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PATHS OF INCOME CONVERGENCE BETWEEN COUNTRY PAIRS WITHIN EUROPE

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ABSTRACT: *This paper explores income convergence in European countries. Unlike previous research, the analysis is based on the pair-wise approach (Pesaran, 2007), identifying four cases: long-run convergence, catching-up, lagging-behind, and divergence. The results suggest that catching-up prevails, while no significant evidence was found for the existence of long-run convergence at the whole sample level. Still, three convergence clubs appear that consist of countries recording long-run convergence, two in transitional countries and one involving advanced countries,*

which indicate the similar growth model of the countries belonging to each club. Nevertheless, the results do not allow us to claim with certainty that the income paths of the club members will not exhibit systematic tendencies toward divergence or changes in membership in future.

KEY WORDS: *European countries, Long-run Convergence/Catching-up/Lagging-behind/Divergence, Convergence Clubs, Time-series and Pair-wise Approach, Panel Analysis*

JEL CLASSIFICATION: O47, C32, O11, O52

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1. INTRODUCTION

According to the European Commission, joining the European Union resulted in stronger growth performance for new members, which helped them to converge with the ‘old’ EU countries (European Commission, 2009). The European growth model has been a powerful engine of economic convergence over the last five decades (Gill and Raiser, the World Bank, 2012).

However, countries have been quite heterogeneous regarding their speed and pattern of convergence in Europe. Therefore, in previous papers on the subject of convergence between European countries the results are mixed, depending on the chosen period, sample, and methodology used (see e.g., Matkowski and Próchniak, 2007, Reza and Zahra, 2008, Costantini and Lupi, 2005, Cavenaile and Dubois, 2011, Ingianni and Žďárek, 2009, Kočenda et al., 2006, Vamvakidis, 2008, Vojinović and Oplotnik, 2008, Tatomir and Alexe, 2012, Varblane and Vahter, 2005, Halmai and Vásáry, 2010, Crafts and Toniolo, 2008, Estrin et al., 2001, Czasonis and Quinn, 2012). Therefore, since EU members and candidates constantly strive for higher income, the path and dynamic of income growth relative to other countries is an important question. Also, convergence of per capita output is one of the basic motives for a country to join the EU. Therefore, income convergence is a significant issue and a recurring theme in the literature.

This paper addresses the question of heterogeneous convergence and analyses the behaviour of output gap (difference in GDP per capita level of two countries) for every pair of observed European countries. It investigates whether, when, and among which country pairs there is convergence. Special attention is paid to the existence of convergence within the group of European transition countries, as well as to convergence between these and the developed countries. The chosen methodology provides the opportunity to get more information about the convergence process for every pair of countries and for every sub-period within the observed time period. In addition, attention is paid to the analysis of data from the beginning of the economic crisis in order to check whether the identified patterns derived from our analysis have been retained despite the various responses of countries to the crisis.

Many EU countries are still going through recession or/and slow recovery from the crisis. Some members of the European Union are facing serious difficulties

(e.g., high indebtedness), which has even called into question the stability and the sustainability of united Europe. Therefore we believe that the convergence of European countries is one of the subjects that needs to be examined to point out the success achieved so far, and further possibilities for even economic growth and reducing the differences between country income levels. It is especially important to discover transition countries' income-growth paths. It can be beneficial to relate their growth model and the similarities they share in the growth process with that of 'old' Europe, and to examine the differences that are influencing their journey. In some countries the convergence process has been particularly compounded by numerous imbalances (see e.g., Abiad et al., 2009, Atoyan, 2010, Berglöf et al., 2009, BRUGEL and wiiw Report, 2010), which has been especially evident throughout the global economic crisis.

The main contribution of the paper to previous research on the subject is twofold. First, the comprehensive methodology is based on detailed implementation of time-series analysis and Pesaran's pairwise approach and multi-country average measures (Pesaran, 2007) in the pre-crisis period, as well as a panel unit root test for both pre-crisis and crisis periods. Previous research has not used such an extensive methodological approach. Second, the approach has enabled us to examine all country pairs (276 in total) separately, addressing the specificities and characteristics of the countries: the economic and non-economic actualities that have influenced output levels, growth, and paths of convergence. This approach also enables us to identify the potential existence of convergence clubs. Therefore, this allows us to compare results with comprehensive economic analysis, particularly with the growth model that each country follows.

The methodology that we use is based on Carlino and Mills (1993), Bernard and Durlauf (1996), Gómez-Zaldívar and Ventosa-Santaulària (2010), and pairwise methodology developed by Pesaran (2007). The approach implies the observation of the stationarity of output gap time series (expressed as an absolute difference between per capita incomes in each pair of countries). We observe four cases: 1) long-run convergence, i.e., the stronger definition of convergence, when output gap is a mean stationary process; 2) catching-up, i.e., the weaker definition of convergence, when output gap is a trend-stationary process along negative trend; 3) lagging-behind, when output gap is a trend-

stationary process along positive trend; and 4) divergence, when output gap contains a unit-root. For every country pair we observe the exact time interval (the initial year and quarter and the final year and quarter) within which there is a possibility of recording the aforementioned cases. Additionally, we consider the number of multi-country average measures obtained as simple or weighted averages of the squared or absolute values of output gap pairs. A panel unit root test will be used as a robustness check of findings obtained through the last analyses before the crisis, this being also the only possible methodology (because of the small number of data) to check whether the findings of convergence pattern have changed since the beginning of the crisis.

The paper is organized as follows. Section 2 contains a brief review of previous research on convergence in European countries. Description of data and a short illustration of methodologies are presented in Section 3. Section 4 contains explanations of applied time-series methodology and results from its implementation. In section 5 multi-country average measures are presented. Section 6 illustrates panel unit root test results. Finally, section 7 presents the conclusion.

2. LITERATURE REVIEW

Matkowski and Próchniak (2005, 2007) analysed real economic convergence of income levels between eight new EU entrants from Central and Eastern Europe (countries that joined the EU in 2004, minus Cyprus and Malta - CEE-8 hereafter) and core EU countries (EU-15). They proved that between these 23 countries, observed individually, there is beta convergence¹. They calculated beta coefficients: 1.67% in the period between 1993 and 1998, 2.66% between 1998 and 2004, and 2.37% for the whole observed period. They also confirmed the existence of β -convergence at the regional level (between two regions – CEE-8 and EU-15, taken as wholes), with a β -coefficient equal to 2.46% for the whole observed period (2.63% in 1993-1998 and 2.32% in 1998-2004). Also, in

¹ β -convergence exists when low-income countries grow faster than high-income countries, reaching an equilibrium (steady-state) income level. If that level is the same for all countries there is unconditional convergence, while conditional β -convergence allows a different steady state for countries depending on country-specific conditions (such as savings rate, population rate, etc.). The other also very well-known concept of convergence is σ -convergence, i.e., when dispersion between income levels decreases over time.

