Long term economic convergence among ten new EU member states in the light of the economic crisis

LUKA ŠIKIĆ*

Luka ŠIKIĆ
Institute of Social Sciences Ivo Pilar, Marulićev trg 19, 10000 Zagreb, Croatia
e-mail: Luka.Sikic@Pilar.hr

Abstract

This paper provides an analysis of absolute economic convergence among the group of ten new member states (NMS-10) that entered European Union in the year 2004. Convergence dynamics is estimated for the period from 1997 to 2012 as well as for two sub-periods: 1997-2007 and 2007-2012. The analysis covers aspects of sigma- (σ-) and beta- (β-) convergence. Convergence is first estimated by testing for panel unit root in GDP per capita series and then by using standard cross-section equations for absolute convergence. Different time intervals were used so that the analysis could capture the impact of the global economic crisis on long-term convergence performance among the NMS-10 countries. Our results show that this group of countries formed one homogenous convergence club during the entire observed period and achieved high convergence rates in the period before the crisis, while the level of homogeneity in the NMS-10 convergence club was significantly diminished in the period after beginning of the crisis.

Keywords: economic convergence, new member states, economic crisis, economic growth

1 INTRODUCTION

This paper analyzes absolute convergence among the ten countries that entered the European Union (NMS-10) in the year 2004. The analysis covers aspects of sigma- (σ) and beta- (β) convergence. The time frame in the analysis includes the period from 1997 to 2012, which is broken down into two sub-periods: 1997-2007 and 2007-2012. This selection of time intervals allows us to compare the convergence dynamics after the period of the initial transition phase with those of the period that began with the onset of the economic crisis. The initial transition phase is associated with the NSM-10 group moving from a socialist towards a market economy and a consequential significant loss in output. This period could be regarded as a time of intensive institutional changes and overall adverse economic conditions. The NMS-10 group did not achieve any mutual convergence during the period 1992-1997, which has therefore been characterized as a period of divergence in the European convergence process (Vojinovic and Prochniak, 2009). Kocenda (2001) analyzes real and nominal convergence for the period 1991-1998 and points to substantial output loss in the first part, but significant output resurgence in the second part of that time interval. Thus, this research first tested for a panel unit root in the time period 1997-2012 so as to check whether convergence among the NMS-10 countries occurred during that time. Since the convergence hypothesis was confirmed by various panel unit root tests, the analysis proceeded with the estimation of β-convergence rates for different time intervals by fitting a cross-section equation to the data. The results indicate a high convergence rate before the crisis and a convergence rate slowdown in the period after the crisis. There is evidence that the NMS-10 group of countries formed one homogenous convergence club throughout the whole time period that was analyzed. Estima-

tions also show that the economic crisis resulted in a reduction of homogeneity in the period 2007-2012. Moreover, all results are corroborated by σ-convergence.

After the divergence period, the NMS-10 group began to undergo dynamic economic growth, linked to their distinctly rapid mutual convergence. Deeper and more intense integration with European Union countries resulted in high economic growth rates for the NMS-10 group, rates that are comparable only with quickly growing Asian countries, which, generally speaking, are of respectable size in global terms (Cihak and Fonteyne, 2009:8). In addition to intensive mutual convergence, the NMS-10 group has also been reducing its income gap with the old European Union member states (Kocenda, Kutan and Yigit, 2006:325). Mutual convergence rates among NMS-10 group members were generally high after the initial transition period and exhibited an ascending trend in each successive sub-period until the beginning of the economic crisis.

The last time interval covered in the analysis is marked by the strong and unfavorable impact of the global economic crisis on NMS-10 countries. Our results show a slowdown in convergence dynamics in the period 2007-2012 as well as change in the structure of the NMS-10 convergence club. The dissimilar impact of the economic crisis on countries from the group and the country-specific crisis policy responses made the NMS-10 convergence club less homogenous. Prospects for renewed convergence dynamization after the onset of the crisis are not reassuring. Although the double-dip recession is over, there is still no recovery in sight (WIIW, 2013). The absence of economic growth acceleration could result in further deterioration of long-term convergence performance and jeopardize continuation of the decade-long positive trend.

Data for the analysis are taken from the IMF (2012) and relate to yearly values of GDP per capita measured at PPP for the period 1997-2012. GDP per capita at PPP value for the year 2012 is from the IMF forecast. The analysis includes the following countries: Cyprus, Czech Republic, Estonia, Hungary, Malta, Latvia, Lithuania, Poland and Slovenia. Romania and Bulgaria are excluded from the sample, although these two countries could be appended to the analyzed group since they have also been new European Union members since the year 2007. The reason for their exclusion can be found in their making the NMS-10 convergence club much more heterogeneous and in the convergence equation showing considerably worse statistical properties if done conversely. The convergence regression line for the extended group shows a much lower residual sum of squares ratio. Fit deterioration could be ascribed to Romania and Bulgaria not belonging to the same convergence club as the entrants from the year 2004 due to some structural differences. The decision to include Cyprus and Malta was made since they do not detract from the convergence club homogeneity level. However, it may be that these two countries do not fit into the analyzed group perfectly, especially due to their size and various other structural differences.

Some theoretical concepts related to the theory of economic convergence are presented in the second part of this article, after an overview of economic convergence literature regarding European transition countries, especially research that covers countries from the NMS-10 group. The third part explains the analysis of σ-convergence for the period 1997-2012. The analysis of β-convergence for the whole period as well as the two sub-periods is presented in the fourth part. The final section contains a conclusion of the article.

