,43	-0,068***	1,17	-0,075	1,3	-0,130**	2,31	-0,109**	1,91
2008-2013	-0,03	0,61	-0,057*	1,16	-0,026	0,53	-0,024	0,48	-0,048***	0,99	-0,03	0,6	-0,057	1,18	-0,088*	1,84
2009-2013	-0,026	0,66	-0,031	0,8	0,008	-0,2	-0,028	0,71	-0,026*	0,65	-0,027	0,68	-0,069	1,8	-0,058	1,51
2010-2013	-0,021	0,69	-0,026	0,88	-0,006	0,18	-0,009	0,3	-0,040**	1,37	-0,026	0,89	-0,008	0,28	-0,046	1,56
2011-2013	-0,026	1,31	-0,023	1,16	-0,005	0,27	-0,014	0,7	-0,01	0,49	0	0,01	-0,041	2,08	-0,072	3,75
2012-2013	-0,052	5,38	-0,003	0,28	-0,008	0,82	-0,004	0,37	-0,006	0,62	0,023	-2,25	0,013	-1,27	-0,007	0,75

Table 4b. ß-convergence of GDP per capita in regions of new EU countries over the time from 2001

Time	Slovenia		Czech Republic		Slovakia		Hungary		Poland		Estonia		Latvia		Lithuania	
	b*	ß-conv.	b*	ß-conv.	b*	ß-conv.	b*	ß-conv.	b*	ß-conv.	b*	ß-conv.	b*	ß-conv.	b*	ß-conv.
2001-2002	0,049**	-2,41	0,038**	-1,86	0,013	-0,66	-0,009	0,43	-0,094***	4,93	0,02	-0,98	0,009	-0,46	0,070**	-3,4
2001-2003	0,043**	-1,39	-0,059	2,03	0,023	-0,74	-0,073**	2,52	-0,074***	2,56	0,01	-0,34	0	0,01	0,036	-1,18
2001-2004	0,032**	-0,79	-0,045	1,15	0,032**	-0,78	-0,063***	1,63	-0,056***	1,44	0,015	-0,36	0,003	-0,08	0,018	-0,46
2001-2005	0,024*	-0,47	-0,017	0,34	0,038**	-0,74	-0,076***	1,58	-0,039**	0,79	0,022	-0,43	0,023	-0,46	0,041**	-0,8
2001-2006	0,033***	-0,55	0	0,01	0,040**	-0,66	-0,063***	1,09	-0,012	0,2	0,040**	-0,65	0,049**	-0,79	0,045**	-0,73
2001-2007	0,050***	-0,7	0,001	-0,01	0,057***	-0,79	-0,049***	0,72	0,016	-0,22	0,051***	-0,72	0,080**	-1,1	0,064***	-0,89
2001-2008	0,046***	-0,56	0,016	-0,2	0,047***	-0,57	-0,050***	0,64	0,038***	-0,47	-0,005	0,06	0,036	-0,44	0,051***	-0,62
2001-2009	-0,019	0,21	-0,059***	0,68	-0,007	0,08	-0,090***	1,04	-0,053***	0,6	-0,077**	0,9	-0,062*	0,71	-0,062**	0,71
2001-2010	-0,030*	0,3	-0,059***	0,61	-0,017	0,17	-0,081***	0,85	-0,032***	0,33	-0,078**	0,81	-0,072**	0,75	-0,063**	0,66
2001-2011	-0,034**	0,31	-0,059***	0,55	-0,022	0,21	-0,077***	0,73	-0,031***	0,28	-0,067**	0,63	-0,062**	0,58	-0,050**	0,46
2001-2012	-0,045***	0,39	-0,073***	0,63	-0,031**	0,26	-0,077***	0,67	-0,034***	0,29	-0,063**	0,54	-0,057**	0,49	-0,048**	0,41
2001-2013	-0,048***	0,38	-0,081***	0,65	-0,037***	0,29	-0,074***	0,59	-0,039***	0,31	-0,060**	0,47	-0,058**	0,46	-0,050***	0,39

Table 4c. ß-convergence of GDP per capita in regions of 8 new EU countries in 2001-2013

