

Kutan, Ali M.; Yigit, Taner M.

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## Nominal and real stochastic convergence within transition economies and to the European Union: Evidence from panel data

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**Nominal and Real Stochastic Convergence  
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Evidence From Panel Data**

**By**

**Ali M. Kutan\* and Taner M. Yigit\*\***

\* Kutan- Economics and Finance Department, School of Business, Southern Illinois University Edwardsville, IL 62026-1102 and Center for European Integration Studies (ZEI), Bonn, Germany. E-mail: akutan@siue.edu

\*\* Yigit- Economics Department, John Cook School of Business, St. Louis University, 3674 Lindell Blvd., St. Louis, MO 63108.

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## **ABSTRACT**

This paper investigates the issue of real and nominal economic convergence of transition economies in two distinct ways: i) within their own groups as in Koèenda (2001) and ii) to the European Union (EU). We extend Koèenda's study not only by using a more stable period (post-93) but also by employing a more recent panel estimation approach developed by Im, Pesaran, and Shin (IPS) (1997), which offers less restrictive assumptions about convergence by allowing heterogeneity in the convergence rates than previous panel unit root techniques. Relaxing the assumption of homogeneity in convergence rates yields less convergence in price level and money supply variables than reported by Koèenda. Again using the IPS method, we extend the investigation to examine the convergence of the first and second round candidate economies to EU standards. We find that the first-round candidates have made significant progress in monetary policy convergence with respect to EU and there is significant real convergence between the first round candidate economies and EU, but not for the second round candidate countries. The results have important implications for full EU membership preparations by these countries, including the choice of an optimal interim exchange rate policy.

## **I. Introduction**

Since the early 1990s, the transition economies of Central and East Europe, the Baltic States, and of the former Soviet Union have introduced a series of fundamental economic reforms, allowing market forces to play a significant role in the decision-making process of economic agents. Although monetary and exchange rate policies implemented varied significantly across countries (Desai, 1998 and Kutan and Brada, 2000), there has been significant progress in reducing the initial inflationary pressures due to monetary overhang. More recently, the countries have begun experiencing positive real economic growth.

With countries displaying similar economic performance over time, we expect real and monetary convergence in macroeconomic fundamentals as the impact of initial conditions decline over time (Backé et al., 2002). Three reasons motivate us to investigate the degree of such convergence in transition economies. First, evidence of no economic convergence within a region can bring about social and political instability as economic performance varies significantly across countries. Second, the majority of the Central and Eastern European transition countries are also the first and second-round candidates for the European Union (EU). Finally, the majority of the countries have signed Association agreements with the EU. Evidence of non-convergence would imply that such institutional linkages with respect to the EU do not necessarily lead to macroeconomic convergence.

Until very recently, emphasis in the literature has focused on the convergence of transition economies to EU standards, and convergence within groups has been neglected. In this paper, we study both issues. Brada and Kutan (2001) examined monetary policy convergence between the candidate economies and EU, proxied by

Germany, and found no convergence between base money in Germany and the transition-economy candidates for EU membership. In contrast, the market-economy candidates, Cyprus, Malta and Turkey, showed significant convergence with German money base. Korhonen and Fidrmuc (2001) tested whether the candidate countries display significant correlation of their supply and demand shocks with selected EU economies over 1991-2000. They reported that, except Estonia and Hungary, the candidate economies display low correlation. Richards and Tersman (1996) examined the issue of price-level convergence between the EU and the transition-economy candidates and reported large gaps in that the latter countries have much lower price levels than do existing EU members. Finally, Estrin et al. (2001) tested whether there has been convergence between the ex-communist block and the West, both pre-and post-reform, using per capita output data during the 1970-98 period. They found little evidence of convergence to the West, either during the pre-reform (1970-90) period or the full period (1970-98). Backé et al. (2002) found significant differences in comparative price levels between EU countries and most Central and Eastern European EU accession countries.

