

# CONVERGENCIA ECONOMIA: UNIT ROOT TESTS IN PANEL DATA

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## Abstract:

The transition process in the Central and Eastern European (CEE) countries offers a unique opportunity to investigate whether these economies tend to eliminate economic disparities during the transition process. We carry out a quantitative analysis to test for Co-movements. This paper analyzes the performance of Co-movements in Growth of the Money Supply in the of the old members of the EU, CEE economies and countries which are in the group of possible new-round EU candidate countries, in terms of their Co-movements in Growth of this aggregate. The analysis is carried out within a group of new EU members to reflect different institutional and geographical aspects of transition. We have found evidence of Co-movements in Growth of the Money Supply among the CEE countries in general and have shown that common institutional attributes and economic policies tend to correlate with a higher degree of convergence. However, the strength of the results differs for particular variables as well as for groups of countries. A certain degree of Co-movements was achieved among CEE countries despite diverse starting conditions at the beginning of transformation, different institutional features accompanying transition, and distinct privatization techniques adopted. This finding is in line with neoclassical growth theory that supports the occurrence of convergence among similar countries.

Keywords: Neoclassical Growth Theory, Money Supply, Panel Data Analysis, Co-movements.

## 1 INTRODUCTION

The Central and Eastern European countries' prospects of becoming EU members depended heavily on, among other things, on introducing structural reforms in the way of getting certain institutional attributes, and on economic policies to correlate with a higher degree of convergence with those of EU. This paper analyzes the convergence performance of the old members of the EU, new EU10 member countries and countries which are in the group of possible new-round EU candidate countries. The transition process in the region provides a unique opportunity to carry out a quantitative analysis of convergence in selected macroeconomic fundamentals within afore groups of countries based on different trade and geographical arrangements. Analysis aims to address the question of whether the new EU10 member countries have achieved a path of economic development leading to a certain degree of convergence. At this point, fifteen years into the transition, the CEE countries have completed a subsequent phase of stabilization and went over in growth of the process. During the ongoing transformation, the CEE countries launched various privatization programs and adopted an extensive range of measures to implement monetary and fiscal policies that would suit the needs of overall transformation. Aside from private investors, numerous international organizations were involved to foster the process. The economic transformations in the CEE countries have shared various common features ranging from institutional changes promoting a market economy to practical issues like the exchange rate regime or the inflow of foreign direct investment to industries with comparative advantage.

Any country in transition must undergo a stage of macroeconomic stabilization, which is inevitably accompanied by large shocks to macroeconomic fundamentals. The nature and magnitude of these disruptions affect the progress of economic development. Due to the relative openness and the close economic relations between transition economies in Central and Eastern Europe, economic interactions, or the lack thereof, are likely to be revealed by the behaviour of macroeconomic fundamentals. All of CEE embarked on an uneasy road of privatizing state-owned companies that had to undergo critical restructuring along the way. At the same time, these countries have striven to establish workable framework for international trade and cooperation to facilitate the transition process. Thus the question arises as to how successful the countries were in achieving a certain degree of natural economic integration. One way of answering this question is to perform a test for convergence in macroeconomic fundamentals among the CEE countries. Thus, we extend a growth convergence methodology to a set of selected macroeconomic fundamentals in order to obtain a broader picture of one aspect of the economics of transition. The further along a country is in its transition process towards a market economy, the more important the standard neoclassical determinants of economic growth become. If the growth process is described adequately by the neoclassical determinants of growth (along the lines of Ramsey, 1928, Solow, 1956 or Cass, 1965), then some clear predictions concerning the long-run co-movement of macro-economic aggregates follow.

The analysis focuses on the core of the New EU10 member Countries, in this context especially Eastern European countries (including Cyprus and Malta) and hence, excludes other transition economies. It uses monthly data for the following 29 countries. In the first group are representatives of the old EU15 member countries. New EU10 member Countries are formed in the second group of analysed sample. In the third group are some countries which try to achieve their neoclassical growth path towards the EU, these are Albania, Romania, Croatia, and Bulgaria.

In choosing countries, we also took account of data problems in other transition countries, such as Russia, Ukraine, and Belarus. The availability and reliability of data in these countries is often questionable. Only recently have these countries adopted the IMF standards for data collection and purification, and furthermore, the frequent changes in measuring methodology make their data rather inconsistent. The data span of the period is from December 1992 to December 2003. Monthly data on money aggregate (*MI*) were compiled from the International Monetary Fund’s International Financial Statistics in order to ensure the reliability of the data set employed. Bulletins of the statistical offices and of the national banks of the chosen countries were used as well to ensure data consistency.