Matkowski and Próchniak (2004) empirical analysis shows that there is convergence between CEE-8 countries for the period between 1993 and 2003, as well as between these countries towards the EU-15 income level. Income differences between individual countries have a tendency to diminish, particularly towards the end of the observed period, while the income gap between CEE and EU countries still remains very large, although generally decreasing. Ingianni and Žďárek (2009) analysed the process of real convergence of new EU member states, paying special attention to CEE-8 countries. The analysis was based on beta and sigma-convergence, as well as time-series-based stationarity² and cointegration tests. They noted that during the last decade these economies experienced robust economic growth, which had a stronger impact on the convergence process within the CEE-8 group than the convergence process of the CEE-8 with the EU-15.

Reza and Zahra (2008) applied different tests of unit root in panel data for the purpose of studying real economic convergence and catching-up in ten European Union member states (all those that joined the EU in 2004 – hereafter referred to as EU-10) with the average of EU-25 and EU-15 per capita income for the period 1995-2005. The obtained results support the existence of absolute convergence and catching-up processes, but not of conditional convergence. Halmai and Vásáry (2010) analysed the experiences gained in real convergence, catch-up processes, and future prospects of new EU member states (EU-10 with the average of the EU-25). They concluded that the integration process of the new EU member states was successful, that the convergence rate was approximately 2.5%, that it would fall by half in the next decade, and that in the future these countries could even record divergence. Vojinović and Oplotnik (2008) observed unconditional beta and sigma convergence among the EU-10. The results obtained through empirical analysis are very similar to the results of other analyses on the same subject. They confirm the existence of both types of convergence (absolute and conditional) in the second half of the 1990s and the 2000s. Generally, the poorer new EU member states recorded faster growth than the richer new EU member states. As a result, the income gap between these countries has decreased (although it remains quite large). The convergence rate

² They analyse time series that represent the income differences of each CEE-8 country with EU-15 average income.

was 2.87% in the years between 1995 and 2006 and 3.23% between 1996 and 2006.

Varblane and Vahterm (2005) analysed the economic convergence of transition countries (new EU entrants in 2004 and 2007: CEE-8 plus Bulgaria and Romania, hereafter referred to as CEE-10) during the period 1995-2004. Within the analysed period unconditional β -convergence across the transition economies was recorded. They also discovered a reduction in the dispersion of income levels between accession countries (sigma-convergence). Comparative analyses of the economic convergence of new EU member states (CEE-10) with the previous entrants (Ireland, Greece, Spain, and Portugal) revealed that the CEE-10 had been much more successful in their convergence process before joining the EU. Analyses of the macroeconomic, human capital, and infrastructure indicators of the current accession of new EU countries in comparison to the previous cohesion countries indicated that the new members had been much better prepared for the enlargement. Tatomir and Alexe (2012) researched and compared CEE-10 with PIIGS countries (Portugal, Italy, Ireland, Greece, and Spain) in terms of economic convergence with the euro area during the last decade (2000-2008, 2000-2010). The paper emphasizes the changes in the economic convergence levels due to the recent international crisis. Accordingly, they calculated the aggregated index of economic convergence, made up of real and structural convergence indices, and highlighted the similarities between the states in the two groups regarding economic convergence. They showed that in the last decade all countries in the two groups, except Italy, made important progress in 'catching-up'. Slovakia and Ireland recorded the fastest economic growth. Cavenaile and Dubois (2011) investigated the convergence process of the CEE-10 and 15 Western countries between 1990 and 2007. Applying the panel approach to the convergence equation, they point out the existence of heterogeneity in the European Union and show that the CEE-10 and the old members of the European Union can be seen as belonging to significantly different groups in terms of convergence.

Vamvakidis (2008) analysed the emerging European economies³. The author proved that in recent years those economies have converged rapidly with more advanced European economies. However, there are still large external imbalances in some parts of the region. This raises questions about sustainability and vulnerabilities. Empirical evidence in this paper suggests that the convergence trend in emerging Europe is based on strong fundamentals and is expected to continue, but at a slower pace. Moreover, the convergence path may become volatile as countries with large external imbalances adjust, with risks of a hard landing in some cases.

Costantini and Lupi (2005) used non-stationary panel data approaches in order to test convergence in real GDP per capita for 15 European countries (EU-15) over the period 1950-2003. They tested for the presence of a unit root in the pairwise differences between German real GDP per capita (taken as a benchmark) and the real GDP per capita of other EU countries. In this process they applied both independent and dependent panel unit root tests and found little evidence of stochastic convergence among EU countries for the whole period between 1950 and 2003. On the other hand, they identified the presence of stochastic convergence in the sub-period between 1950 and 1976.

3. ILLUSTRATION OF DATA AND METHODOLOGY

In our econometric research we used data on real GDP per capita from the EUROSTAT database. The data are quarterly - from the first quarter of 1995 until the third quarter of 2013 - in euros, logarithmic, and seasonally adjusted⁴.

In our analysis we observe output gaps (the difference between the countries' logarithmic GDP per capita) for every pair of 24 European countries – a total of

³ Albania, Belarus, Bosnia & Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, FYR Macedonia, Moldova, Poland, Romania, Russia, Serbia, Slovakia, Turkey and Ukraine.

⁴ Data were downloaded as non-seasonally adjusted, and then seasonally adjusted using the TRAMO/SEATS method.

276 time series⁵. In our sample of 24 countries we included Norway along with 23 selected EU members⁶.

We observed two subsamples:

- 1) pre-crisis period (1995Q1-2008Q3)
- 2) crisis period (2008Q4-2013Q3)⁷

In the pre-crisis period we implemented comprehensive analysis of the time series approach, with the addition of multi-country average measures and panel unit root testing.

In the crisis period we based our conclusion solely on the results from unit root tests in panel data. Although we considered time series and average measures extremely reliable for testing convergence, we did not have enough data for the period from the beginning of the crisis. This is why, with the panel approach, we are performing a kind of preliminary examination of output-gap behaviour during the crisis.

4. TIME SERIES APPROACH: METHODOLOGY AND RESULTS

4.1 Time series approach: methodology

In the literature the question of convergence is examined by using a cross-section, panel, time series, or distribution approach⁸. The time series approach originated in the 1990s. The idea arose from an equation that was derived from the well-known growth-initial level equation related to the concept of β -

⁵ Total number of pairs can be calculated as $N(N-1)/2$, where N is the number of observed countries.