The only notable exception to the literature is a recent study by Koèenda (2001). He studied the nominal and real convergence of macroeconomic fundamentals in several groups of transition economies based on their geographical location and key institutional factors, such as the Association agreements with the EU. He examined the issue of real convergence based on industrial output and monetary convergence using data on producer price index (PPI), consumer price index (CPI), money (M1), and nominal and real interest rates during the period from January 1991 to December 1998. Using a commonly employed panel unit root technique, he tested for convergence within groups

to account for the impact of different institutional and geographical aspects of transition countries. His results indicated considerable real and monetary convergence with real output displaying the greatest degree of convergence across all groups of countries while price-level exhibiting the least. Although the first-round EU candidates showed relatively high degrees of convergence in most variables studied, the highest degree of convergence was displayed by the Baltic States.

The purpose of this paper is twofold. First, we provide additional evidence about real and nominal economic convergence of transition economies by extending Koèenda's (2001) study in two significant ways: (1) we utilize a more stable period (post-93) to examine the robustness of his findings to leaving out the turbulent years of transition, and (2) we investigate the sensitivity of his convergence results by using a more recent panel estimation approach that offers less restrictive assumptions about convergence rates than Koèenda's panel technique. His methodology assumes that countries share *identical* convergence rates to reach an equilibrium level over time. In this paper, we allow for heterogeneity in these rates and investigate the impact of imposing less restriction on convergence results. Second, using the same methodology, we extend the investigation to examine the convergence of the first and second round candidate economies to EU standards. This has important implications for full EU membership preparations by these countries.

In the next section, we describe our panel methodology and compare it with the technique utilized by Koèenda. Section III explains our data and reports the empirical findings. Section IV discusses the policy implications of our findings and concludes the paper.

## II. Methodology

In the past decade, a wide variety of empirical work on neoclassical growth model was undertaken. One branch of these studies has utilized time series methodology to test for the key proposition of convergence hypothesis. Based on mostly unit root tests, these papers focus on capturing the persistence of shocks relative to per capita incomes<sup>1</sup>. Such (stochastic) convergence applies if per capita income disparities between economies follow a mean-stationary process, so that relative per capita income shocks lead to transitory deviations from any tendency toward convergence. This stationarity would imply that the economies have reached their own steady state and are prone to short-lived shocks.

It is widely known that univariate unit root tests suffer from low statistical power in finite samples. This might lead to failures in rejecting the null-hypothesis. Recently, panel unit root tests have been adopted to address the issue, significantly increasing the power when testing for convergence. Three popular tests include Quah (1992), Im, Pesaran and Shin (IPS, 1997), and Levin and Lin (henceforth LL, 2002).<sup>2</sup>

Quah considers the simple following dynamic model to improve the power of the univariate Dickey-Fuller procedures

$$(y_{i,t} - \bar{y}_t) = \mathbf{r}(y_{i,t-1} - \bar{y}_{t-1}) + \mathbf{e}_{i,t} \quad (1)$$

where  $y_{i,t} - \bar{y}_t$  is the income disparity from mean output (or benchmark economy) of  $i = 1, \dots, N$  countries at time  $t$ . He suggests a pooled OLS estimation, in which values of  $\tilde{n}$  less

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<sup>1</sup> Earlier papers concentrated on the notions of **b** convergence (where poor countries grow faster than rich ones) and **s** convergence (where income variance between poor and rich countries is diminishing). Our analysis concentrates on stochastic convergence, which does not necessitate each country to converge to the same steady state.



than 1 indicate that disparity from the mean is decreasing with time. He not only shows that his statistic would weakly converge to  $N(0,1)$  as  $N,T$  get large, but also uses this technique to find evidence against convergence to U.S. output.

Levin and Lin (2002) provide a more general testing framework and consider the following three models:

$$\Delta(y_{i,t} - \bar{y}_t) = \mathbf{r}(y_{i,t-1} - \bar{y}_{t-1}) + \mathbf{a}_m d_m + \mathbf{e}_{i,t} \quad (2)$$

for  $m = 1,2,3$  and where  $d_m$  contains deterministic variables;  $d_{1t} = \{1\}$ ,  $d_{2t} = \{1, t\}$ ,  $d_{3t} = \{1, t, t^2\}$ .