Time	Slovenia		Czech Republic		Slovakia		Hungary		Poland		Estonia		Latvia		Lithuania	
	b*	β-conv.	b*	β-conv.	b*	β-conv.	b*	β-conv.	b*	β-conv.	b*	β-conv.	b*	β-conv.	b*	β-conv.
2001-2013	-0,048***	0,38	-0,081***	0,65	-0,037***	0,29	-0,074***	0,59	-0,039***	0,31	-0,060**	0,47	-0,058**	0,46	-0,050***	0,39
2001-2002	0,049**	-2,41	0,038**	-1,86	0,013	-0,66	-0,009	0,43	-0,094***	4,93	0,02	-0,98	0,009	-0,46	0,070**	-3,4
2002-2013	-0,050***	0,47	-0,079***	0,74	-0,047***	0,44	-0,052***	0,49	-0,024**	0,22	-0,065**	0,61	-0,068**	0,64	-0,064***	0,6
2001-2003	0,043**	-1,39	-0,059	2,03	0,023	-0,74	-0,073**	2,52	-0,074***	2,56	0,01	-0,34	0,001	0,01	0,036	-1,18
2003-2013	-0,045**	0,46	-0,063***	0,65	-0,057***	0,58	-0,031**	0,31	-0,038***	0,39	-0,075**	0,78	-0,079**	0,82	-0,084***	0,88
2001-2004	0,032**	-0,79	-0,045	1,15	0,032**	-0,78	-0,063***	1,63	-0,056***	1,44	0,015	-0,36	0,003	-0,08	0,018	-0,46
2004-2013	-0,055***	0,63	-0,091***	1,06	-0,058***	0,66	-0,028*	0,31	-0,075***	0,87	-0,087**	1,01	-0,108***	1,27	-0,094***	1,1
2001-2005	0,024*	-0,47	-0,017	0,34	0,038**	-0,74	-0,076***	1,58	-0,039**	0,79	0,022	-0,43	0,023	-0,46	0,041**	-0,8
2005-2013	-0,055**	0,71	-0,101***	1,33	-0,055***	0,71	-0,019	0,24	-0,096***	1,27	-0,104**	1,37	-0,126***	1,68	-0,098***	1,29
2001-2006	0,033***	-0,55	0,001	0,01	0,040**	-0,66	-0,063***	1,09	-0,012	0,2	0,040**	-0,65	0,049**	-0,79	0,045**	-0,73
2006-2013	-0,054**	0,79	-0,087***	1,29	-0,067***	1,0	-0,018	0,26	-0,071***	1,06	-0,091*	1,36	-0,139**	2,14	-0,103**	1,55
2001-2007	0,050***	-0,7	0,001	-0,01	0,057***	-0,79	-0,049***	0,72	0,016	-0,22	0,051***	-0,72	0,080**	-1,1	0,064***	-0,89
2007-2013	-0,051*	0,87	-0,068**	1,18	-0,059**	1,02	-0,026	0,43	-0,068***	1,17	-0,075	1,3	-0,130**	2,31	-0,109**	1,91
2001-2008	0,046***	-0,56	0,016	-0,2	0,047***	-0,57	-0,050***	0,64	0,038***	-0,47	-0,005	0,06	0,036	-0,44	0,051***	-0,62
2008-2013	-0,03	0,61	-0,057*	1,16	-0,026	0,53	-0,024	0,48	-0,048***	0,99	-0,03	0,6	-0,057	1,18	-0,088*	1,84
2001-2009	-0,019	0,21	-0,059***	0,68	-0,007	0,08	-0,090***	1,04	-0,053***	0,6	-0,077**	0,9	-0,062*	0,71	-0,062**	0,71
2009-2013	-0,026	0,66	-0,031	0,8	0,008	-0,2	-0,028	0,71	-0,026*	0,65	-0,027	0,68	-0,069	1,8	-0,058	1,51
2001-2010	-0,030*	0,3	-0,059***	0,61	-0,017	0,17	-0,081***	0,85	-0,032***	0,33	-0,078**	0,81	-0,072**	0,75	-0,063**	0,66
2010-2013	-0,021	0,69	-0,026	0,88	-0,006	0,18	-0,009	0,3	-0,040***	1,37	-0,026	0,89	-0,008	0,28	-0,046	1,56
2001-2011	-0,034**	0,31	-0,059***	0,55	-0,022	0,21	-0,077***	0,73	-0,031***	0,28	-0,067**	0,63	-0,062**	0,58	-0,050**	0,46
2011-2013	-0,026	1,31	-0,023	1,16	-0,005	0,27	-0,014	0,7	-0,01	0,49	0,001	0,01	-0,041	2,08	-0,072	3,75