⁶ Out of all EU members, our sample does not include the following five countries: Romania, Greece, Ireland, Cyprus, and Malta. Romania, Greece, and Ireland are excluded because of the problem with data availability. Cyprus and Malta have specific structural characteristics and past political experiences, and therefore they have usually been excluded from analysis in previous papers on the subject.

⁷ For advanced countries the time range is 2008Q4-2013Q2, because of data availability.

⁸ For details about these approaches see Islam (2003).

convergence⁹ (i.e. higher initial per capita output level – lower output growth rate and vice versa):

$$y_t = \mu - \beta gt + (1 + \beta)y_{t-1} + \varepsilon_t \quad (1)$$

where y_t and y_{t-1} are per capita output values of a country in the current and previous periods, respectively; β is the convergence parameter which is negative; μ represents constant; and t is a deterministic trend.

When there is no convergence of the country's income to a steady-state level ($\beta = 0$), the output will be a non-stationary process. The opposite is true in cases when convergence exists ($\beta < 0$): i.e., the output will be stationary. Even though some previous research studies were based on this equation (e.g., Lee et al., 1997), this kind of analysis has two main shortcomings. First, it only enables research of convergence within a country, not across (between) countries. When a country's output is a stationary process, it means that the country converges to its own steady-state level. Second, the trend in the equation is deterministic (the end result pointing to the existence of convergence means that the convergence is 'deterministic'). Therefore, the equation does not lead to the correct conclusion if there is a stochastic trend in per capita output (which, according to Pesaran, 2007, can be the case because of the stochastic nature of technology that influences the output level).

These can be overcome by observing output gaps (output deviation, expressed as an absolute difference between per capita incomes in each pair of countries) series and testing the unit-root in those output deviations instead of individual output-level data. In this way the time series approach focuses on an across-country convergence analysis. Also, gap series (because they represent deviations) eliminate the influence on the test results of the question of whether the technological process is deterministic, stochastic, and/or has a random walk component. Therefore, it is possible that there is an across-country convergence

⁹ “While the cross-section, panel, and (in part) time series approaches have in one way or the other investigated β -convergence, the distribution approach focuses on σ -convergence and on changes in the cross-section income distribution as a whole.” (Islam, 2003, p. 336)

even if there is not a within-country convergence (output of individual countries is a non-stationary process)¹⁰.

In literature there are several ways to calculate output deviation:

- a) as the difference between the output of a country (or a region) and the average output value of the chosen sample of countries (a sample of regions or all the regions of a country),
- b) as the difference between the output of a country (or a region) and output value of the chosen reference country (reference region),
- c) as pair-wise output differences, where gaps between all pairs of countries (or regions) in the sample are calculated.

Carlino and Mills (1993) examined US regional data deviations of the log of per capita output in relation to the average output level of the U.S. as a whole. The results lead to the conclusion that regional conditional convergence in the U.S. exists. Evans and Karras (1996) conducted a panel unit root test, which is a modified version of the unit root test proposed by Levine and Lin (1993), designed specifically for pooled data. They analysed the deviation of output of the 48 contiguous U.S. states over the period 1929-1991 and of 54 countries over the period 1950-1990 from their average output level, and the results for the set of samples also support the conditional convergence hypothesis. The problem of obtaining the deviation from the average is that if the output of only one economy contains a unit root, the average will be a unit root process. Therefore in such cases, when the deviations from the average of each stationary output series are calculated, they will contain a unit root.

Quah (1990) chose the U.S. as a reference country and observed the deviation of the output of 114 countries from the U.S. output level. Using a panel unit root test, he tested a more rigorous hypothesis: that there is an absolute convergence between countries. Although the results dismiss this hypothesis, they are in line with the results obtained through other methodologies for testing the unconditional convergence in large samples of countries¹¹. Bernard and Durlauf (1996) test output convergence by implementing multivariate cointegration

¹⁰ Islam (2003), p. 334.

¹¹ Referred to Islam (2003), p. 335.

techniques for individual output series for 15 OECD countries, as well as for output deviations calculated with respect to the U.S. output level. They also consider two subsamples of 11 and 6 OECD countries, upon which they perform a cointegration analysis, first on all individual output series and then on all output deviations from the French output level. The limitations of this 'reference country' methodology are that the author/authors have to choose the benchmark country. Even though it is methodologically simpler to consider deviation from the output level of one country (benchmark country), the results are determined by the choice of benchmark.

Pesaran's pair-wise approach differs from the approaches of other authors that apply time series for convergence analysis, because it takes into account the output gaps for all possible pairs of countries ($N(N-1)/2$ output gaps across N economies). According to Pesaran, two countries are convergent (non-divergent) if their output gap is a mean-stationary process. In all other cases, when the gap contains a deterministic or stochastic trend, countries exhibit non-convergence (divergence). When he identifies mean-stationary output gap series, he calculates the percentage (fraction) as the number of those series in total gaps, compares this proportion with the significance level of the unit-root test, and draws a conclusion about the existence of long-run convergence. Pesaran proves that in the case of non-convergence in a sample of countries and under the null of non-convergence (or divergence, e.g., if the Augmented Dickey Fuller unit-root test is applied), one could expect the fraction of output gap pairs for which the unit-root hypothesis is rejected to be close to the significance level of the unit-root test applied to the individual output gap pairs α (because the fraction of the rejections converges to alpha as N and $T \rightarrow \infty$) and under the null of convergence (e.g., in the case of the Kiatowski-Philips-Smith-Shin unit-root test) the number of the fraction converges to 100% as N and $T \rightarrow \infty$. The advantage of Pesaran's pairwise approach in comparison to a multivariate cointegration approach is that the latter can only be applied to a limited number of countries. The advantage in relation to the cross-section and panel approaches is that "it relates more naturally to the club convergence literature", i.e., "the convergence results from the analysis of pairwise output gaps can be used to form convergence clubs" (Pesaran, 2007, p. 314).

We based our analysis on Pesaran’s pairwise approach, but, unlike Pesaran, our analysis goes further. We not only concentrate on long-run convergence (only mean stationary output gaps) or the corresponding percentage, but also, based on the broad literature that applies time series methodology (see Bernard and Durlauf, 1996, Gómez and Ventosa-Santaulària, 2010 and 2012), we observed and divided non-convergent (divergent, as defined by Pesaran) output gap behaviour into three different processes: catching-up, lagging-behind, and divergence (see cases 2-4 below).

In our analysis we first calculated output gaps as the difference between log per capita output level for every pair of countries (total pairs $N(N-1)/2$):

$$d_{ijt} = y_{it} - y_{jt} \tag{2}$$

For output gap series, we test the unit root by using the Augmented Dickey Fuller (ADF) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test with two bandwidth selection methods: automatic and with a bandwidth parameter equal to three¹². The order of the ADF regressions p_{ij} is chosen using model-selection criteria, primarily the Akaike information criterion (AIC)¹³.