In other words, they improve on Quah's method by including fixed effects and individual time trends for each country. Such a framework allows for both different steady states for variable  $y_{i,t}$  and different time trends for each country. After establishing that asymptotics of their statistics weakly converge to  $N(0,1)$  under the null, they illustrate that no convergence, namely  $\mathbf{r} = 0$ , can be tested against the alternative of income disparities dying out with time,  $\mathbf{r} < 0$ . Koèenda (2001) utilizes this methodology to illustrate the existence of convergence in transition economies<sup>3</sup>.

It is important to note that both of Quah and LL tests, and consequently Koèenda's paper, assume a common  $\mathbf{r}$  ( $1 - \mathbf{r}$  represents the convergence rate) and impose homogeneity throughout the countries in each group. This assumption implies that all countries within each group share the same speed of adjustment to steady state in all variables. For example, it assumes that, in the enlarged CEFTA group, Romania and

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<sup>2</sup> It is important to note that the original working paper for the LL approach dates back to 1993 before it was eventually published in 2002. In this sense, the IPS method is the most recent panel test utilized in the literature.

<sup>3</sup> Koèenda improves this methodology in two significant ways. First is that his methodology controls for serial correlation in errors. Second, he computes the exact sample critical values for the tests.

the Czech Republic reach a long-run group average at the same rate. The next paragraph describes a less restrictive test that allows differences in convergence rates.

A more recent paper by Im, Pesaran and Shin (1997) relaxes Quah's and LL's assumption of homogeneity in convergence rates due to concerns of bias that may result in heterogeneous panels. Therefore, their test avoids the imposition of identical convergence rates and consequently possible misspecification of the model, which may lead to false inference.<sup>4</sup> Their method pools  $N$  separate independent ADF regressions

$$\Delta(y_{i,t} - \bar{y}_t) = \mathbf{d}_i + \mathbf{r}_i (y_{i,t-1} - \bar{y}_{t-1}) + \sum_{k=1}^p \mathbf{f}_{i,k} \Delta(y_{i,t-k} - \bar{y}_{t-k}) + u_{i,t} \quad (3)$$

,allowing for heterogeneity in  $\mathbf{r}$ , to test  $H_0 : \mathbf{r}_i = 0$  for all  $i$  against  $H_A : \mathbf{r}_i < 0$  for at least one  $i$ . The limiting distribution for their t-statistic is given as:

$$\sqrt{N} \frac{(\bar{t}_{ADF} - \mathbf{m}_{ADF})}{\sqrt{\mathbf{s}_{ADF}^2}} \rightarrow N(0,1) \quad (4)$$

where the moments  $\mathbf{m}_{ADF}$  and  $\mathbf{s}_{ADF}^2$  are obtained from Monte Carlo simulations, and  $\bar{t}_{ADF}$  is the average estimated ADF  $t$ -statistics from the sample. Subsequent Monte-Carlo simulations in their paper compare the size and power performance of their method against LL's. Their results not only demonstrate that the IPS test has significantly greater power compared to the LL test, especially when the number of countries,  $N$ , is small, but it also has better size properties than LL's when the choice of ADF order is misspecified.

Differences in performance of these two techniques are caused mainly by the imposition of the homogeneity assumption in LL, which leads to false inference due to misspecification of the model. These disparities will grow as the degree of heterogeneity

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<sup>4</sup> For the recent applications of the IPS approach, see Wu and Chen (2001) and Wu and Shaowen (2001).

within the panels gets larger than used in the IPS simulations. This possibility of misspecification related to LL test constitutes our motivation for re-examining the Koèenda's results and test for convergence in transition economies.

### **III. Data and Results**

As in Koèenda (2001), we test for convergence in seasonally adjusted growth rates in monthly output (industrial production), price (PPI and CPI), money (M1), and nominal and real interest rate spreads series for 5 groups of countries.<sup>5</sup> These groups are original participants of Central European Free Trade Agreement<sup>6</sup> (CEFTA), expanded CEFTA after joining of Romania, first<sup>7</sup> and second<sup>8</sup> round countries according to their candidacy category for membership to the EU, and finally the Baltic states<sup>9</sup>. The data used in estimations are obtained from *International Financial Statistics* of the IMF.