Figure 5a. Regional convergence before during and after the crisis: Czech Republic
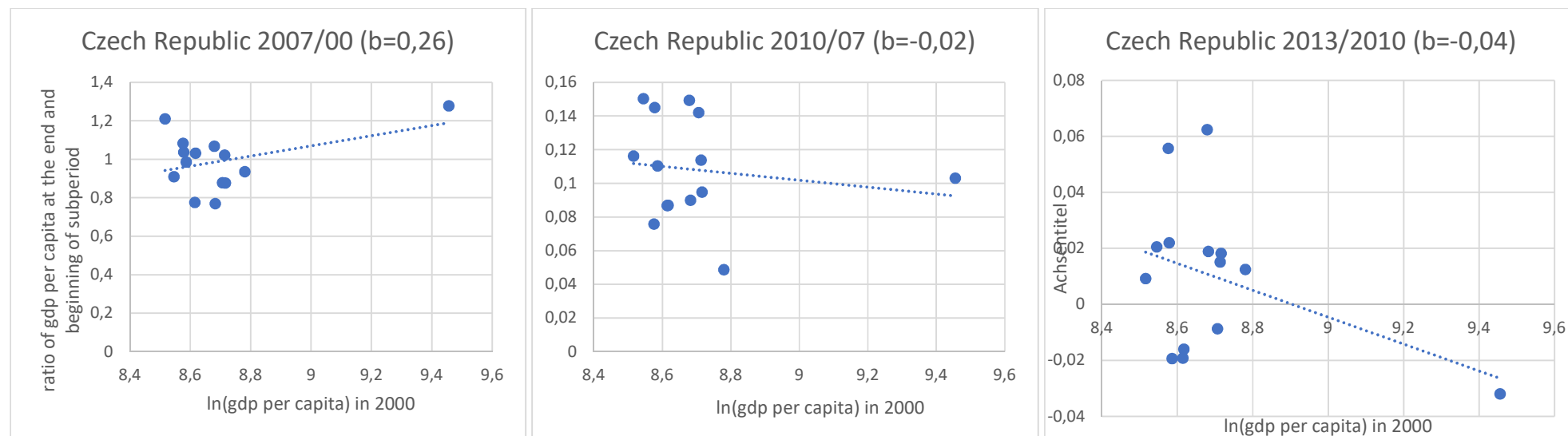
Source: Own calculations with data from Eurostat.
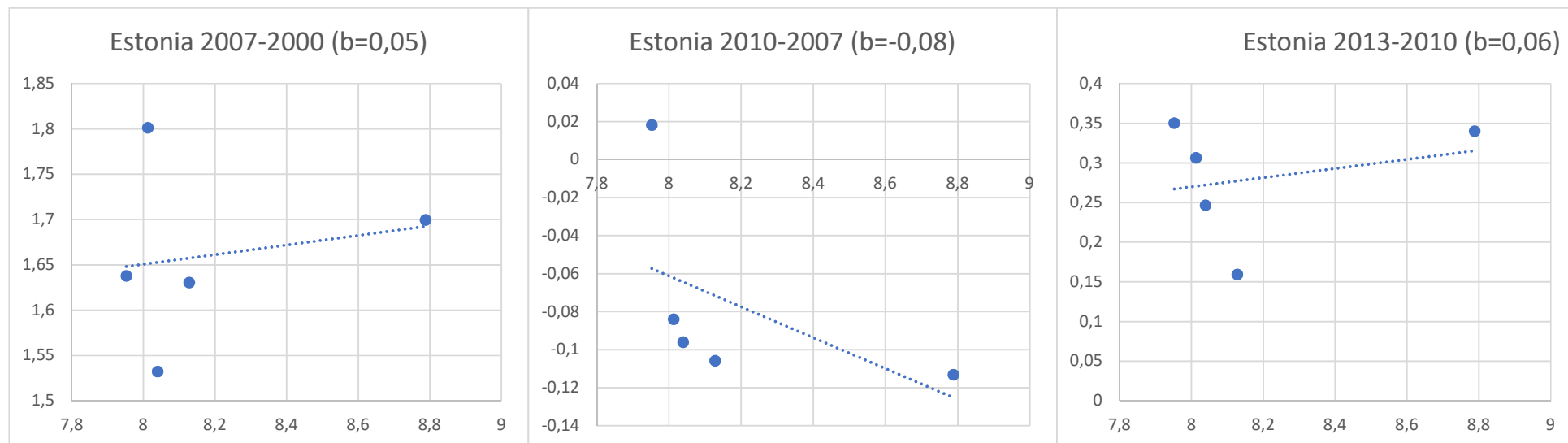Note: Source and axis titles are the same for all panels in Figure 5