We classified all test results into four different cases:

1. *Long run convergence (con)*. We start with the Pesaran pairwise approach and test for existence of output gap stationarity around the mean value¹⁴:

$$\lim_{k \rightarrow \infty} E(y_{i,t+T} - y_{j,t+T} | I_t) = a_{ji} \tag{3}$$

¹² As suggested by Pesaran, the lag window should be computed using the formula: $0.75T^{1/3}$

¹³ There are a certain number of gaps where Schwarz information criterion (SIC) is applied for determining the number of lags. This is done in cases where we find it much more appropriate than applying AIC. That is noted in our results, which are available upon request.

¹⁴ In many research studies preceding Pesaran (2007) (e.g., Bernard, 1991 and Bernard and Durlauf, 1995), the authors tested long-run convergence using the following equation:

$$\lim_{k \rightarrow \infty} E(y_{i,t+T} - y_{j,t+T} | I_t) = 0$$

This definition implies that output gap is stationary around null. In contrast to that definition, Pesaran’s definition is relaxed, in the sense that convergence countries do not need to be identical in all aspects.

where a_{ji} is a fixed mean that represents the countries' structural differences (savings rate, population growth, initial endowment, etc.). In this case, there are no more reductions or increases of the output gap and the difference in income for these countries remains stable over time. This definition implies deterministic convergence and represents the stronger definition of convergence.

2. *Catching-up (cu)*. Unlike Pesaran's, our analysis does not concentrate only on the long-run convergence. Based on the broad literature on convergence that applies time series methodology (see Bernard and Durlauf 1996, Gómez and Ventosa-Santaularia 2010, 2012), we also take into account the stochastic ('weaker') version of convergence when the output differences narrow between dates t and $t + T$:

$$E(y_{i,t+T} - y_{j,t+T} | I_t) < y_{i,t} - y_{j,t}, \text{ where } y_{i,t} > y_{j,t} \quad (4)$$

This definition represents 'convergence as catching-up' and appears when the output gap is stationary around a negative trend.

3. *Lagging-behind (lb)*. When output gaps are stationary around a positive deterministic trend they are classified as a lagging-behind case. Lagging-behind means that output difference increases over time between countries.

$$E(y_{i,t+T} - y_{j,t+T} | I_t) > y_{i,t} - y_{j,t}, \text{ where } y_{i,t} > y_{j,t} \quad (5)$$

4. *Divergence (div)*. Divergence, as we define it in our analysis, occurs when the gap series have a unit-root. In this case the difference in per capita output cannot be predicted.

We test for the presence of the unit root in all output gaps (276 in total). We test every output gap series using the three unit-root test statistics discussed above, namely ADF(p), KPSS (automatic bandwidth), and KPSS (bandwidth set to three)¹⁵. For every specific pair we observe in detail all possible time ranges and

¹⁵ The results of the two different KPSS tests we applied were used for the robustness check. They almost invariably supported the decision we made based on graph, correlogram, and ADF test analysis.

determine the exact time intervals (initial year and quarter, and final year and quarter) within which some of the four abovementioned cases and their combinations are recorded (*cu cu*, *cu lb*, *lb lb*, *lb cu*, *con cu*, *cu con*, *con lb*, *lb con*, *con con*).

4.2 Time series approach: results

Our empirical results, using stationarity analysis of all 276 series that represent pair-wise output gaps, suggest four main conclusions regarding EU countries' income-gap behaviour previous to the crisis¹⁶:

1. Catching-up dominated in Europe. As many as 70% of pairs in the sample recorded catching-up during at least a certain period within the observed time interval. However, 60% of country pairs recorded catching-up during the entire observed period.
2. On the whole sample level, we can conclude that there is no significant evidence of long-run convergence (as defined in Pesaran, 2007);
3. However, three convergence clubs have formed in our sample, according to the level of long-run convergence. Two convergence clubs are within transition countries: *Baltic* and *Visegrad+3*. The third club consists of a certain number of pairs within developed EU economies and we named it *Advanced* club;
4. *Baltic* is catching-up with *Visegrad+3* and *Advanced*, and *Visegrad+3* is catching up with *Advanced*. This conclusion is the consequence of the first result, i.e., countries with lower per capita output levels have been catching-up with the economies with higher per capita output levels in general in Europe during the observed period.

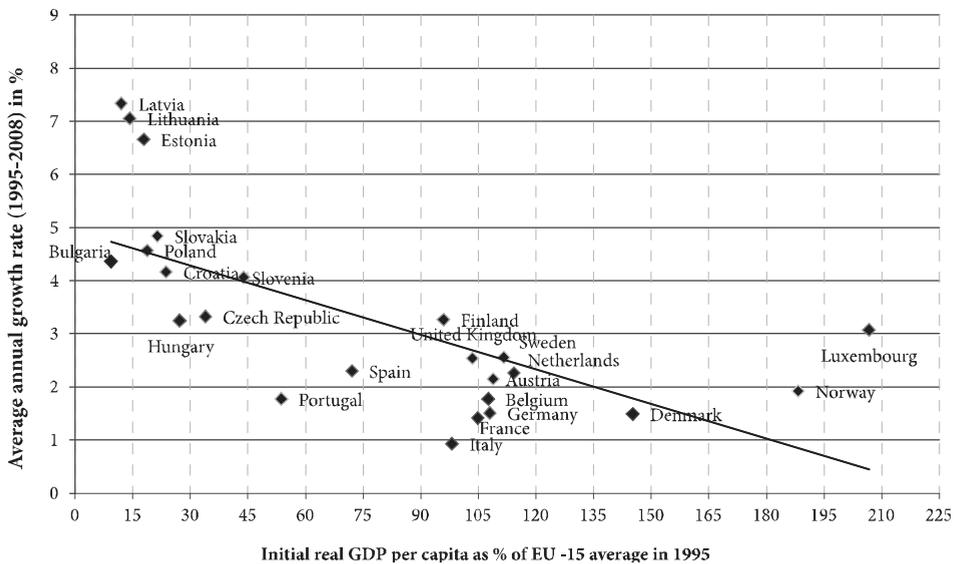
The first result is that *cu* has appeared in the majority of cases. Catching-up means a reduction in the differences in output. This corroborates the results of previous research mentioned in the literature on convergence in Europe. Therefore, our methodology clearly confirms the fact that β -convergence characterizes Europe in the pre-crisis period: countries with a lower initial level

¹⁶ Because of space constraints we did not include detailed results in the paper, but they are available upon request.

of per capita output (per capita GDP in 1995) record a higher average annual growth rate in the observed period (1995-2008) and vice versa (Graph 1).