Since we use monthly data and since almost any monthly data are subject to seasonal effects, we calculate seasonally adjusted growth rates. We use seasonal differencing, which lowers the variance of such time series. Thus, we define the variable  $X_t$  as a logarithmic 12th difference of original data; i.e.,

$$X_t = \ln V_t - \ln V_{t-12}; \quad (1)$$

where  $V_t$  is the original variable at time  $t$ , and  $X_t$  is a growth rate of a variable  $V_t$  over the period of 12 months, say the January-to-January growth rate.

Table 1: Groups of countries

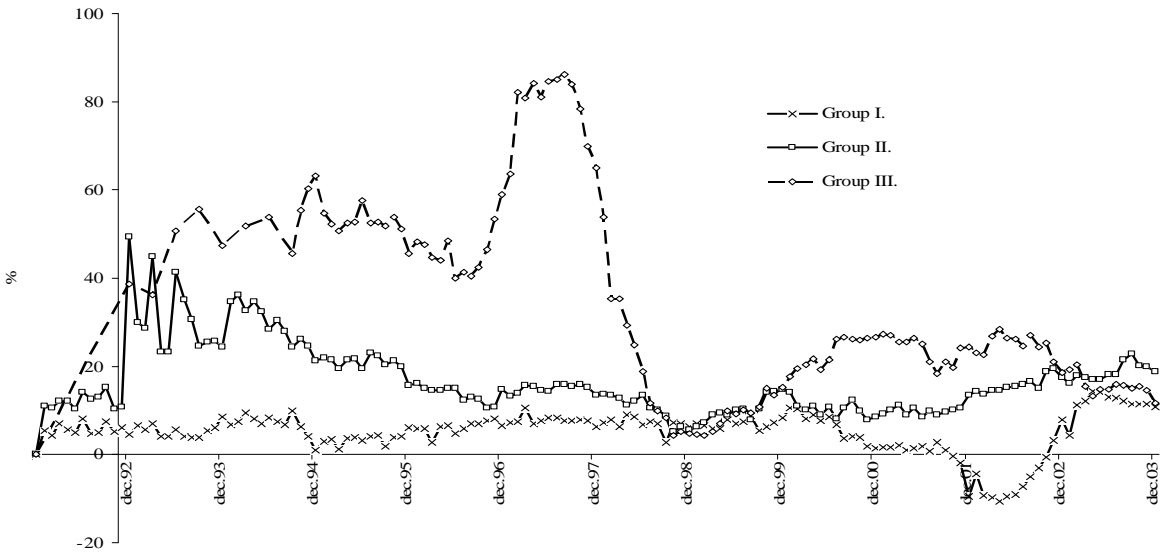
Group	Number	List of Countries in a group
I.	15	Austria, Belgium, Denmark, Finland, France, Greece, Ireland, Italy, Luxemburg, Germany, The Netherlands, Portugal, Spain, Sweden and UK
II.	10	Cyprus, Czech Republic, Estonia, Lithuania, Latvia, Hungary, Malta, Poland, Slovakia in Slovenia
III.	4	Albania, Romania, Croatia, and Bulgaria

For the purpose of further analysis, the countries are pooled in several logically differentiated groups that allow us to form panel data sets. Because of our aim to employ only reliable and consistent data, certain panels are unbalanced.

## 2 CONVERGENCE METHODOLOGY

Empirical research on economic growth has witnessed an enormous amount of interest during the last 10 to 15 years. One of the reasons for this renewed interest is the general current interest of the profession on growth theory. Another reason is the formulation and empirical investigation of different notions of convergence within this framework. Convergence in the key economic variables may be researched by several methods. Baumol (1986), Barro (1991), and Barro and Sala-i-Martin (1991, 1992) pioneered the conventional approach that examines cross-sectional relationships between the per capita growth rate over time and its initial level. Research of Bernard and Durlauf (1995) shows, that this conventional approach is too simple and is valid only under very strong assumptions. There are many analyses of growth patterns in the CEE area, including our own (Vojinović and Oplotnik, 2008a). For a comprehensive review see: Havrylyshyn (2001). There are also many analyses of income-level equalisation within this group and towards the EU (e.g. Baldwin et al., 1997; Boone and Maurel, 1998; Marini, 2003; Kaitila, 2004 and Vojinović and Oplotnik, 2008b) and some analyses of business cycle synchronisation (2004; Kutan and Yigit, 2004, 2005; Artis et al., 2005). However, we saw no study devoted to both aspects of economic convergence between those countries and towards the EU. We focus on the new EU10 member states and derive lessons from these countries' experience for the candidate countries. In addition, like in Martin and Velázquez (2001), Wagner and Hlouskova (2002) and Boldrin and Canova (2003), we provide lessons for the candidate economies by focusing the empirical evidence from the recent EU members.