We concentrate on a more recent and relatively calmer period than did Koèenda, namely 1993:01 to 2000:12, assuming that evidence for convergence, when present, would be stronger with the more recent period. Descriptive statistics in Table 1, especially the standard deviations, illustrate this point by consistently staying below the values in Koèenda tables.

In this paper, real convergence is measured by the industrial production variable. Analysis of nominal convergence starts with tests of monetary policy convergence. Despite using both narrow money (M1) and interest rate spreads to measure monetary convergence in this paper, we believe that interest rate spreads are the better measure of

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<sup>5</sup> Spread is measured by the difference between lending and deposit rates. Real spread is constructed by dividing the nominal spread by inflation.

<sup>6</sup> The Czech Republic, Hungary, Poland, Slovakia, and Slovenia.

<sup>7</sup> The Czech Republic, Estonia, Hungary, Poland, and Slovenia.

<sup>8</sup> Latvia, Romania, the Slovak Republic, Lithuania, and Bulgaria

<sup>9</sup> Estonia, Latvia, and Lithuania.

monetary policy. Changes in nominal lending and interest rates directly affect demand and time deposits (thus the composition of M1). Thus changes in M1 reflect more policy outcomes than actual implementation of the policy. We therefore rely more on interest rate results when deriving our conclusions. Another part of the tests for nominal convergence is the analysis of CPI and PPI. They not only reflect monetary policy outcomes, but also the trade linkages between sample countries.

### ***Convergence of Transition Economies***

Initially, we run LL tests, as utilized by Koèenda's, on the same sets of countries and variables to examine the sensitivity of his results to using an updated dataset. These and subsequent IPS panel unit root tests are applied after demeaning to remove the common time component, which might cause false inference due to cross-correlation within the panels. Comparison of these results in Table 2 with that of Koèenda's shows that coefficient values and their significance levels are similar between the two different time periods. As expected, evidence in Table 2 indicates real and nominal convergence between the countries in each group as reported in Koèenda. Although moving the window of analysis from 1991-1998 to 1993-2000 raises the degree of convergence across all countries, it does not lead to significant differences in the evidence for convergence between Koèenda's findings and that of ours in Table 2.

A key issue in our subsequent estimations is the sensitivity of results to using a different panel approach that imposes a less restrictive assumption about the convergence rates. Application of IPS tests on the same sets of variables shows (Tables 2 to 7) that the strong evidence for convergence found in almost all series in Koèenda does not hold well

when we allow for heterogeneity in convergence rates<sup>10</sup>. We also note that average convergence rates of groups from IPS estimations are slightly higher than the convergence rates found using the LL technique.

Looking at the results in Table 3 first for the original CEFTA countries, we observe evidence of real convergence, complementing the finding in Koèenda, who suggests that this result is likely to be driven by the institutional trade linkages between countries through CEFTA. There is strong evidence of monetary policy convergence as given by the spread variable. There is no evidence of price level convergence, indicating that the countries have experienced uncommon price shocks, driven by different types supply and demand shocks.

Adding Romania to the original CEFTA countries generates the results for enlarged CEFTA displayed in Table 4. The evidence of real convergence disappears with the inclusion of Romania. However, we observe price-level convergence for both CPI and PPI, still with no evidence of monetary policy (M1) convergence. The dramatic change in results indicates the fragility of panel tests to adding an outlier country, such as Romania.<sup>11</sup>

Table 5 reports the results for the first-round candidate countries. There is no evidence of real convergence but significant monetary policy (spread) convergence. Price level convergence and convergence in money supply growth rates are not supported by the data, reflecting the effects of different inflationary and/or supply shocks experienced by the countries.

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<sup>10</sup> IPS test is sensitive to residual cross correlation between countries after demeaning, so Monte Carlo simulations or bootstrapping is advised. However, simulation results not included in the paper showed that cross correlation does not constitute a big problem due to the small sample size  $N$ .

<sup>11</sup> The sensitivity of panel techniques to outliers such as Romania is further discussed later in this section.