The subsample results of simple unconditional convergence regressions are insignificant for all three periods. Prague is always an outlier and its position determines the slope of the (insignificant) regression line. While Prague achieved the highest increase of its gdp per capita between 2000 and 2007 (before the GFC) it suffered from the largest decline among all regions between 2010 and 2013 (after the crisis).

Convergence for the period 2004-2015 is found when the distribution of cohesion funds is added as an independent variable (Zazek et al, 2019). Prague appears as an outlier, but omission does not change econometric results significantly. For the period 2000-2015 a spatial panel model for Czechia, Slovakia, Poland, Hungary, Germany and Austria confirms significant convergence for NUTS2 regions (Formanek, 2018).

Artelaris et al (2010) find a convergence club of NUTS3 regions in Czech Republic, which deviates from the leading capital city region, but converges internally for the time period 1990-2005.

EU-Accession is estimated to have a rather small effect on reducing regional inequality (Horridge and Rokicki (2018).

Figure 5b. Regional convergence before during and after the crisis: Estonia
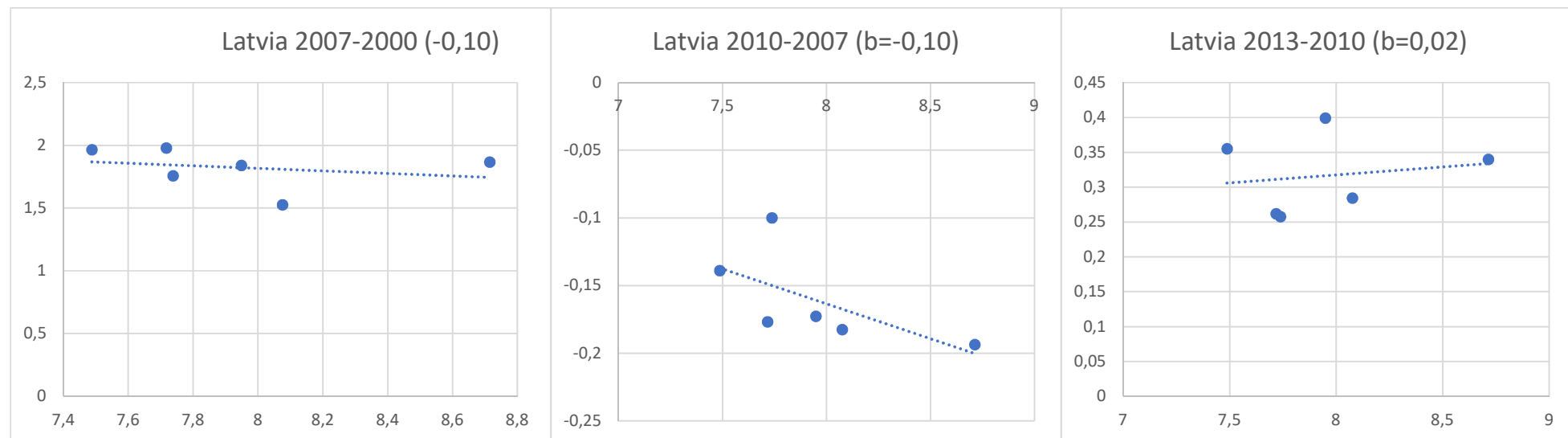