The percentage of country pairs that indicate catching-up, lagging-behind, convergence, or divergence in any period is 69.6%, 22.8%, 15.2%, and 4.3%, respectively (Table 1). The fact that either lagging-behind or divergence during at least a certain time interval within the observed period was identified in only 27% of pairs indicates that convergence significantly dominated in Europe, regardless of whether it was defined as strong or weak.

Graph 1. Initial level of real per capita GDP and average annual growth rate



Source: Author's calculation based on EUROSTAT data

Table 1. Share of country pairs that show convergence, catching-up, lagging-behind, or divergence in any period within the observed time interval

	cu	lb	con	div
Share in total number of pairs	69.6%	22.8%	15.2%	4.3%

Source: Author’s calculation

Note:

1. cu - catching-up, lb - lagging-behind, con - long-run convergence, div - divergence
2. The sum of percentages is higher than 100% because Table 1 is derived from Table 2. Therefore, some output gaps are included in two groups if they show different behaviour in different time-intervals (as can be seen in Table 2).

If we observe more detailed results (Table 2), catching-up (*cu*) occurs in 59.1% of pairs, lagging-behind (*lb*) in 12.7% of pairs, and long-run convergence (*con*) in 9.1% of pairs. The decrease of difference in per capita income, which is followed by a period of increase in difference (*cu lb*), was recorded in 5.8% of pairs, whereas 4.3% of pairs recorded divergence. Each of the combinations (*lb cu*), (*con cu*), (*con lb*), (*con con*), and (*cu con*) appeared in 1.4% of total pairs. The case of increase in the difference in two consecutive periods, brought to an end by a break in series (*lb lb*), appears in 1.1% of pairs. Finally, only one pair has recorded (*cu cu*), and the same applies to (*lb con*).

Table 2. Number of country pairs that indicate convergence, catching-up, lagging-behind, divergence, or their combinations, and the share in total number of pairs

	cu	lb	con	cu lb	div	lb cu	con cu	con lb	con con	cu con	lb lb	cu cu	lb con
Number of country pairs	163	35	25	16	12	4	4	4	4	4	3	1	1
Share in total number of pairs	59.1%	12.7%	9.1%	5.8%	4.3%	1.4%	1.4%	1.4%	1.4%	1.4%	1.1%	0.4%	0.4%

Source: Author’s calculation

Note: cu - catching-up, lb - lagging-behind, con - long-run convergence, div - divergence

The second result follows Pesaran criteria. Non-convergence exists when the fraction of rejection under the null of unit root (the number of series that are stationary around a constant out of the total number of observed series) is close to 5% (Pesaran, 2007). Our results suggest that the ratio of pairs that have recorded long-run convergence during at least a certain period (within the observed time interval) and the total number of observed pairs is very low at

15.2% (see Table 1, case *con*). Therefore we can conclude that on the whole sample level there is no significant evidence of long-run convergence.

This result is in line with the process of transition from centrally planned to market economies, the differences in the pace at which these changes were applied, individual country characteristics, significant differences between the development level of these transition countries and the advanced part of Europe (which is still large, despite the convergence that took place), etc.

The third result is that two convergence clubs can be distinguished within the group of transition countries: *Baltic* (Estonia, Latvia and Lithuania) and *Visegrad+3* (Slovakia, Poland, Czech Republic, and Hungary along with Croatia, Bulgaria, and Slovenia). The third club we called the *Advanced countries* convergence club (see tables 3 and 4).

In the *Baltic* group the fraction rate is 67%, whereas in *Visegrad+3* it is 43% (53% excluding Bulgaria) and in *Advanced* it is 30%. Although the values of these parameters are still not of a level to suggest that shocks to the output gap in these groups of countries will not have a permanent effect, they are still high, especially taking into account the following circumstances:

- First, these countries are characterized by certain country-specific factors (e.g., regime, institutional changes). These factors can have a highly persistent influence on output gap, which at the same time does not have to be permanent – i.e., the series is not a random walk but contains a stochastic trend.
- Furthermore, the sample is relatively short since it contains only 55 observations, which makes the unit root tests somewhat limited in their ability to identify long-term stationarity around a constant.

Table 3. Results of the analysis: Pairs of transition European countries that indicate long-run convergence

Baltic countries			
Pair	Est Lit		Lat Lit
Period	1996q2 2000q2	2000q3 2008q3	@all
Visegrad+3 countries			
Pair	Sloven Pol	Cze Pol	Slovak Pol
Period	@all	1996q3 2008q3	@all
Pair	Sloven Cze	Hun Pol	Slovak Bul
Period	1996q4 2008q3	2001q1 2007q1	1998q2 2008q3
Pair	Sloven Cro	Hun Cro	Slovak Cro
Period	2000q1 2008q3	2000q1 2007q4	2000q1 2006q3

Source: Author’s calculation

Note:

1. @all stands for countries that exhibited long-run convergence during the entire observed time interval (1995 Q1 to 2008 Q3). In other cases the time interval when countries exhibited long-run convergence (within the observed time interval) is specified, e.g., 1996 Q3 – 2008 Q3 in the cases of the Czech Republic and Poland, which means that they recorded long-run convergence between the third quarter of 1996 and the third quarter of 2008.
2. Countries that make up the first convergence club are marked in dark grey (*Baltic group*: Estonia, Latvia, and Lithuania) and countries that represent the second convergence club in light gray (*Visegrad group*: Poland, Czech Republic, Slovakia, and Hungary + 3: Slovenia, Bulgaria, and Croatia).

Table 4. Results of the analysis: Pairs of advanced European countries that indicate long-run convergence

Countries	Lux Swe	Swe Pol	Nor Bel	Den UK	Fin UK	Net Fra	Ita Por
Period	2000q1 2008q3	1996q4 2002q4	@all	2003q1 2008q3	1996q4 2003q4	1996q3 2005q1	1998q1 2008q3
Countries	Lux Fin	Nor Den	Nor Fra	Den Ger	Fin Spa	Net Bel	Ger Ita
Period	1998q1 2008q3	@all	@all	1995q1 2007q4	1996q3 2001q2	1995Q1 2007Q2	1995q1 2006q4
Countries	Swe Fin	Nor Net	Nor Spa	Den Fra	Fin Pol	Net Aus	Fra Por
Period	1997q1 2007q2	@all	1997q4 2008q3	@all	1995q1 2003q1	@all	1996q1 2008q3
Countries	Swe Por	Nor Aus	Den Net	Den Spa	Aus Bel	UK Pol	Spa Pol
Period	1995q1 2002q1	1995q2 2007q4	2002q2 2007q1	2002q4 2008q3	1995q1 2008q2	1996 2002	1995q1 2003q1
Countries	Net UK		UK Spa		Bel UK	UK Bel	
Period	1997q1 2001q4	2003q1 2007q2	1997q1 2003q1	2003q2 2008q3	1995q1 2001q1	2001q3 2008q3	

Source: Author’s calculation

Note: @all stands for countries that exhibited long-run convergence during the entire observed time interval (1995 Q1 to 2008 Q3). In other cases the time interval when countries exhibited long-run convergence (within the observed time interval) is specified, e.g., 1995 Q1 – 2007 Q4 in the cases of Denmark and Germany means that they recorded long-run convergence between the first quarter of 1995 and the fourth quarter of 2007.