2 CONVERGENCE THEORY

The economic convergence debate has been one of the central issues in economic literature. Although extensively covered, the topic of economic convergence is still far from resolved. Generally, it is possible to distinguish between two major approaches in the analysis of economic convergence: the neoclassical approach and the endogenous growth approach (Temple, 1999; Durlauf and Quah, 1999; Islam, 2003). These two approaches imply different conclusions regarding the convergence process. Nevertheless, both the neoclassical and the endogenous model tend to explain reasons why income levels in different countries or regions become closer or drift away from each other. It is possible to identify four basic methodological approaches in the analysis of economic convergence: cross-section data, panel data, time series and the distributional approach (Islam, 2003: 312). In samples consisting of a homogenous group of countries or regions, the cross-section or panel data approaches are most commonly used.

Convergence analysis is mostly based on the neoclassical concept of economic growth. This type of approach assumes the convergence of all countries towards the same level of economic development, uniform agent preferences and free access to technology. Technology is the same for all countries. Technological progress is exogenous, and initial technological differences are displaced to error term (Mankiw, Romer and Weil, 1992). An additional assumption in the neoclassical analytic framework, important in the context of NMS-10 economic growth, relates to instantaneous knowledge diffusion. According to this idea, a country that opens up internationally should benefit in terms of faster economic growth and convergence. The main economic growth driver in the neoclassical model is assigned to capital accumulation, while economic convergence occurs as a consequence of diminishing capital returns. Countries with low capital reserves will benefit from higher marginal productivity of capital and higher returns on capital. This implies swift capital accumulation and faster economic growth in poorer countries. Neoclassical models therefore predict that countries will converge in the long run.

On the other hand, endogenous models do not necessarily predict income convergence between poor and rich countries or regions. This analytical approach considers different growth paths between countries (Grossman and Helpman, 1991; Barro and Sala-i-Martin, 1992; Temple, 1999). The assumption of diminishing

marginal returns on capital may not hold (Romer, 1986). Assuming that human capital plays a major role in economic growth (Lucas, 1988), lack of competence, knowledge and skills can cause income to diverge between countries. Endogenous models therefore center on R&D and regard it as the main factor to explain technological and income differences in the world. The aim of this theory is accordingly to explain how the process of knowledge and technology accumulation works. The substantive difference between the endogenous and neoclassical growth models can be found in the role of economic policy. Given that poorer countries grow faster than rich ones, policies have no influence on long-term economic growth in the neoclassical framework. Conversely, active support of technological innovations in endogenous models will lead to higher growth. In this way, it is possible to have convergence between countries in endogenous growth models.

Beta-convergence denotes the concept of income catch-up between poor and rich countries because poor countries tend to grow faster than rich ones (Sala-i-Martin, 1994; 1996). The existence of β-convergence is confirmed when beta-coefficient in a convergence equation has a negative value. The countries from the analyzed sample with lower initial incomes and lower development levels tend to grow faster in that case. This type of relation implies a negative relationship between the initial income level and average economic growth. Convergence dynamics is determined by the β coefficient from the convergence equation and describes the rate at which the country approaches a stationary state.

It is possible to distinguish between two concepts of β-convergence: absolute and conditional. Absolute convergence assumes that the countries from the analyzed group have the same characteristics and the same stationary state. In the case of a heterogeneous sample, an additional cluster of proxy variables is used to control for stationary state, and the convergence equation gets more terms. Conditional convergence is analyzed then. In the evaluation of conditional convergence, parameters such as investment rate, human capital, and political and institutional variables are added to the convergence equation. These parameters condition provide the conditions for a stationary state in each country and possibly vary from country to country. Therefore, the concept of conditional convergence relates to convergence towards different stationary states, while absolute convergence assumes that all countries converge towards a common stationary state. Moreover, conditional convergence implies that different countries achieve different income levels in the stationary state. This idea refers to the concept of convergence clubs (Baumol, 1986). Countries that form one convergence club have to be very similar in terms of historical, political and economic traits or have to be implementing institutional harmonization according to equal criteria.

The concepts σ- and β-convergence are in many respects very close. The assumption behind the σ-convergence concept is that income dispersion among the analyzed group of countries or regions falls through time. Beta-convergence is in

this way conditioned by the existence of σ-convergence. The reverse case need not be confirmed, or said differently; it is not possible to have β-convergence and σ-divergence at the same time. There is a very strong objection to the concept of β-convergence in that regard, because it is at the same time equally compatible with diminishing and growing income inequalities (Quah, 1993; 1996). It could be said that σ-convergence is a qualitative indicator of economic growth.

2.1 CONVERGENCE IN EUROPEAN TRANSITION COUNTRIES

Empirical research into economic convergence that relates to European transitional countries could be distinguished with respect to the group covered in the analysis, the time frame and the goals of the analysis. Ingianni and Zdarek (2009) recognize three main approaches in the analysis of economic convergence for this set of countries. The first approach includes the analysis of long-term growth rates through the aspects of σ- and β-convergence, the second avenue centers on a wider spectrum of macroeconomic indicators in relation to the convergence process, and the last one analyzes the post-transition convergence period in differently defined groups of countries and the relation of convergence dynamics between these and the old European member states. Extension of this classification to other areas of research would relate to optimal currency area convergence (Horvath, 2003), fiscal convergence (Kocenda, Kutan and Yigit, 2008) and various other aspects of nominal and real convergence (EEAG, 2004; ECB, 2007). Comprehensive and systematic coverage of the topics related to real convergence in Central, Eastern and South-Eastern Europe can also be found in Martin and Winkler (2009).

Kocenda (2001) confirms the existence of convergence in various structural macroeconomic indicators for the CEE group of transition countries. Faster convergence was observed in countries with similar institutional characteristics, and the most homogenous group of countries turned out to be Baltic group. The strongest convergence was found in output growth rates, while levels of production and consumption prices converged more slowly. Kocenda (2006) thoroughly analyzes real and nominal convergence in different macroeconomic parameters towards European levels for the ten new member states. His results show slow and steady convergence in per capita income but very dynamic nominal convergence, especially in interest rates and inflation level indicators.