Source: Own calculations with data from Eurostat.
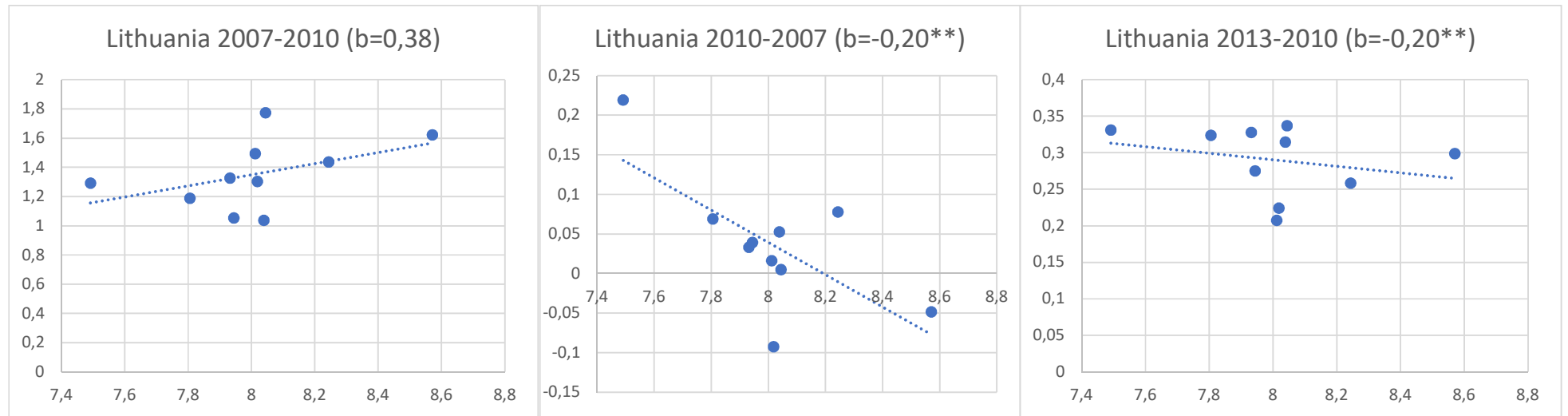Note: Source and axis titles are the same as in Figure 5a

In Estonia it is again the position of the capital region, which determines the slope of the (insignificant) unconditional regression line.

Artelaris et al (2010) find a convergence club of NUTS3 regions in Estonia, which deviates from the leading capital city region, but converges internally for the time period 1990-2005. Smetkowski and Wójcik (2012) do not find beta-convergence for Estonia, independent whether the capital region is included or not.

Figure 5c. Regional convergence before during and after the crisis: Latvia

Source: Own calculations with data from Eurostat.
Note: Source and axis titles are the same as in Figure 5a

In Latvia also all three subperiod regression lines are insignificant and convergence only takes place in the crisis period. Again the capital city is an outlier region.

Contrary to Czech Republic and Estonia, the convergence club formed by the regions outside the capital region is converging towards the income level of the capital region (Artelaris et al, 2010). A structural analysis of economic convergence in Latvia and the EU reveals, that for new EU member states convergence was driven by their capital regions becoming richer, therefore increasing within-country regional inequality (Melihovs and Kasjanovs, 2011.

The hysteresis of employment structure has contributed to the persistence of regional inequality (Mihnenoka and Senfelde, 2017).