Figure 1: Money (M1) growth rate.



Note: Data sets were compiled from the International Monetary Fund's WEO- World Economic Indicators.

Source: Own calculations

The following econometric methodology, which was used in several published studies, relies upon weaker assumptions and utilizes a combination of cross sections of individual time series. This approach was used by Ben-David (1995, 1996), who performed an analysis of real per capita income growth in numerous countries. Kočenda and Papell (1997) applied this methodology to study inflation convergence in the European Union.

Kočenda and Hanousek (1998) used it to test for convergence and integration of Asian capital markets. Recent adoption of panel-data estimation techniques combines the dynamics in time series with cross sectional variation in analyses of convergence. One group of authors utilizes panel unit root techniques to check for the existence of a common stochastic trend as evidence of convergence across a panel of countries (e.g., Evans and Karras, 1996; Evans, 1998, Fleissig and Strauss, 2001). Recent applications of this technique (e.g., Kočenda, 2001) assume homogeneity in growth rates across panel countries studied. Kutan and Yigit (2004), however, show Kočenda's evidence for convergence is sensitive to the assumption of homogeneity in growth rates, and that further investigation, especially allowing for heterogeneity, is necessary. That is why Kutan and Yigit (2004) choose to employ dynamic panel data estimation techniques with the assumption of unobservable country-specific heterogeneity (Islam, 1995; Lee, Pesaran & Smith, 1997; Nerlove, 2000). Newer the less, we adopted defined methodology and calculated convergence coefficients.

However, we start our convergence analysis by modelling the time path<sup>2</sup> of macroeconomic variables for a group of  $i$  individual countries with observations spanning  $t$  time periods as an autoregressive process, i.e.,

$$X_{i,t} = \alpha + \Phi X_{i,t-1} + \epsilon_{i,t}; \quad (2)$$

where  $X_t$  is a growth rate of a specific variable over the period of 12 months as defined by (1) or an interest rate spread as defined earlier. The fact that the variables are modelled as an autoregressive process is based on common practice in the literature and does not represent any theory of how this variable is determined. The convergence measure adopted is based on the following relationship that describes the dynamics of the differentials of the respective variables in a panel setting. Formally, we can transcribe this as

$$X_{i,t} - \bar{X}_t = \Phi (X_{i,t-1} - \bar{X}_{t-1}) + u_{i,t} \quad (3)$$

where  $\bar{X}_t = \frac{1}{n} \sum_{i=1}^n X_{i,t}$ .

In the presence of pooling, the intercept  $\alpha$  vanishes since, by construction, the differentials have a zero mean over all the countries and time periods. Convergence in the above context requires that the differentials of the respective variables become smaller and smaller over time. For this to be true,  $\Phi$  must be less than 1 and statistically significant. On other hand,  $\Phi$

greater than 1 and statistically significant indicates divergence. Ben-David (1995) has established that a subunity convergence coefficient  $\Phi$  is indeed a robust indication of convergence, and this is respectively true for divergence when  $\Phi > 1$ . Author performed 10,000 simulations for each of three possible cases in which data should portray the processes of convergence, divergence, and neutrality. His numerous simulations provide ample evidence of convergence or divergence when these features truly reflect the situation.

When neutral data with no strong inclination in either direction are used, the convergence coefficient  $\Phi$  tends toward unity. Once calculated, the estimated  $\Phi$  provides an indication of the speed of convergence within the given group. From the construction of the test, it follows that, as the value of the statistically significant coefficient  $\Phi$  approaches unity, the rate of convergence decreases. In order to make the speed of convergence much more readily interpretable it is useful to compute its half-life. The half-life of the convergence process is the number of time periods that it takes for the gap to be cut in half. The half-life is derived and used in Ben-David (1993, 1996) and is given by  $\ln(0.5)/\ln(\Phi)$ . Recent adoption of panel-data estimation techniques combines the dynamics in time series with cross sectional variation in analyses of convergence.