Vojinovic and Oplotnik (2008) analyze real convergence for the group of countries that became members of European Union in year 2004. Their analysis covers the period 1992-2006 as well as various sub-periods. The authors use both cross-section and panel data in their study of β-convergence to get more stable results. After the period 1992-1997, for which convergence could not be confirmed, evidence of β-convergence speed-up was found in each successive future sub-period: 1996-2006 – 3.23%, 2002-2006 – 6.51% and 2004-2006 –7.46%. The study also confirms the existence of σ-convergence for the entire analyzed period.

An extensive analysis of the convergence process in 27 European transition countries and the respective constituent regional groups (CEE-8, CEE-10, CIS-12, CSEE-15) is given in Rapacki and Prochniak (2009). Absolute σ- and β-convergence is confirmed for the whole transitional group, but statistically significant results include the period 2000-2005, when convergence rate amounted to 1.39%. The authors are unable to confirm convergence for the CIS-12 group. Although the analysis for the period 1990-2005 shows statistically significant β-convergence, the results do not confirm the parallel existence of σ-convergence after the year 1998. There is also evidence of a meaningful slowdown in β-convergence dynamics for the group after the year 2000. On the other hand, the analysis of real convergence for the Balkan states in relation to European Union countries for the period 1989-2005 reveals a diminution of the development gap after the period 1991-1993 (Kapetanovic and Ouardighi, 2008). The most homogenous group among the 27 transition countries is CEE-10 or the more restrictively defined CEE-8 group. Beta-convergence is confirmed for both groups, and regression coefficients show faster convergence in CEE-8.

Vojinovic, Acharya and Prochniak (2009) investigate real convergence for the ten new member states of European Union. They confirm convergence on cross-section data for the whole analyzed period and other sub-periods except 1992-1997. Beta-convergence for the period 1992-2006 is 4.2%, in the sub-period 1995-2006 the β-rate advances to 7.0%, while in 2002-2006 β-convergence reaches the very high level of 9.6%. The authors use panel data for conditional convergence estimation. The panel data results show the existence of conditional convergence but not absolute convergence. The hypothesis of equal β-convergence rate for different time periods has also been tested. An F-test could not confirm statistically significant β-convergence rate differences among various time intervals. Finally, the conclusion is that there is no systematic acceleration of β-convergence in each successive period. The authors remark that, although the test shows no sign of the β-rate picking up in successive periods, the convergence rates for 1995-2006 and 2002-2006 are higher than in the entire period covered in the analysis.

A study by Prochniak (2011) of economic growth determinants for the ten new member states in the period 1993-2009 shows that investment, human capital evaluated according to educational level of the labor force, financial sector development, good fiscal position, low inflation rate and low interest rates, demographic structure, the level of IT and communication technology development, the share of the private sector in GDP and institutional conditions have the most important impact on growth performance. The income convergence hypothesis is confirmed for the whole analyzed interval, even if the economic crisis period is included in the analysis. Including the economic crisis period, Bucur (2012) analyzes convergence dynamics for new and old European Union countries as well as their mutual convergence. Her results show convergence slowdown in

each successive period (1999-2010, 2004-2010 and 2007-2010) between the two groups and within each group.
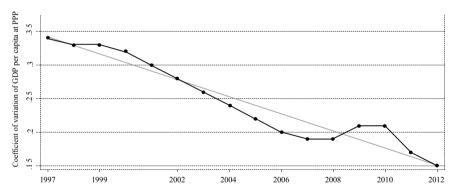
3 SIGMA-CONVERGENCE IN THE PERIOD 1997-2012

Sigma-convergence refers to the tendency of income dispersion to decrease over time and between countries. It is measured by estimating either the standard deviation of income (SD) or the variation of the income coefficient. The methods yield similar results. The concept of σ-convergence analyzed as a variation of income coefficient is accepted here:

$$CV = \frac{SD}{Mean} \tag{1}$$

Income is represented by GDP per capita measured at PPP. An overview of σ-convergence is given in figure 1. The results show the coefficient of income variation trend for the NMS-10 group. Here the existence of σ-convergence for the whole analyzed period can be seen. Income differences in this group of countries have been narrowing during the period 1997-2012.

FIGURE 1
σ-convergence for GDP per capita at PPP in NMS-10 countries, 1997-2012

Source: Data were compiled from the IMF (2012).

A more detailed view of these results reveals more rapid σ-convergence dynamics in the period 1999-2007. There has been a significant and rapid reduction in income differences between NMS-10 countries during that time span. The implementation of intensive market-oriented measures in the initial transition period, beneficial economic conditions in the surrounding countries and preparations for European membership all stand in the background of these developments. Out of the factors listed, the accession process and related membership preparations should be underlined. The positive effects of European membership for the NMS-10 countries could be associated with higher intensity of capital and services exchange, increased trade and generally, various institutional adjustments. Institu-

tional convergence is mainly related to the legal, regulatory and policy framework and originates from acceptance of the Maastricht criteria, the Lisbon Agenda, the Stabilization and Association Agreement, different policies for financial integration and various other prudential measures (Cihak and Fonteyne, 2009:13).

The period of unfavorable σ-convergence tendencies refers to the time after the year 2007. Income dispersion in the NMS-10 countries tends to widen in that period. Particularly strong negative movements can be seen in the period 2008-2010, when the economic crisis had the strongest impact on NMS-10 economies. The economic crisis returned the coefficient of income variation to levels from around the year 2002. This could be seen as a consequence of a very deep and long-term crisis manifestation in this group of countries as well as the absence of new economic growth.