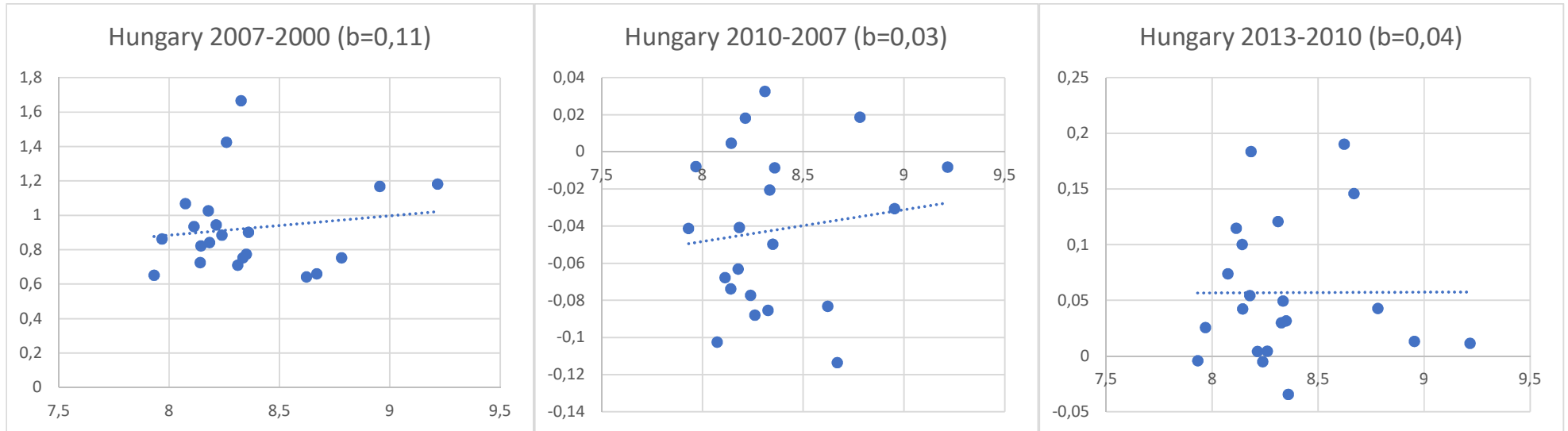Figure 5d. Regional convergence before during and after the crisis: Lithuania

Source: Own calculations with data from Eurostat.
Note: Source and axis titles are the same as in Figure 5a

In Lithuania significant convergence can be observed during and after the crisis.

Svetikas and Dzemyda (2009) find traces of beta convergence before 2010, but divergence according to sigma-convergence indicators. Before the GFC strong divergence occurred, which came to a halt during the crisis period (Kramar, 2016). Regional inequality is also related to the type of regional centers (Maknickiene et al, 2018). Laskiene et al (2020) find that regional inequality exists despite a large degree of uniformity of wages and disposable income.

Figure 5d. Regional convergence before during and after the crisis: Hungary
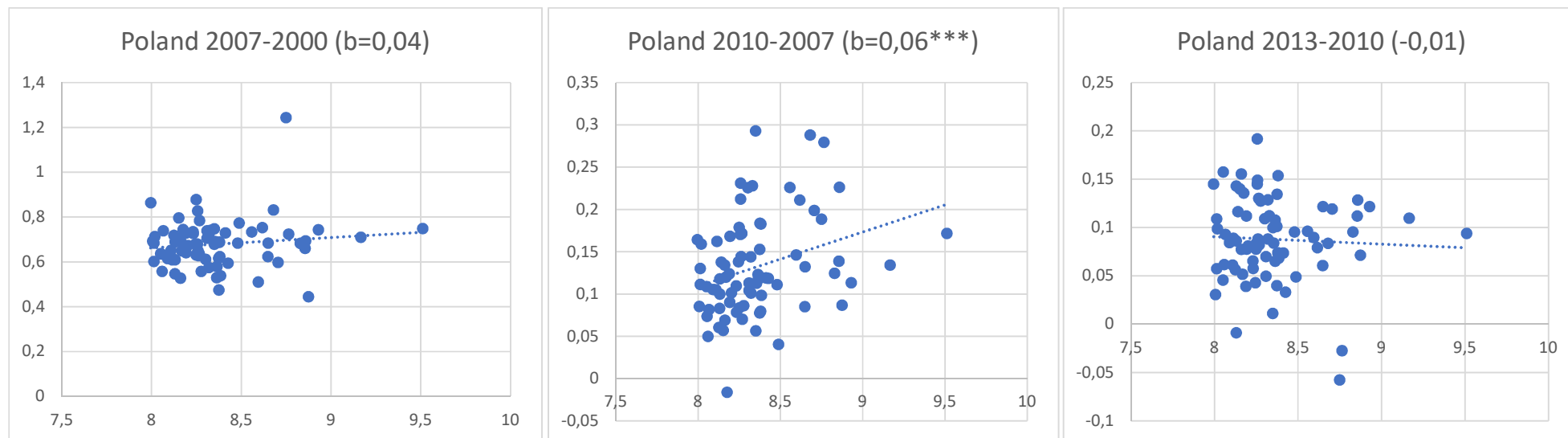

Source: Own calculations with data from Eurostat.
Note: Source and axis titles are the same as in Figure 5a

In Hungary all regression lines are insignificantly positive. A result confirming the finding that Hungarian micro-regions diverge (Bakucs, 2018). Convergence club studies find that in Hungary regions show a diverse pattern (Artelaris et al, 2010). However, EU-Accession is estimated to have a rather small effect on reducing regional inequality (Horridge and Rokicki (2018).