Table 6, which reports the findings for the second-round candidate countries, reveals interesting results. Unlike the first-round candidate countries, there is no evidence of real convergence. However, there is significant degree of price-level convergence for both CPI and PPI and money supply (M1) convergence. This evidence is consistent with Koèenda<sup>12</sup>. These results suggest that the second-round candidates have made significant progress in price convergence as a result of the significant disinflation policies they implemented after 1993. This leads us to believe that perhaps the gap between the first and second round candidate countries is not as large as expected<sup>13</sup>.

Finally, Table 7 provides the results for the Baltic States. These countries have achieved convergence the most. Except money supply growth rates, there is evidence of convergence in every other variable. The lack of convergence in M1 is due to the currency board regimes adopted by these countries during our sample period.

In summary, our results suggest that significant monetary policy (spread) convergence has been achieved in the transition economies. There is also evidence of real convergence in the original CEFTA, first round, and Baltic countries. Price level convergence is more evident in the Baltic States and second round candidates than others. This latter finding is a function of our sample period, because the first round and CEFTA countries achieved significant price level convergence in the early 1990s. The least convergence is observed in money supply (M1) rates.

Our final point emphasizes a methodological problem related to tests of convergence in general. As suggested by all authors (Quah, LL, and IPS), data series are

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<sup>12</sup> Koèenda does not report results for real convergence for the second group candidates due to lack of data.

<sup>13</sup> This does not, however, mean that the first group countries have not made progress. It simply suggests that given our sample period (post-93), the second-group countries made a significant progress relative to the first group during this period.

demeaned prior to estimations to remove the common time component. Following this guideline in our tests, we note that our results change when the CEFTA group is enlarged with the addition of Romania. When Romania is added to the original CEFTA group in Table 4, IPS tests support convergence in the price series despite rejecting it previously. Close inspection of the data illustrates the high levels of growth in Romanian price series. Having such an outlier that significantly affects the group mean has serious implications on tests for mean reversion.

To further illustrate this point, we use the original CEFTA group and generate an outlier by multiplying Czech Republic growth rate values arbitrarily by 10. Results in Table 8 demonstrate that having outliers may have serious repercussions in tests for convergence. Previous statistics that failed to reject the null of no convergence suddenly reject the null in 3 of the 4 series. Scrutiny of this reversal is beyond the scope of our current paper, but will be covered in future research.

In Table 9, we summarize the differences between Koèenda's results and ours. The key difference is that our evidence indicates less convergence in the price indexes and M1 than what his results indicate. Nominal spread results are also sensitive to the methodology used. We find stronger convergence in nominal spreads for the Baltic States and weaker convergence for the CEFTA-5 members than what Koèenda reported. We also showed that the results of panel tests in general are quite sensitive to outliers in data.

### ***Convergence of Transition Economies to EU Standards***

Table 10 reports the progress made by the first round transition economies as to their convergence to EU economic standards. The results indicate significant real and monetary policy convergence. The latter is given by both M1 and nominal interest rate spread results. There is no evidence of convergence in real spreads. This result is likely

driven by the price level results as there is no indication of significant price level convergence between the first round candidate countries and the EU. This finding suggests that changes in price indexes are not merely dominated by changes in monetary policy, but they reflect more the effects of trade channels via the CEFTA.

Turning to results for the second round candidate countries, the results, reported in Table 11, show no evidence of real convergence, but significant price level convergence with respect to EU. This outcome also is probably the result of the price indexes being more related to strong trade linkages between the transition countries and EU, rather than being affected more by monetary policy conditions. This notion is further supported by the finding of no convergence in monetary policy (M1) between the second round countries and EU.

#### **IV. Policy Implications and Conclusions**

We have tested real and monetary stochastic convergence in transition economies, using macroeconomic data from January 1993 to December 2000. Using a different sample period but employing the same method used by Koèenda has not produced qualitatively different inference about convergence. However, utilizing a less restricted panel test that does not impose the assumption of homogeneity in convergence rates has yielded less degree of convergence in the CPI, PPI, and M1 than reported by Koèenda. The results suggest that the inference about convergence is not sensitive to sample period used, but to the restrictions of the panel technique employed by practitioner.