3 BETA-CONVERGENCE

Because the NMS-10 group consists of countries with similar structural characteristics, this analysis continues with the estimation of absolute β-convergence. Since the analyzed time frame in large part covers the accession period of NMS-10 to the European Union and legal, institutional and economic harmonization based on equal principles, the assumption of a homogenous sample makes sense. Enlargement transmission effects also extend to the after-the-accession period and are mainly reflected in a speed-up of structural reforms, various institutional improvements, facilitation of the flow of goods and services, as well as the activation of European policies for the reduction of income disparities (Vojinovic and Oplotnik, 2008:24). Critiques related to heterogeneities in countries that became members earlier (Greece, Ireland, Spain) and their mutually divergent growth paths are not applicable to the NMS-10 group. That is, the NMS-10 countries implemented institutional and economic standards in the pre-accession period that prepared them much more adequately for membership, and the *acquis communautaire* was by then substantially more demanding than in previous decades (Varblane and Vahter, 2005:42).

The methodological approach used for convergence analysis here consists of panel as well as cross-section data. Beta-convergence for the NMS-10 countries was first analyzed by testing for a panel unit root in log of GDP per capita series and then by fitting a cross-section convergence equation (average yearly GDP growth rates are regressed on GDP levels at the beginning of the period) to the data. Different panel unit root tests are applied to estimate whether these countries displayed mutual convergence in the entire analyzed period (1997-2012). The convergence rate is estimated based on cross-section data for the whole period as well as for the two sub-periods. The examination of different time periods enables the comparison of the convergence rate during the whole analyzed period with the intervals from before and after the economic crisis. Two methods of computation are used for the sake of mutual verification of results.

Panel unit root is tested by applying the following Augmented Dickey Fuller type equation:

$$\Delta y_{i,t} = \alpha_i + \left(\rho_i - 1\right) y_{i,t-1} + \sum_{j=1}^{p} \varphi_{i,j} \, \Delta y_{i,t-j} + \varepsilon_{i,t} \qquad (2)$$

or written differently,

$$\Delta y_{i,t} = \alpha_i + \beta_i \, y_{i,t-1} + \sum_{j=1}^{p} \varphi_{i,j} \, \Delta y_{i,t-j} + \varepsilon_{i,t} \qquad (3)$$

for $i = 1, 2, \ldots, N$ and $t = 1, 2, \ldots, T$. The panel unit root hypothesis, meaning $\rho_i = 1$ in (2), implies that $\beta_i = 0$ in (3), for all i. If the T dimension is large enough, this can be tested by using the t-ratio for β_i and the non-standard critical values. Levin, Lin and Chu (2002) (LLC), propose a model where the coefficients are homogeneous for all panel units, namely $\beta = \beta_i \, \forall_i$. The model takes the following form:

$$\Delta y_{i,t} = \alpha_i + \beta \, y_{i,t-1} + \sum_{j=1}^{p} \varphi_{i,j} \, \Delta y_{i,t-j} + \varepsilon_{i,t} \qquad (4)$$

LLC suggest a test for the null hypothesis, $H_0 : \beta = 0$, against the alternative where $\beta < 0$ for all $i = 1, \ldots, N$. The test is proposed under the condition that N and T go to infinity with $\sqrt{N}/T$ going to zero. Im, Pesaran and Shin (2003) (IPS), devise a test where autoregressive coefficients are allowed to vary across panels. Coefficients can differ across panels due to various cultural, institutional, and other factors that are country-specific. IPS use (3) to estimate the average ADF statistic (t-ratio for β_i) and give simulated test statistics. This allows for the testing of the hypothesis $H_0 : \beta_i = 0$ for all i against the alternative $\beta_i < 0$ for some i. The alternative hypothesis is that only one part of the panels that are stationary is nonzero. Maddala and Wu (1999) point out that imposing homogeneity on all panel coefficients is an overly restrictive approach and agree that heterogeneous coefficients serve as a better option. However, their suggestion is to use a Fischer-type test. This combines the p-values from independent tests to obtain an overall test statistic:

$$P = -2 \sum_{i=1}^{N} \left(\ln p_i \right).$$

Under the null hypothesis of $p_i = 0$ for all i, P is distributed $\chi^2 (2N)$. The Breitung test (Breitung, 2000) adjusts the data before fitting the regression and in that way avoids the necessary bias adjustments that are common to LLC tests. This test has high power even in small samples but tends to deteriorate when T is fixed and N is increasing. It assumes an error structure that is uncorrelated across panels and time.

To test convergence, the baseline methodology proposed by Ben-David (1996) is followed here. The convergence equation assumes the following form:

$$\Delta\left(y_{i,t} - \overline{y}_t\right) = \alpha_i + \beta_i\left(y_{i,t-1} - \overline{y}_{t-1}\right) + \sum_{j=1}^{p}\phi_{i,j}\,\Delta\left(y_{i,t-j} - \overline{y}_{t-j}\right) + \delta_i'x_{i,t}' + \varepsilon_{i,t} \qquad (5)$$

$y_{i,t}$, $i = 1, \dots, N$ and $t = 1, \dots, T$, represents the log of real GDP per capita measured at PPP in country i at time t, and $\overline{y}_t$ is the group average of the log of real per capita GDP measured at PPP at time t. Vector x allows for the inclusion of panel-specific means and linear-time trends. Testing convergence relates to estimating whether the series $(y_{i,t} - \overline{y}_t)$ for N countries contains a unit root or not. If the null hypothesis $\beta_i = 0$ cannot be rejected, there is a unit root in the time series $(y_{i,t} - \overline{y}_t)$. This is the indication that per capita incomes do not converge over time. On the other hand, if β_i is significantly less than zero, the time series is said to be stationary and per capita income convergence can be confirmed.