In Hungary regional inequality is high, both due to geographical factors along an East-West divide and the presence of minorities with a traditionally large distance from education and employment (Kertesi and Kézdi, 2011).

Figure 5e. Regional convergence before during and after the crisis: Poland
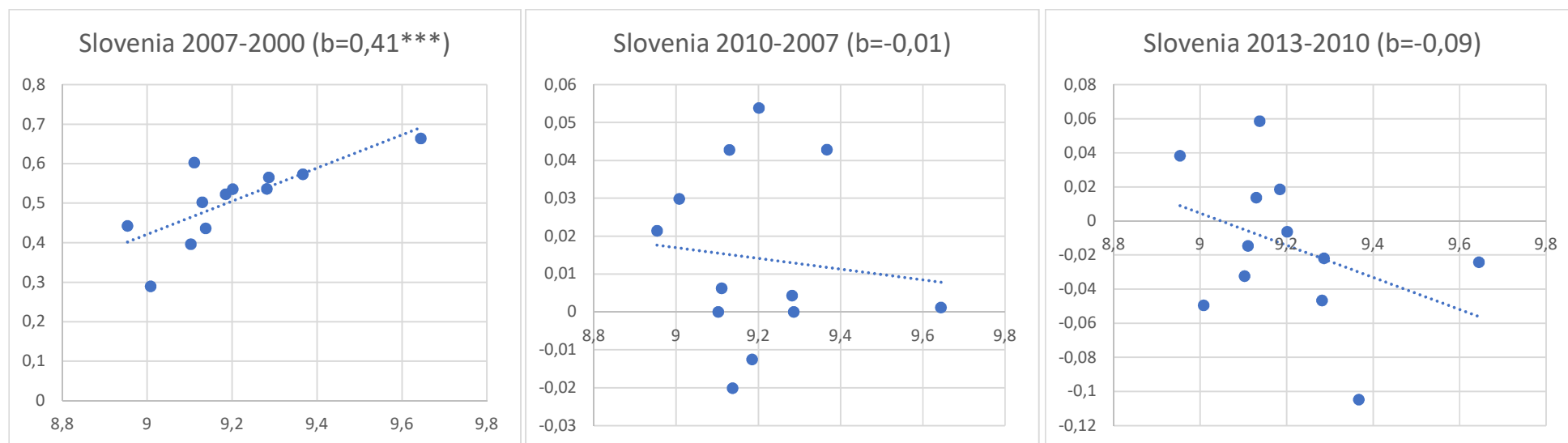

Source: Own calculations with data from Eurostat.
Note: Source and axis titles are the same as in Figure 5a

In Poland regional dynamics is either significantly diverging (during the crisis years) or insignificant (before and after the GFC.

Rokicki and Hewings (2016) find that the use of real regional income instead of nominal income increase the significance of regional convergence in Polish NUTS2 regions as well as AS states. Moroianu-Dumitrescu and Novac (2020) find that convergence clubs in Poland are linked to specific local policies.