The convergence coefficient  $\Phi$  for a particular group of countries can be obtained by estimating Eq. (3). In order to remove any possible serial correlation from the data, we rewrite Eq. (3) in the form of the augmented Dickey and Fuller (1979) test, which is

$$d_{i,t} = \Phi d_{i,t-1} - \sum_{j=1}^k \gamma_j \Delta d_{i,t-j} + z_{i,t} \quad (4),$$

where the differential  $d_{i,t} = X_{i,t} - \bar{X}_t$ , and its first difference  $\Delta d_{i,t} = d_{i,t} - d_{i,t-1}$ . The subscript  $i = 1, \dots, k$  indexes the countries in a particular group. The number of lagged differences ( $k$ ) in Eq. (4) is determined using the parametric method proposed by Campbell and Perron (1991), Ng and Perron (1995) and Kočenda (2001). An upper bound of the number of lagged differences ( $k_{\max} = 7$ ) is initially set at the appropriately chosen level. The regression is estimated and the significance of the coefficient  $k$  is determined. If the coefficient is not found to be significant,  $k$  is reduced by 1 and Eq. (4) is reestimated. This procedure is repeated with a diminishing number of lagged differences until the coefficient is found to be significant. If no coefficient is found to be significant in conjunction with the respective  $k$ ;  $k=0$  and a standard form of the Dickey–Fuller test is used in the analysis. A 1% value of the asymptotic normal distribution is used to assess the significance of each lag. The advantage of this recursive  $t$ -statistic method over alternative procedures where  $k$  is either fixed or selected in order to minimize the Akaike Information Criterion is discussed in detail by Ng and Perron (1995). The above methodology, i.e., the panel unit-root test, exploits the effect of cross-variances in a pooled time series of moderate length. A theory was derived by Levin and Lin (1992) that shows that the statistical power of a unit-root test for a relatively small panel may be of an order of magnitude exceeding the power of the test for a single time series.

### 3 EMPIRICAL FINDINGS

Induced major systemic transformation from centrally planned to market based economies, for nearly all the Central and Eastern European countries, membership within the European Union was one, if not the primary goal of policy. However, the prospects of becoming a member of the EU depend strongly on the economic performance of the respective applicant country. As all potential entrants, the Eastern European applicant countries had to meet legal standards and had to achieve satisfactory levels of political developments. Criteria have been formulated at the Copenhagen summit. For all the Eastern European countries we investigated, the rough picture of the last thirteen years. The initial period of transition was characterized by drastic falls in output, high inflation and rising unemployment (see e.g. Kornai, 1994, Fischer, Sahay and Vegh, 1998a, Berg et al., 1999 or Fischer and Sahay, 2000). The most drastic example is real GDP growth of about -40 % in Latvia in 1992. For most countries in the sample, with the exception of Bulgaria, Romania and Albania output started to grow sustainedly in 1994 or 1995. Inflation rates also soared up, with some countries experiencing hyper-inflations. Again, with the exception of Bulgaria, Romania and Albania, by the end of the 1990s inflation had been brought down to one-digit or low two-digit numbers. Thus, among these countries, stabilization policy has been successful and growth is now widely experienced.

The results of convergence tests for all the constructed groups of countries are presented in Table 2. In order to translate the results from the tables properly, please recall that, by construction of the test, as the value of the statistically significant coefficient  $\Phi$  approaches unity, the rate of convergence becomes smaller. In order to interpret the speed of convergence more readily, the table also shows the computed half-life (H-L), or the number of time periods that it takes for the gap to be halved. The convergence of growth in the money supply is the largest among the old EU15 member states (e.g.  $\Phi=0.874$ ) and also the speed of convergence, represented by the smallest H-L (5.15). These results are clear consequence of ECB the monetary policy. After new EU10 member states implemented monetary reforms that also in some cases introduced new national currencies, the countries adopted tight exchange rate regimes. By pegging their currencies to the U.S. dollar, the Deutsche mark, or the Special Drawing Rights (basket), these countries essentially abdicated independent monetary policies. Hence, high convergence (e.g.  $\Phi=0.908$  and H-L=7.18) can be observed from this perspective. The policies were naturally more restrictive or expansive at different stages of transition in different countries.

Several Balkan countries (including those of the group III.) hope to be considered for membership in a future round of EU expansion. Whether these countries can become serious candidates for membership will depend on their ability to align themselves with the institutions and the macroeconomic policies of the EU. Although structural change and institutional adaptation to EU norms will be important in this process, the convergence of monetary policy between the EU and the candidate countries will be a necessary condition. In this context the successful accession to membership in the European Union will depend to a large extent to which the candidate countries are able to achieve some measure of

convergence between the evolution of the monetary policy stance of the European Central Bank (ECB). On the other hand, weak policy coordination would suggest the need for strengthening the financial sectors of these countries, for macroeconomic stabilization and for a period in which they tie their policies more closely to the ECB before they can be considered serious candidates for EU membership. Figure 1 documents the dramatic growth in money supply in the Balkan countries that coincided with the inflation surge starting in 1996 and continuing into 1997. Expansionary money creation was used by these countries to cope with their economic difficulties. Our analysis confirmed the need for strengthening the financial sectors of these countries by presenting high H-L (number of time periods that it takes for the gap to be cut in half) and lowest degree of convergence (e.g.  $\Phi=0.952$ ) in the segment of M1 growth rate.