TABLE 1

Panel unit root test for absolute convergence among NMS-10, 1997-2012

Method	Statistic			p-value
LLC	Adjusted t*		-3.5339	0.0002
Fisher test	Inverse chi-squared (20)	P	50.3146	0.0002
	Inverse normal	Z	-3.5974	0.0001
	Inverse logit t (54)	L*	-3.8729	0.0001
	Modified inv. chi-squared	Pm	4.7932	0.0000
IPS	W-t-bar		0.0777	0.5310
Breitung test	Lambda		-2.5612	0.0052

Source: Calculations based on data from the IMF (2012).

LLC and Breitung tests make the assumption of a common autoregressive parameter across all panels, while IPS allow for an autoregressive term to be determined for each panel specifically. Various tests also make different assumptions about the rate at which the number of panels, N, or number of time periods, T, tend towards infinity or whether N or T is fixed. This analysis uses a data set where the T dimension increases faster than N and N is also fixed. Therefore, panel unit root tests that accommodate those criteria as closely as possible are chosen. Generally, the data sample in the analysis is of a somewhat smaller size than each of the above-listed tests would suggest. Our results could suffer from some loss of statistical power because of this. The optimal lag selection in this estimation procedure was chosen by AIC criteria. The time trend has been included in the testing procedure. Cross-section averages have been subtracted in order to mitigate the impact of cross-sectional dependence.

LLC's test shows the adjusted test statistic $t^* = -3.5339$, which is significantly less than zero ($p < 0.0002$) so the null hypothesis of the unit root in log GDP per capita series is rejected in favor of the alternative that all series are stationary. This conclusion supports the convergence hypothesis for the NMS-10 group of countries.

The Fisher test combines the p-values obtained from the panel-specific unit root tests into one overall statistic. The null hypothesis in the Fisher test is that all panels contain a unit root. An alternative hypothesis for a finite number of panels is that at least one panel is stationary. All test statistics strongly reject the null hypothesis that all panels contain unit roots.

The IPS test assumes independently and normally distributed errors across panels and through time but allows the error term to have heterogeneous variances across panels. The biggest difference from other tests is that IPS allows for a panel-specific autoregressive parameter. In table 1 the test produces the IPS W-t-bar statistic. This statistic has an asymptotically standard normal distribution when $T \to \infty$ followed by $N \to \infty$. This means that the test requires a large cross-section and time dimension so that our sample might not fit the asymptotic properties of the test well and could have low statistical power in that respect. Since the W-t-bar statistic = 0.0777 is not significant at the 10% level (p-value = 0.5310), the null hypothesis that all panels have unit root cannot be rejected. The alternative hypothesis for the IPS test is that fraction of panels are stationary.

The Breitung test has high power even in small samples and prefers situations when the T dimension is not fixed. Therefore, it fits our sample well. It assumes uncorrelated errors across panels and through time. The test shows the lambda statistic = -2.5612 and the associated p-value = 0.0052. This result is taken as support for the convergence hypothesis among the NMS-10 group.

The different panel unit root tests have different asymptotic properties and cannot be directly compared. Another issue is whether our sample size matches various test requirements. It could be that the displayed results are somewhat weakened by the small sample size. However, three out of four tests show significant support for income convergence among NMS-10 countries in the period 1997-2012. Only the IPS panel unit root test rejects stationarity. In consequence of all test results, the conclusion is drawn that the convergence hypothesis holds.
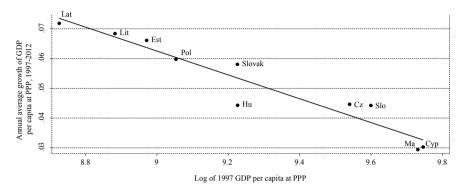
The rate of β-convergence for different time periods is estimated on cross-section data in the following part. The equation for cross-section data takes the following form:

$$\frac{1}{T}\log\frac{y_{i,T}}{y_{i,0}} = \alpha_0 + \alpha_1 \log y_{i,0} + \varepsilon_i$$

(6)

in which $\log y_0$ and y_T stand for the natural logarithms of GDP per capita measured at PPP in country i for the first and last year in given time period while T represents the length of the time interval.

Since

$$\alpha_i = -\left(\frac{1 - e^{-\beta T}}{T}\right)$$, the rate of β-convergence is calculated as

$$\beta = -\frac{1}{T}\log(1 + \alpha_1 T)$$. Convergence is verified if coefficient $\alpha_1 < 0$ in equation (6).

FIGURE 2

Absolute β-convergence based on cross-sectional data, 1997-2012

Source: Data were compiled from the IMF (2012).

Results are shown in figures 2, 3 and 4 as well as in tables 2, 3 and 4. Figures 2, 3 and 4 depict the ratio of average GDP per capita at PPP growth rate and initial-period GDP per capita at PPP for the NMS-10 countries. These results are calculated on cross-section data. Tables 2, 3 and 4 show the estimates of β-convergence. The dependent variable is the average yearly GDP per capita at PPP growth rate, while the initial-period GDP per capita at PPP is the independent variable. A negative regression line slope is shown on every figure. This is an indication of the existence of β-convergence among the NMS-10 countries in every period covered in the analysis. It implies a tendency of long-term income leveling in the group.