Extending the convergence issue to the EU, we have also investigated convergence of the first and second round candidate economies with the EU. Evidence has indicated that the first-round EU candidates have made significant progress in real



output and monetary policy convergence with respect to EU, suggesting that these countries are moving in the same direction as EU economies. History on accession shows that moving in the right economic direction is desirable for further progress in the enlargement attempts. The lack of significant price level convergence can be explained by different degrees of trade linkages and real exchange shocks experienced by these countries.<sup>14</sup>

Finally, we have found significant real convergence between the first round candidate economies and EU, but not for the second round candidate countries. Since we used industrial production, a real or supply shock variable, our findings indicate that the second-round candidate countries in our sample have experienced different supply-side shocks, thus displayed no convergence with real shocks in other countries within the group. An important policy implication of this result is that second-round candidate countries need to retain some measure of policy autonomy to deal with productivity shocks whose magnitude and timing may differ significantly from the shocks affecting other countries in that group. In terms of exchange rate policy, this signals more flexible exchange rate policies for these countries.

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<sup>14</sup> Brada (1998) argues that, as a result of diverse fiscal and monetary policies, real exchange rates in the transition economies should follow a different path. Dibooglu and Kutan (2001) provide evidence that sources of real exchange rate fluctuations have been different in transition economies.

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## TABLES

*Table 1: Descriptive Statics of Percentage Growth Rates: Averages (Standard deviations)*

	<i>Industrial Production</i>	<i>PPI</i>	<i>CPI</i>	<i>MI</i>	<i>Nominal Spr.</i>	<i>Real Spr.</i>
<i>Czech</i>	4.96 (8.6)	4.08 (2.1)	7.29 (3.0)	11.93 (18.29)	1.83(0.1)	1.00(0.7)
<i>Slovak</i>	3.61 (4.9)	8.80 (3.2)	6.12 (3.4)	6.40 (9.4)	1.55(0.2)	0.74(0.3)
<i>Poland</i>	5.06 (9.2)	13.31 (7.8)	16.25 (7.7)	23.49 (10.3)	1.23(0.2)	0.39(0.3)
<i>Hungary</i>	9.59 (7.3)	14.40 (6.7)	16.05 (5.6)	14.38 (6.1)	1.29(0.1)	0.33(0.1)
<i>Slovenia</i>	2.96 (4.2)	8.02 (4.6)	10.42 (3.7)	26.21 (15.6)	1.54(0.1)	0.82(0.2)
<i>Estonia</i>	4.25 (15.7)	11.86 (10.8)	11.86 (10.8)	28.57 (23.4)	2.25(0.4)	1.04(0.8)
<i>Latvia</i>	7.21 (20.0)	12.45 (10.4)	4.50 (6.1)	16.21 (13.8)	2.44(0.5)	2.22(1.2)
<i>Lithuania</i>	-2.06 (22.4)	31.11 (47.3)	34.68 (59.9)	23.09 (23.5)	1.69(0.5)	4.71(13.6)
<i>Romania</i>	-0.90 (11.6)	54.16 (33.8)	52.94 (32.9)	43.32 (13.8)	NA	NA
<i>Bulgaria</i>	3.09 (12.2)	67.20 (84.3)	71.02 (105.8)	63.52 (68.2)	2.51(1.2)	-1.04(17.8)

Note: NA means data not available.

*Table 2: LL Methodology Results for all Groups (coefficients and t-statistics)*

<i>Group</i>	<i>Industrial Production</i>	<i>PPI</i>	<i>CPI</i>	<i>MI</i>	<i>Nominal Spr.</i>	<i>Real Spr.</i>
	<i>Coeff.</i>	<i>Coeff.</i>	<i>Coeff.</i>	<i>Coeff.</i>	<i>Coeff.</i>	<i>Coeff.</i>
<i>CEFTA-5</i>	0.82 <sup>***</sup>	0.97 <sup>***</sup>	0.98 <sup>***</sup>	0.96 <sup>***</sup>	0.97 <sup>***</sup>	0.95 <sup>***</sup>
<i>CEFTA-6</i>	0.86 <sup>***</sup>	0.95 <sup>***</sup>	0.94 <sup>***</sup>	0.96 <sup>***</sup>		
<i>First group</i>	0.85 <sup>***</sup>	0.97 <sup>***</sup>	0.97 <sup>***</sup>	0.95 <sup>***</sup>	0.97 <sup>***</sup>	0.94 <sup>***</sup>
<i>Second group</i>	0.80 <sup>***</sup>	0.94 <sup>***</sup>	0.96 <sup>***</sup>	0.97 <sup>**</sup>		
<i>Baltic</i>	0.82 <sup>***</sup>	0.92 <sup>***</sup>	0.84 <sup>***</sup>	0.93 <sup>***</sup>	0.82 <sup>***</sup>	0.56 <sup>***</sup>