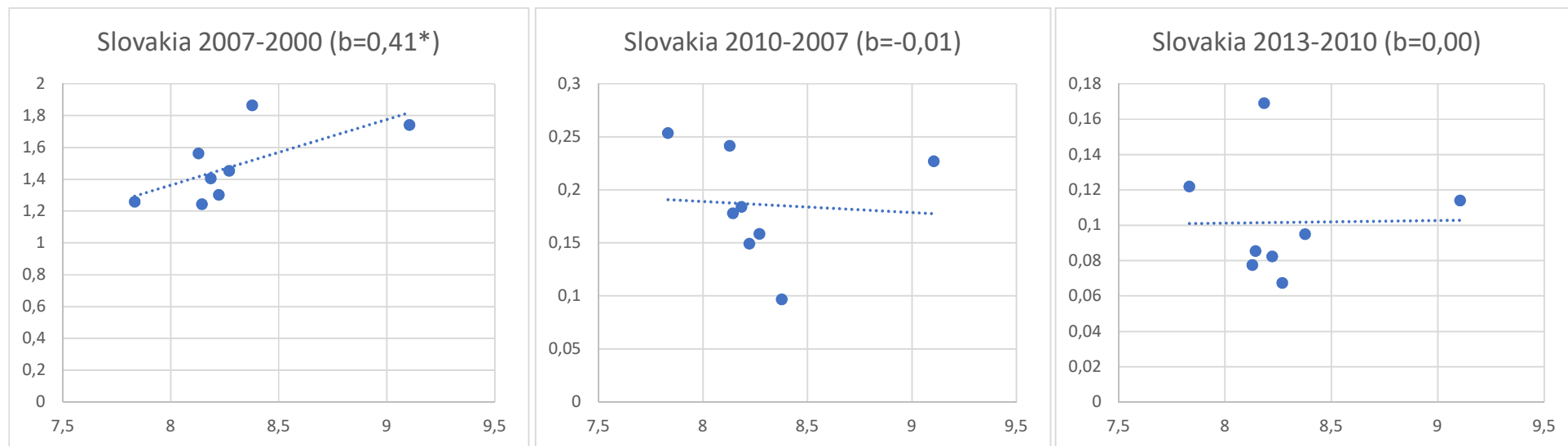Figure 5f. Regional convergence before during and after the crisis: Slovenia

Source: Own calculations with data from Eurostat.
Note: Source and axis titles are the same as in Figure 5a

In Slovenia we observe significant divergence before the GFC and insignificant convergence during and after the crisis.

Banerjee and Jesenko (2015) find considerable heterogeneity in the regional convergence process in Slovenia. The high-income capital region has diverged further, while some poor regions were falling even further behind. Kuhar and Juvancic (2007) expected that EU cohesion policy would stimulate economic activity and foster regional convergence in poorer Slovene regions.

Figure 5g. Regional convergence before during and after the crisis: Slovakia

Source: Own calculations with data from Eurostat.
Note: Source and axis titles are the same as in Figure 5a

Also in Slovakia divergence before the GFC is significant. This is due to the above average growth in the two regions (Bratislava and Trnava) with the already highest GDP per capita.

Pauhofva and Zelinsky (2017) find that incomes in districts converge towards different regional levels, confirming a fragmented pattern.

Summary

Many studies confirm regional convergence also for post-communist countries. Our study apparently confirms this result, although with qualifications.

Concerning sigma-convergence the evidence for eight new EU members (Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Hungary and Slovenia) is mixed. The Gini coefficient for Czech Republic, Hungary, Poland and Slovakia increases and falls or remains constant for Estonia, Latvia and Lithuania, and Slovenia. The Theil index (within) signals constant regional differences.

The main result of this paper (Tables 4a-c) is that we find significant unconditional convergence for regions in CEECs only if the GFC is included in the sample, but not at both ends of the observation period. The only exceptions are Hungary and Poland (Tables 4a-c). These results confirm findings for the OECD that the nature of regional convergence changes with the GFC (OECD, 2018a).

The speed of convergence and regional unemployment differentials are weakly related: In countries with a higher convergence speed the regional unemployment differentials are lower. This is especially true for the Czech Republic.

Before the GFC, simple convergence regressions (Figures 5a-h: no effects, no panel) hint at significant divergence (Slovakia, Slovenia), insignificant divergence (Czech Republic, Estonia, Hungary and Poland) and insignificant convergence (Latvia).

As a conclusion it is therefore warranted to request more robustness tests before the general positive message about regional convergence in the new EU member countries is accepted. Considerable remaining regional divergence is masked by rapid overall growth, which is not spread equally over regions, but more concentrated in capitals.

An area of further research could be the role of the exchange rate system for regional convergence, because only in countries with floating exchange rates (Hungary and Poland) unconditional convergence also holds outside the GFC period.

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