TABLE 2

Linear regression model of β-coefficients for the EU-10 countries, 1997-2012

	Estimate	**Std. error**	**t-value**	**p-value**
Intercept	0.4235	0.0403	10.49	0.000
GDP in initial period	-0.0401	0.0043	-9.21	0.000

R-squared: 0.913   *Adjusted R-squared: 0.903*
F-statistic: 84.86 on 1 and 8   *p-value: 0.000*
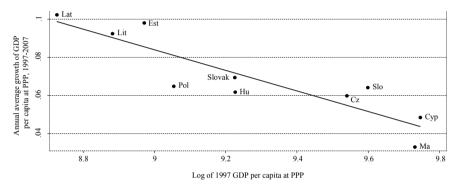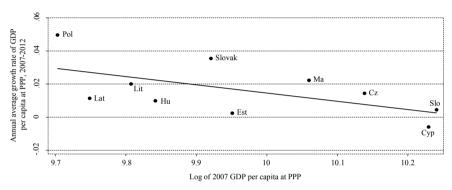*Implied convergence rate: 6.1%*

Source: Calculations based on data from the IMF (2012).

It can be seen that regression line y = -0.040x + 0.423 (R-sq = 0.9139) from figure 2 fits the data very well. The equation shows the existence of β-convergence. The

R-sq coefficient has a high value, so a lot of residual deviations seem to be captured by the regression line. This could be understood as a sign of the NMS-10 group having been a considerably homogenous convergence club throughout the whole time period 1997-2012.

The results presented in table 2 show a rapid β-convergence rate equal to 6.1% for the period 1997-2012. The regression coefficients are highly significant (p-value = 0.000), and the residual deviations coefficient also shows high value. It can be concluded that convergence among the NMS-10 countries in the period 1997-2012 existed, that it was rapid, and that the countries from the sample formed one homogenous convergence club.

FIGURE 3

Absolute β-convergence based on cross-sectional data, 1997-2007

Source: Data were compiled from the IMF (2012).

Figure 3 depicts the regression equation y = -0.054x + 0.570 (R-sq = 0.7999) for the period 1997-2007. This is a period of intensive economic growth and rapid convergence dynamics among the NMS-10 countries. The convergence rate is higher in this period than for the time interval 1997-2012. A high R-sq coefficient in the period 1997-2007 can be seen, but it is somewhat lower than for the entire analyzed period. Obviously, the period of economic expansion is marked by some countries growing faster than others.

Table 3 gives cross-section regression results for the period 1997-2007. Here a 7.7% β-convergence rate has been observed. The period from after-the-transition until the beginning of the economic crisis is characterized by positive convergence performance in the NMS-10 group. Convergence regression has good statistical properties, p-values for respective coefficients show a high significance of regression parameters and the R-sq ratio is also high.

TABLE 3

Linear regression model of β-coefficients for EU-10 countries, 1997-2007

	Estimate	**Std. error**	**t-value**	**p-value**
Intercept	0.5707	0.0887	-6.43	0.000
GDP in initial period	-0.0540	0.0095	-5.66	0.000

R-squared: 0.799   *Adjusted R-squared: 0.775*
F-statistic: 31.99 on 1 and 8   *p-value: 0.0005*
Implied convergence rate: 7.7%

Source: Calculations based on data from the IMF (2012).

FIGURE 4

Absolute β-convergence based on cross-sectional data, 2007-2012

Source: Data were compiled from the IMF (2012).

The results for the period after the onset of the crisis are shown in figure 4. Parameters from regression line y = -0.0497x + 0.512 (R-sq = 0.3509) are not significant at the 5% level, and this is also accompanied by a low R-sq ratio. It is possible to see a slowing down of β-convergence in the period after the crisis began, compared to both 1997-2012 and 1997-2007 periods. The low R-sq ratio can be interpreted as an indication of NMS-10 convergence club homogeneity dissipation due to unequal economic crisis impact on countries from the group. The NMS-10 countries have responded to the crisis with unequal economic policies. This also in part explains the weakening of the convergence indicators. NMS-10 convergence club homogeneity reduction could also indicate a decline in the institutional impact of the European Union on this group respective to the crisis. That would be particularly upsetting since institutional harmonization played a pronounced role in stimulating economic convergence in the past.

TABLE 4

Linear regression model of β-coefficients for EU-10 countries, 2007-2012

	Estimate	Std. error	t-value	p-value
Intercept	0.5123	0.2385	2.15	0.071
GDP in initial period	-0.0497	0.0239	-2.08	0.064

R-squared: 0.351   *Adjusted R-squared: 0.2697*
F-statistic: 4.32 on 1 and 8   *p-value: 0.0712*
Implied convergence rate: 5.7%

Source: Calculations based on data from the IMF (2012).

The convergence rate levels off in the period 2007-2012, especially in comparison to the previous sub-period. The results depicted in table 4 are weaker than in previous periods. Regression coefficients show worse significance indicators; results could be confirmed on 10% significance levels only (p-values for the first and second sub-period equal 0.710 and 0.064, respectively). Convergence deceleration is observed because the β-coefficient for the whole time period 1997-2012 is 6.1%, while in the sub-period 1997-2007 it reaches 7.7%. It is therefore obvious that a convergence slowdown appears in the last period. Low regression coefficient significance is also flanked by a low R-sq ratio.

FIGURE 5

GDP growth rates in NMS-10 countries, 1997-2012

Source: Data were compiled from the WIIW (2013).

The given results match the fact that the convergence among the NMS-10 countries in the period 1997-2012 outperformed that in the old member states, so their mutual income differences became lower (European Commission, 2006). The effects of transition reforms in the NMS-10 countries and European policies with respect to these countries produced good economic results, especially in the rapid convergence period that started around the year 1997 and ended with the begin-

ning of the economic crisis a decade later. The economic crisis had an adverse reflection on the NMS-10 countries. Output losses were big, and in the post-crisis period they have failed to show the kinds of growth rates that were observed in the past. Nevertheless, the results for the entire period covered in this analysis allow us to make positive conclusions about the long-term convergence process.