The fourth result stems from detailed observation of the obtained results and each country's income path. The Baltic states had the highest growth rates in Europe from 2000 until the beginning of the global crisis. According to our results, they were, without exception, catching-up with all individual countries with higher output levels, i.e., countries that belong to the *Visegrad +3* and *Advanced* groups.

At the start of the observed period, Baltic countries experienced hitches in their economic growth:

- Estonia had experienced slower growth in 1999. This was a consequence of previous problems on the stock market, the banking crisis, and the crisis in the CIS¹⁷. Estonia had the best results among CEE countries when it comes to catching-up, because in the observed period it caught up with and even overtook Hungary, Slovakia, Croatia, and Poland.
- The Latvian economy stabilized towards the end of 1994, with the help of a recovery in light industry and a sudden growth boom in commerce and finance. This recovery was disrupted twice, first in 1995 by a banking crisis and the bankruptcy of Banka Baltija, the largest Latvian bank, and then in 1998 by a serious financial crisis in Russia.
- By 1998 the Lithuanian economy had also survived early years of uncertainty and a few setbacks.

Still, in the pre-crisis period the growth of Baltic states was based on unsound foundations. Just before the crisis started they experienced large imbalances: a very high current account (CA) deficit and increasing indebtedness, an extremely high share of bank-related capital inflows in GDP (capital investments which can be withdrawn faster than other types of investment) and a very large share of foreign currency loans. The rapid growth was stimulated by the growth of domestic demand, followed by the growth of CA deficit. In 2007 CA deficit in GDP grew as high as 14.4% in Lithuania, 15.9% in Estonia, and 22.4% in Latvia¹⁸. CA deficits were mainly financed by foreign banks.

¹⁷ Commonwealth of Independent States.

¹⁸ Source: Eurostat.

The Baltic states were very hard hit by the crisis (according to the IMF, GDP based on purchasing-power parity in these countries decreased by 13% in Estonia and 17% in Latvia and Lithuania between 2008 and 2009). Latvia was the hardest hit of all European Union member states.

The *Visegrad+3* group, on the other hand, had much smaller external imbalances, but its economic growth was relatively modest in comparison to the Baltic states¹⁹. Even with the slower growth, *Visegrad* countries recorded convergence with countries with a higher level of output belonging to the *Advanced* group.

Bulgaria is an exception because, according to our results, it had been constantly lagging behind Baltic countries, although it has lower income: the output differences between Bulgaria and the Baltic countries had been increasing.

Slovenia is also specific because it has often shown irregularity/unpredictability of its output trends, i.e., divergence with other countries.

At the beginning of the period Poland recorded similar growth to the developed countries, but later its output began to display trends similar to the other CEE countries. Most likely the reasons for slower growth - which put Poland in a growth path similar to advanced countries at the beginning of our observed period - were the country's transformation reforms to a market-oriented economy during 1992-1997.

A sudden increase in output gap occurred between Hungary and the majority of other countries at the beginning and the end of the period. By 1995 Hungary had many economic problems, including the highest foreign debt in Europe, a large trade deficit, rising inflation, etc. A stabilization plan was applied in 1995, which resulted in slower economic growth for the next several years. The reason for the slowdown at the end of the observed period was the implementation of an austerity programme, which derailed the growth of the Hungarian economy in 2007.

¹⁹ With the exception of Bulgaria, which recorded the highest CA deficit in the EU of as much as 25% of GDP in 2007.

The transition from a centrally planned to a free market economy (from 1994-2008) also slowed down Slovakian growth at the beginning of the observed period.

In the group of *Advanced* countries, several regularities can be singled out:

- Italy, France, and Germany mostly lagged behind more developed countries. Italy and Germany converged until 2006. After 2005 Italy experienced a huge drop in output level compared to Germany and the output gap between Italy and Germany suddenly widened at the end of the period.
- After a successful beginning, Portugal started to lag behind advanced countries in output after 2000. Because of the very poor results of the Portuguese economy in the 2000s, some economists called this country in 2007 “the new sick man of Europe”²⁰.
- The difference between the per capita outputs of advanced economies grew in relation to the output of Luxembourg and Sweden (i.e. many countries lagged behind these two developed countries). The lagging of other advanced countries behind Luxembourg can be explained by the fact that it achieved enormous financial integration during the observed period (see Abiad et al., 2009).

5. AVERAGE MEASURES: METHODOLOGY AND RESULTS

5.1 Average measures: methodology

According to Pesaran (2007), it is possible to derive the series of ‘average’ deviations at the level of groups of countries and use them as a basis for testing the existence of long-run convergence within a group. Instead of observing a large number of output-gap series the idea is to calculate the average value of gaps and test the stationarity of thus-obtained series. We obtained the average value series as the unweighted or population-weighted average of squared or absolute output gaps. In the case of long-run convergence, i.e., when output gaps are stationary around the constant mean, the multi-country average measure of dispersions will also be stationary around a constant mean.

²⁰ <http://www.economist.com/node/9009032>

Like Pesaran (2007), we consider four different kinds of ‘average’ measure. First, two of them are unweighted measures:

1. Simple average with squared output gaps (D unweighted: D_{uw})

$$D_t^2 = \frac{2}{N(N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^N (y_{it} - y_{jt})^2 \quad (6)$$

2. Simple average of the absolute output gaps (delta unweighted: $delta_{uw}$)

$$\Delta_t = \frac{2}{N(N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^N |y_{it} - y_{jt}| \quad (7)$$

The third and fourth measures are weighted averages, where the weights are population size:

3. Weighted average with squared output gaps (D weighted: D_w)

$$D_t^{*2} = \frac{\sum_{i=1}^{N-1} \sum_{j=i+1}^N P_{it} P_{jt} (y_{it} - y_{jt})^2}{\sum_{i=1}^{N-1} \sum_{j=i+1}^N P_{it} P_{jt}} \quad (8)$$

4. Weighted average of the absolute output gaps (delta weighted: $delta_w$)

$$\Delta_t^{*2} = \frac{\sum_{i=1}^{N-1} \sum_{j=i+1}^N P_{it} P_{jt} |y_{it} - y_{jt}|}{\sum_{i=1}^{N-1} \sum_{j=i+1}^N P_{it} P_{jt}} \quad (9)$$

Unweighted average measures also have important theoretical meaning:

D_t^2 is equivalent to $2s_t^2$. Therefore D_t is proportional to the standard deviation within the group (root of the squared deviation of y_{it} from the average for the group, for each i), which is used in literature as a measure of the existence of σ -convergence. If the series of output gaps in the observed group of countries records long-run convergence, $E(s_t^2)$ is fixed and therefore invariant. On the other hand, $E(s_t^2)$ will have a deterministic or stochastic trend if one or more series of output gaps in the observed group is trend-stationary or contains a unit root.