Note: CEFTA-5 refers to the original CEFTA countries while CEFTA-6 is the enlarged one. Interest rate results for CEFTA-6 and Group-2 are not reported due to lack of data for Romanian interest rates. Since sample sizes are similar, we use the same critical values derived by Koëenda simulations. For this and the remaining tables <sup>\*\*\*</sup> ( <sup>\*\*</sup> ) indicates 99% (95%) significance while <sup>\*</sup> represents significance at 90%.

*Table 3: IPS Results for Original CEFTA Countries (coefficients and individual t-statistics)*

	<i>Industrial Production</i>	<i>PPI</i>	<i>CPI</i>	<i>MI</i>	<i>Nominal Spr.</i>	<i>Real Spr.</i>
	<i>Coeff.</i>	<i>Coeff.</i>	<i>Coeff.</i>	<i>Coeff.</i>	<i>Coeff.</i>	<i>Coeff.</i>
<i>Czech</i>	0.50	0.93	0.95	0.92	0.79	0.82
<i>Hungary</i>	0.32	0.95	0.94	0.96	0.86	0.89
<i>Poland</i>	0.83	0.89	0.94	0.93	0.83	0.72
<i>Slovak</i>	0.79	0.84	0.90	0.94	0.66	0.85
<i>Slovenia</i>	0.63	0.91	0.90	0.89	0.31	0.74
<i>t-ave.</i>	-2.73	-2.17	-2.03	-1.62	-2.69	-2.96
<i>z-stat.</i>	-1.71 <sup>**</sup>	-0.18	0.21	1.32	-1.60 <sup>*</sup>	-2.36 <sup>***</sup>

Note: T=96 for all series in the following tables.

represents here and in the following tables the series where a time trend was used. t-statistics averages are compared to simulated IPS (1997) critical values of mean and variance -2.11 and 0.66, respectively. Critical values for no time trend are -1.51 with variance 0.76.

Table 4: IPS Results for Enlarged CEFTA Countries (coefficients and individual t-statistics)

	Industrial Production	PPI	CPI	MI
	Coeff.	Coeff.	Coeff.	Coeff.
Czech	0.64	0.89	0.91	0.79
Hungary	0.62	0.88	0.95	0.97
Poland	0.72	0.90	0.96	0.92
Romania	0.82	0.86	0.94	0.82
Slovak	0.84	0.81	0.96	0.92
Slovenia	0.74	0.86	0.938	0.87
<i>t-ave.</i>	-2.34	-3.69	-2.20	-2.07
<i>z-stat.</i>	-0.69	-4.78 <sup>***</sup>	-1.94 <sup>**</sup>	0.09

Notes: Interest rate results are not reported due to lack of data for Romanian interest rates.

Table 5: IPS Results for the First-round Candidate Countries (coefficients and individual t-statistics)

	Industrial Production	PPI	CPI	MI	Nominal Spr.	Real Spr.
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
Czech	0.77	0.94	0.96	0.94	0.60	0.77
Estonia	0.85	0.92	0.90	0.94	0.51	0.66
Hungary	0.73	0.95	0.94	0.93	0.75	0.86
Poland	0.73	0.91	0.87	0.90	0.71	0.80
Slovenia	0.67	0.89	0.89	0.88	0.55	0.83
<i>t-ave.</i>	-2.10	-2.17	-2.34	-2.10	-3.80	-2.79
<i>z-stat.</i>	-1.51 <sup>*</sup>	-0.17	-0.65	0.01	-4.65 <sup>***</sup>	-1.88 <sup>**</sup>