Figure 5 depicts GDP growth rates for the analyzed countries in the period 1997-2012. One can see that the economic crisis had a diverse and negative impact on growth rates among the NMS-10 countries. As shown previously, this has been reflected in the NMS-10 countries becoming a less homogenous convergence club. Since this convergence club was formed more than decade-and-a-half ago, the economic crisis threatens to become the turning point in this long-term positive macroeconomic trend. Results imply this as regression coefficients show low significance levels and the R-sq ratio falls considerably in the period after the onset of the crisis. Decline in NMS-10 convergence club homogeneity can be an issue of particular concern for future European member states. Absolute convergence slowdown in the NMS-10 group therefore implies greater incentive for growth-inclined economic policies in its constituent and future members. This could be a way to compensate for slowdown in respective convergence dynamics. In the event of proper policy response failures, the economic crisis could further develop into a long-term negative inflection point causing growth rates to slow down and the positive convergence trend to vanish. Such a perspective would also conflict with efforts to equalize income differences in the European Union.

4 CONCLUSION

This paper analyses aspects of σ- and β-convergence among the NMS-10 countries. The analysis covers the 1997-2012 period as well as two sub-periods: 1997-2007 and 2007-2012. Setting up the time framework in this way allows for the exclusion of an adverse initial transition period so that long-term convergence could be put in the context of the recent economic crisis. The results confirm both σ- and β-convergence among the NMS-10 countries in period 1997-2012. During this period, β-convergence reaches 6.1%. Rapid convergence occurs in the 1997-2007 period and amounts to 7.7%. These results are also confirmed by various panel unit root tests, which indicate that the GDP per capita series exhibited mutual convergence in the period 1997-2012. Similar results are found in other economic convergence studies for this or similarly-defined groups of countries. The time of rapid convergence could be related to positive growth in the initial transition period and the beneficial impact of preparation and European membership afterwards. Since convergence was faster in each successive year until the beginning of the crisis, the European integration process could be described as having had positive economic results.

The economic crisis has had a very deep, prolonged negative impact on the NMS-10 group that could be described as a double dip with slow recovery. Additionally,

the crisis had varying impacts on the countries from the analyzed sample. Some countries experienced very big output losses, while others fared much better. This has been reflected in the convergence performance results for the period 2007-2012. Regression equations for that period show a deterioration of some statistical indicators, the parameters have low significance levels and the R-sq coefficients indicate a bad fit. Therefore, the economic crisis has resulted in a reduction of NMS-10 convergence club homogeneity. Nevertheless, the crisis did not stop convergence dynamics, it only slowed them down. This can be seen from the relation between the β-convergence rate in the entire analyzed period and the sub-period 1997-2007.

The results of this analysis should also be considered in the context of further European enlargement. The economic convergence slowdown in the NMS-10 convergence club implies the necessity of economic growth stimulation policies in order for these negative trends to be compensated for. The economic growth rate deceleration and the related convergence slowdown imply that the reduction of income differences between old and new European member states could come to a standstill. This stands in opposition to the European Union's efforts towards regional and income equalization and calls for measures to avert this trend.

REFERENCES

1. Barro, R. J. and Sala-i-Martin, X., 1992. Convergence. *Journal of Political Economy*, 100(2), pp. 223-251. doi:10.1086/261816

2. Baumol, W. J., 1986. Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show. *American Economic Review*, 76(5), pp. 1072-1085.

3. Ben, D. D., 1996. Trade Convergence among Countries. *Journal of International Economics*, 40(3-4), pp. 279-298. doi: 10.1016/0022-1996(95)01405-5

4. Breitung, J., 2000. The local power of some unit root tests for panel data. In: Badi H. Baltagi, Thomas B. Fomby, R. Carter Hill, eds. *Advances in Econometrics*, Volume 15: Nonstationary Panels, Panel Cointegration, and Dynamic Panels. Amsterdam: JAI Press. pp.161-177. doi: 10.1016/S0731-9053(00)15006-6

5. Bucur, A.I., 2012. National and Regional Coordinates of the Real Convergence Process Intensity in the Enlarged European Union. *CES Working Papers* [online]. Available at: <http://cse.uaic.ro/WorkingPapers/articles/CESWP2012_IV3_BUC.pdf>.

6. Cihak, M. and Fonteyne, W., 2009. Five Years After: European Union Membership and Macro-Financial Stability in the New Member States. *IMF Working Paper*, No. 0968 [online]. Available at: <http://www.imf.org/external/pubs/ft/wp/2009/wp0968.pdf >.

7. Durlauf, S. N. and Quah, D. T., 1999. The new empirics of economic growth. In: J. B. Taylor and M. Woodford, eds. *Handbook of Macroeconomics*. Amsterdam: Elsevier. doi: 10.1016/S1574-0048(99)01007-1

8. ECB, 2007. Determinants of Growth in The Central and Eastern European EU Member States – A Production Function Approach. *Occasional Paper Series* [online]. Available at: <http://www.ecb.int/pub/pdf/scpops/ecbocp61.pdf>.

9. EEAG, 2004. *Report on the European Economy 2004*. Munich: CESifo [online]. Available at: <http://blog.iese.edu/xvives/files/2011/09/54.pdf>.

10. European Commission, 2006. Enlargement, two years after: an economic evaluation. *Occasional Papers* [online]. Available at: <http://ec.europa.eu/economy_finance/publications/publication7548_en.pdf>.