Δ_t represents a numerator in the known Gini coefficient²¹. $E(\Delta_t)$ does not vary in time in the case of existence of long-run pair-wise convergence of output gaps. On the other hand, even in the case of long-run convergence, the Gini coefficient can have a trend if \bar{y}_t has a deterministic and/or stochastic trend. Therefore, despite the wide usage of the Gini coefficient in economic literature, Δ_t is a better measure when testing the existence of cross-country output convergence.

These two average measures can lead to the wrong conclusion in cases where there is a big difference in population between observed countries. Therefore we try to get the weighted average of the squared or absolute values of output deviation from the population, and we obtain D_t^{*2} and Δ_t^* . Stationarity around the constant or the existence of trend in the thus-obtained series will manifest themselves in the same manner as in the case of their counterparts (D_t^2 and Δ_t), depending on the characteristics of output gaps (depending whether all the series are stationary or one or more of them contain a deterministic or stochastic trend). Still, the characteristics of these two measures will also be determined by the differences in the population growth between the countries.

First we calculated the measures at the level of the sample, that is, for all observed European countries²² noted as eu_D_unweighted, europe_D_weighted, eu_delta_unweighted, and eu_delta_weighted, for D_t^2 , D_t^{*2} , Δ_t and Δ_t^* , respectively in Table 5. We also performed the same calculations at the level of the group of developed countries (advanced_D_unweighted, advanced_D_weighted, advanced_delta_unweighted, and advanced_delta_weighted). When it comes to countries in transition, we also observed average measures at the level of convergence clubs which emerged in the results of previous analysis: *Baltic* and *Visegrad* (baltic_D_unweighted, baltic_D_weighted, baltic_delta_unweighted, baltic_delta_weighted, and visegrad_D_unweighted, visegrad_D_weighted, visegrad_delta_unweighted, visegrad_delta_weighted). Because of a pronounced volatility of Bulgarian GDP

²¹ Still, weighted income values are not used in the calculation of the Gini coefficient, as is the case with the calculation of Δ_t .

²² All the average measures are calculated without Croatia, since the data for that country are only available for the period after 2000 and so could not be included in the calculations.

per capita, we calculated average measures for the *Visegrad* convergence club within the group of countries in transition after excluding Bulgaria.

5.2 Average measures: results

The results point to the following conclusions, which are generally in line with the expectations and the findings of the previous pair-wise analysis:

- There is catching-up at the level of the sample (see EU in Table 5). Catching-up is recorded within this larger group, since there is a significant number of individual output gaps with a deterministic or a stochastic trend. In addition, three out of four measures suggest that catching-up began at the end of the 1990s.
- Long-run convergence, according to average measures, occurs in two out of three convergence clubs: in the *Advanced* club (two out of four measures point to long-run convergence at the beginning of the period) and the *Visegrad* club (excluding Bulgaria and Croatia, see note below Table 5).
- The group of *Baltic* countries record catching-up, which we explain by the lack of long-run convergence between Estonia and Latvia.

Table 5. Average measures unit root test results

Convergence club	Mean stationary	Trend stationary	Note	
eu D unweighted		1996q1 2008q3	cu	w/o Cro
eu D weighted		2000q2 2008q3	cu	w/o Cro
eu delta unweighted		1998q1 2008q3	cu	w/o Cro
eu delta weighted		1999q3 2008q3	cu	w/o Cro
advanced D unweighted	1995q1 2001q4	2002q1 2008q3	lb	
advanced D weighted		1995q1 2001q4	cu	
		2002q1 2008q3	lb	
advanced delta unweighted	1995q1 2002q1	2002q2 2008q3	lb	
advanced_delta_weighted		1995q1 2001q4	cu	
		2003q1 2008q3	lb	
baltic D unweighted		@all	cu	
baltic D weighted		@all	cu	
baltic delta unweighted		@all	cu	
baltic delta weighted		@all	cu	
visegrad D unweighted	1995q1 2005q1			w/o Cro and Bul
visegrad D weighted	@all			w/o Cro and Bul
visegrad delta unweighted	1997q1 2007q1			w/o Cro and Bul
visegrad delta weighted	@all			w/o Cro and Bul

Source: Author's calculation

Note:

1. @all stands for clubs that recorded long-run convergence, catching-up, or lagging-behind during the entire observed time interval (1995 Q1 to 2008 Q3). In other cases the time interval when clubs exhibited specified behaviours (within the observed time interval) is particularly highlighted, e.g., 1996 Q1 2008 Q3 in EU cases means that entire sample countries recorded catching-up from the first quarter of 1996 to the third quarter of 2008.
2. Because data for Croatia are available from 2000 Q1 to 2008 Q3, we had to exclude it from average measure calculations.
3. Because Bulgaria shows high volatility of per capita GDP, we calculated average measures for the *Visegrad* club after we had excluded it.
4. The table contains results of the ADF unit root test. The KPSS test confirms the findings shown here. The KPSS test points to trend-stationarity during a somewhat longer time interval (from 1995/96 until 2008) for EU countries, and mean-stationarity during the entire time interval (@all) in the case of visegrad_delta_unweighted.

6. PANEL UNIT ROOT TESTS: METHODOLOGY AND RESULTS

6.1 Panel unit root tests: methodology

Further empirical analysis of convergence is based on the implementation of the panel data and use of unit root tests. There are two reasons for this additional methodology:

1. For the pre-crisis period, only as another validation of the division of countries into three different convergence clubs, derived from the previous more extensive, more precise, and more detailed pair-wise analysis and multi-country average measures.
2. From the beginning of the global crisis, as a way to test how countries from the three clubs behaved during the crisis period. Since, from the beginning of the crisis, the time series of countries' income (and therefore of output gaps) are short, the panel is at present the only way to carry out this examination.

In panel unit root testing we use several different tests: Levin-Lin-Chu (LLC), Harris-Tzavalis (HT), Im-Pesaran-Shin (IPS), Fisher-type unit-root based on augmented Dickey-Fuller tests including drift term (Fisher), and Maddala and Wu (MW).