Table 2: Money (M1) Growth Rate

Group	No.	$\Phi$	t-stat ( $\Phi$ )	k	H-L	Standard error
I.	15	0.874*	-49.32	6	5.15	0.0178
II.	10	0.908*	-83.39	6	7.18	0.011
III.	4	0.952*	-82.44	6	14.09	0.011

Note. "No." denotes number of countries in a particular group,  $k$  denotes number of lags, and  $H-L$  denotes half-life. \*Significant at 1% level.

Source: Own calculations.

#### 4 CONCLUSIONS

One aim of this paper was to confirm the hypothesis, that linking the economies of Central and Eastern Europe (today's EU10 new member states) to those of the European Union (EU) was generally considered the principal mean of securing the future growth prospects and political stability of the new member countries. We have shown that common institutional features and economic policies tend to correlate with this higher degree of convergence. When testing for convergence we found evidence of convergence in macroeconomic fundamental M1 among all three formed groups of countries in general. For the countries of Central and Eastern Europe, membership in the European Union has likewise been seen as the key to political and economic stability, and ultimately prosperity. The Return to Europe was expected to bring rewards surpassing the costs of EU accession and, in its pursuit, the governments of Central and Eastern Europe have adopted market reforms and EU regulations with a passion. There is a broad consensus, that a closer economic tie with the EU represents the most promising alternative for future of new EU10 member countries prospects. We carry out a quantitative analysis to test for convergence in selected macroeconomic variables within specific groups of the CEE countries from December 1992 to December 2003. The logical formation of groups of transition countries reflects the institutional attributes of the transition process. A certain degree of macroeconomic convergence was achieved among today's new EU10 member countries despite diverse starting conditions at the beginning of



transformation, different institutional features accompanying transition, and distinct privatization techniques adopted. Comparing convergence across groups of countries, new EU10 member states achieved the highest degree of convergence in analysed macroeconomic fundamental M1. We attribute convergence to two important factors. First, international trade within the framework serves as a natural means of coordinating economic development. Second, the prospective accession to the EU (with linking to the ECB monetary policy) served as an institutional means of coordination in order to satisfy a set of pre-accession criteria.

For the third group of countries highly aggregative approach of this paper represents a short-coming. The process and the dynamics of economic reform depend strongly on the specific economic structure present in the individual countries. In the applicant countries of the third group, substantial progress has been made in several areas, e.g. with respect to the liberalization of prices (for the instalment of a market price system in the first place), with respect to established foreign exchange markets or with respect to trade. In other areas further efforts are required. Examples include privatization and banking sector reform. However, the EU is the explicit destination of these countries' development journey. The individual countries vary substantially with respect to the projected convergence times. In our quantitative experiments the effects of integration with or possible accession to the EU are significantly positive. Substantial acceleration of the convergence times may be possible. A more detailed analysis with sectoral disaggregation is required to obtain further understanding concerning the process of convergence in applicant countries in the future. Sectoral disaggregation is especially interesting when studying transition economies, as a substantial degree of sectoral reallocation is observed throughout the process of transition. A new private sector is emerging, the state sector is declining and the agricultural sector is also over-sized in some countries. We see our contribution not as a substitute for detailed investigations into the mechanics of sectoral adjustment, but more as a complement that is intended to give a bird-eye's view. A second dimension where further disaggregation can be expected to shed further light on the growth prospects is regional disaggregation. In some of the Balkan countries it is observed that growth is based on a relatively small set of regions (as well as sectors). Further ongoing work should be devoted to assess the extent and the implications of a possibly observable Harrod-Balassa-Samuelson effect in the Balkan countries. Faster rising prices in faster growing countries may speed up (nominal) convergence towards the EU.

The further along a country is in its transition process towards a market economy, the more important the standard neoclassical determinants of economic growth become. If the growth process of convergence is described adequately by the neoclassical determinants (along the lines of Ramsey, 1928, Solow, 1956 or Cass, 1965), then some clear predictions concerning the long-run co-movement of macro-economic aggregates follow. As a final summarizing conclusion one may say that convergence of the applicant countries towards the EU level is a long-run perspective. This perspective can be and is influenced both by domestic policy choices in the applicant countries and by the EU's policy approach towards enlargement and towards the candidate countries.

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