11. Grossman, G. and Helpman, E., 1991. *Innovation and Growth in the World Economy.* Cambridge: The MIT Press.

12. Harris, R. D. F. and Tzavalis, E., 1999. Inference for unit roots in dynamic panels where the time dimension is fixed. *Journal of Econometrics*, 91(2), pp. 201-226. doi: 10.1016/S0304-4076(98)00076-1

13. Horvath, J., 2004. Optimum currency area theory: a selective review. *Macroeconomics 0401014, EconWPA* [online]. Available at: <http://128.118.178.162/eps/mac/papers/0401/0401014.pdf>.

14. Im, K. S., Pesaran, M. H. and Shin, Y., 2003. Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, 115(1), pp. 53-74. doi: 10.1016/S0304-4076(03)00092-7

15. IMF, 2012. *World Economic Outlook Database.* Washington: International Monetary Fund.

16. Ingianni, A. and Zdarek,V., 2009. Real Convergence in the New Member States: Myth or Reality? *Journal of Economic Integration*, 24(2), pp. 294-320. doi: 10.11130/jei.2009.24.2.294

17. Islam, N., 2003. What Have We Learnt from the Convergence Debate? *Journal of Economic Surveys*, 17(3), pp. 309-362. doi: 10.1111/1467-6419.00197

18. Kapetanovic, S. R. and Ouardighi, E. J., 2008. Do Balkan Countries Have a European Future? An Analysis of Real Economic Convergence, 1989-2005. *South East European Journal of Economics and Business*, 2(2), pp. 23-30.

19. Kocenda, E., 2001. Macroeconomic Convergence in Transition Countries. *Journal of Comparative Economics*, 29(1), pp. 1-23. doi: 10.1006/jcec.2000.1696

20. Kocenda, E., Kutan, M. A. and Yigit, T. M., 2006. Pilgrims to the Eurozone: How far, how fast? *Economic Systems*, 30(4), pp. 311-327. doi: 10.1016/j.ecosys.2006.07.003

21. Kocenda, E., Kutan, M. A. and Yigit, T. M., 2008. Fiscal convergence in the European Union. *The North American Journal of Economics and Finance*, 19(3), pp. 319-330. doi:10.1016/j.najef.2008.06.003

22. Levin, A., Lin, C. F. and Chu, C. S. J., 2002. Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics*, 108(1), pp. 1-24. doi: 10.1016/S0304-4076(01)00098-7

23. Lucas, R.E., 1988. On the mechanics of economic development. *Journal of Monetary Economics*, 22(1), pp. 3-42. doi: 10.1016/0304-3932(88)90168-7

24. Maddala, G. S. and Wu, S., 1999. A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics*, 61(0), pp. 631-652. doi: 10.1111/1468-0084.0610s1631

25. Mankiw, G., Romer D. and Weil, D., 1992. A contribution to the empirics of economic growth. *Quarterly Journal of Economics*, 107(2), pp. 407-437. doi: 10.2307/2118477

26. Martin, R. and Winkler, A., 2009. *Real Convergence in Central, Eastern and South-Eastern Europe.* London: Palgrave Macmillan. doi: 10.1057/9780230235434

27. Prochniak, M., 2011. Determinants of economic growth in Central and Eastern Europe: the global crisis perspective. *Post-Communist Economies*, 23(4), pp. 449-468. doi: 10.1080/14631377.2011.622566

28. Quah, D. T., 1993. Empirical Cross-section Dynamics in Economic Growth. *European Economic Review*, 37(2-3), pp. 426-434. doi: 10.1016/0014-2921 (93)90031-5

29. Quah, D. T., 1996. Empirics for Economic Growth and Convergence. *European Economic Review*, 40(6), pp. 1353-1375. doi: 10.1016/0014-2921(95) 00051-8

30. Rapacki, R. and Prochniak, M., 2009. Real beta and sigma convergence in 27 transition countries, 1990-2005. *Post-Communist Economies*, 21(3), pp. 307-326. doi: 10.1080/14631370903090616

31. Romer, P. M., 1986. Increasing returns and long run growth. *Journal of Political Economy*, 94(5), pp. 1002-1037. doi: 10.1086/261420

32. Sala-i-Martin, X., 1994. Cross-sectional regressions and the empirics of economic growth. *European Economic Review*, 38(3-4), pp. 739-747. doi: 10.1016/0014-2921(94)90109-0

33. Sala-i-Martin, X., 1996. Regional cohesion: evidence and theories of regional growth and convergence. *European Economic Review*, 40(6), pp. 1325-1352. doi: 10.1016/0014-2921(95)00029-1

34. Temple, J., 1999. The new growth evidence. *Journal of Economic Literature*, 37(1), pp. 112-156. doi: 10.1257/jel.37.1.112

35. Varblane, U. and Vahter, P., 2005. An analysis of the economic convergence process in the transition countries. *Faculty of Economics and Business Administration Working Paper Series 37* [online]. Available at: <http://infutik.mtk.ut.ee/www/kodu/RePEc/mtk/febpdf/febawb37.pdf>.

36. Vojinovic, B. and Oplotnik, J. Z., 2008. Real convergence in the new EU member states. *Prague Economic Papers, University of Economics*, 2008(1), pp. 23-39 [online]. Available at: <http://www.vse.cz/pep/abstrakt.php?IDcl =317>.

37. Vojinovic, B. and Prochniak, M., 2009. Divergence Period in the European Convergence Process. *Transition Studies Review*, 15(4), pp. 685-700. doi: 10.1007/s11300-008-0037-y

38. Vojinovic, B., Acharya, S. and Prochniak, M., 2009. Convergence Analysis among the Ten European Transition Economies. *Hitotsubashi Journal of Economics*, 50(2), pp. 17-35.

39. WIIW, 2013. *Double-dip Recession over, yet no Boom in Sight 39* [online]. Available at: <http://wiiw.ac.at/double-dip-recession-over-yet-no-boom-in-sight-p-2799.html>.