All of the tests are based on the null hypothesis, claiming that the observed variable (output gap between income levels of countries within groups) has a unit root. If the null hypothesis is rejected, this result leads to a conclusion consistent with our findings from the pre-crisis period: i.e., that, within every group, there are pairs of countries that have long-run convergence (that are stationary around the mean value).

Although we consider the previous two analyses - Pair-wise and Multi-country average measures - to be more reliable for testing for convergence, we do not have enough data for the crisis period to use them: which is why, with the panel approach, we are performing a first illustration of output gap behaviour during the crisis in three separate groups. This analysis is done with the sole purpose of overcoming the lack of data and achieving some sort of preliminary proof of the behaviour of these groups in the crisis period.

6.2 Panel unit root tests: results

Table 6 contains the results of the panel unit root tests applied on the data of series of country pairs grouped in three clubs, isolated in the previous analysis. The table presents the results of the tests, as an answer to our hypothesis about the existence of long-run convergence within groups. The results are given only for tests that involve a constant as the only deterministic component. The Yes answer means that the null hypothesis is rejected at the five percent significance level, and that tests clearly suggest the absence of stochastic and deterministic trends in the output gap.

Table 6. Panel unit root test results

Period Test	Advanced				Baltic		Visegrad	
	1995Q1 2008Q3	2008Q4 2013Q2			1995Q1 2008Q3	2008Q4 2013Q3	1995Q1 2008Q3	2008Q4 2013Q3
	All advanced	All advanced	Advanced w/o PIS	PIS				
LLC	No	Yes	Yes	Yes	Yes *	Yes	Yes *	Yes
HT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IPS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fisher	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MW	Yes	No	Yes	No	Yes	Yes *	Yes	No

Source: Author's calculation

Note:

1. For the pre-crisis period in the *Advanced*, *Baltic*, and *Visegrad* groups we included only gaps that we had already verified to be $I(0)$ in previous pair-wise analysis. Here we excluded Poland from the advanced group and Croatia and Bulgaria from the *Visegrad* group.
2. PIS-Portugal, Italy, and Spain.
3. Level of significance is 5%. For * 15%.
4. LLC is Levin-Lin-Chu test, HT is Harris-Tzavalis test, IPS is Im-Pesaran-Shin test, Fisher is Fisher-type unit-root test based on augmented Dickey-Fuller tests included drift term, and MW is Maddala and Wu test.

Most of the results based on the panel unit root tests suggest rejection of the null hypothesis for output gaps, which leads to the conclusion that the series of output gaps do not contain stochastic and deterministic trends: i.e., there is long-run convergence between countries within the groups. Regarding the model with individual constants, the Levin, Lin, and Chu test shows the non-stationary output gaps within the advanced group in the pre-crisis period. However, this test implies homogeneity of the autoregressive coefficient in all of the entities (in the case of convergence, this means an equal speed of

convergence in all of the panel countries). Therefore it is considered less reliable than those which are not limited in the same way.

The tests that have been done confirm previous findings about output-gaps mean-stationarity within the examined groups in the pre-crisis period.

In addition, the results have tentatively confirmed the stationarity for the second sub-period regarding the country groups. Furthermore, the data show that the countries in the advanced group can be divided into a PIS-countries group – Portugal, Italy, and Spain – and other advanced countries that have had similar income behaviour during the crisis.

7. CONCLUSION

In our paper we performed a detailed analysis of 276 time series that represent output gaps (absolute difference between per capita incomes between pairs of countries) in Europe. We used a pair-wise approach in the pre-crisis period, along with multi-country average measures and panel method, as well as panel method for the crisis period.

According to our results, catching-up dominated in Europe before the crisis. This means that the difference in per capita output between European countries mostly narrowed in the observed time period. On the other hand, during the same period long-run convergence was not significant at the sample level. Still, it is considerably present in the group of transition countries, which are divided into two groups, *Baltic* and *Visegrad+3*. A certain number of pairs in the group of advanced economies also recorded long-run convergence. The results of average dispersion measures and panel unit root tests confirm the results of the previous pair-wise analysis. Our results indicate that countries within each club had certain similarities when it came to the initial level of development and applied growth models in the pre-crisis period. In addition, it is particularly noticeable that when countries were divided into *Baltic* and *Visegrad +3* groups they were catching up with one another as well as with the *Advanced* group of countries.

From the beginning of the global crisis, panel unit root test results suggested the existence of the *Visegrad*, *Baltic*, and *Advanced* convergence clubs: i.e., the

countries belonging to each club showed a similar response to the recession regarding income behaviour. Furthermore, according to our results the *Advanced* club can be split into two subgroups: PIS (Portugal, Italy, and Greece) and others.

Therefore, our analysis confirms that 'new' EU member states recorded an indisputable catching-up with the developed part of Europe, which started considerably before they joined the EU. The pre-accession harmonization process with the implementation of major economic reforms primarily lead to the fast integration and the quick growth towards developed Europe.

Our findings also indicate that there are two different growth models within transition countries and one model for developed European countries. Developing EU countries' rapid financial integration resulted in a sudden influx of capital, creating large imbalances. This was particularly significant in the *Baltic* states, which recorded the largest CA deficits in the pre-crisis period. On the other hand, *Visegrad* had a relatively balanced and modest growth before the crisis, but much smaller declines in income than *Baltic* states during the crisis. Therefore, despite the positive results that financial liberalization and integration have had on income convergence, a huge drop in GDP and slow recovery in *Baltic* countries after the beginning of the crisis have proved that this model was unsustainable in the long run. This has stressed the need for Europe to base its future economic growth and income convergence on sound economic foundations. This implies a model of growth which would, above all, guarantee macroeconomic stability.

Overall, our results point to the conclusion that, although there are signs of the existence of long-run convergence within the three convergence clubs with similar European growth models, the obtained percentage is still not on a level which would enable us to claim that the income paths of countries that are members of a certain club will not exhibit systematic tendencies towards membership changes and divergence in the future.

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APPENDIX**Table A1. List of countries**

Country	Abbreviation
Austria	Aus
Belgium	Bel
Bulgaria	Bul
Croatia	Cro
Czech Republic	Cze
Denmark	Den
Estonia	Est
Finland	Fin
France	Fra
Germany	Ger
Hungary	Hun
Italy	Ita
Latvia	Lat
Lithuania	Lit
Luxembourg	Lux
Netherlands	Net
Norway	Nor
Poland	Pol
Portugal	Por
Slovenia	Sloven
Slovakia	Slovak
Spain	Spa
Sweden	Swe
United Kingdom	UK

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