Table 6: IPS Results for the Second-round Candidate Countries (coefficients and individual t-statistics)

	Industrial Production	PPI	CPI	MI
	Coeff.	Coeff.	Coeff.	Coeff.
Bulgaria	0.25	0.93	0.93	0.94
Latvia	0.83	0.94	0.94	0.92
Lithuania	0.84	0.94	0.95	0.91
Romania	0.44	0.45	0.71	0.92
Slovak	0.28	0.94	0.94	0.93
<i>t-ave.</i>	-1.61	-3.72	-3.54	-2.21
<i>z-stat.</i>	1.36	-5.67 <sup>***</sup>	-3.94 <sup>***</sup>	-1.80 <sup>**</sup>

Notes: Interest rate results are not reported due to lack of data for Romanian interest rates.

Table 7: IPS Results for Baltic States (coefficients and individual t-statistics)

	Industrial Production	PPI	CPI	MI	Nominal Spr.	Real Spr.
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
Estonia	0.85	0.90	0.765	0.94	0.56	0.12
Latvia	0.64	0.91	0.70	0.90	0.43	0.20
Lithuania	0.85	0.94	0.68	0.90	0.42	0.16
<i>t-ave.</i>	-2.18	-2.21	-7.80	-1.99	-3.29	-3.55
<i>z-stat.</i>	-1.33 <sup>*</sup>	-1.40 <sup>*</sup>	-12.14 <sup>***</sup>	-0.97	-2.53 <sup>***</sup>	-3.08 <sup>***</sup>

Table 8: IPS Results for CEFTA Countries with Outlier (coefficients and individual t-statistics)

	Industrial Production	PPI	CPI	M1	Nominal Spread	Real Spread
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
Czech	0.68	0.86	0.93	0.91	0.91	0.87
Hungary	0.65	0.88	0.93	0.93	0.92	0.88
Poland	0.68	0.90	0.94	0.92	0.93	0.85
Slovak	0.75	0.85	0.93	0.91	0.88	0.88
Slovenia	0.65	0.88	0.92	0.91	0.88	0.88
<i>t-ave.</i>	-2.65	-3.16	-1.95	-3.11	-1.80	-2.57
<i>z-stat.</i>	-1.50*	-2.91***	0.43	-11.85***	-0.76	-2.73***

Note: IPS test is applied to the original CEFTA countries after having multiplied the Czech Republic growth rates arbitrarily by 10. Comparison of these results with those of Table 3 shows that results for convergence change significantly due to an outlier in the dataset.

Table 9: Comparison of results: Is there stochastic convergence?

Group	Industrial Production		PPI		CPI	
	Koèenda	Ours	Koèenda	Ours	Koèenda	Ours
CEFTA-5	Yes	Yes	<b>Yes</b>	<b>No</b>	<b>Yes</b>	<b>No</b>
CEFTA-6	<b>Yes</b>	<b>No</b>	Yes	Yes	Yes	Yes
First group	Yes	Yes	<b>Yes</b>	<b>No</b>	<b>Yes</b>	<b>No</b>
Second group	N/A	No	N/A	Yes	Yes	Yes
Baltic	Yes	Yes	Yes	Yes	Yes	Yes
	M1		Nominal Spr.		Real Spr.	
	Koèenda	Ours	Koèenda	Ours	Koèenda	Ours
CEFTA-5	<b>Yes</b>	<b>No</b>	<b>Yes</b>	<b>Weak</b>	Yes	Yes
CEFTA-6	<b>Yes</b>	<b>No</b>				
First group	<b>Yes</b>	<b>No</b>	Yes	Yes	Yes	Yes
Second group	Yes	Yes				
Baltic	<b>Yes</b>	<b>No</b>	<b>Weak</b>	<b>Yes</b>	Yes	Yes

Notes: N/A indicates that estimation is not included in Koèenda due to lack of data. Weak indicates evidence of convergence at 90% significance

Table 10: IPS Results for the First-round Candidate Countries (convergence to EU standard)

	Industrial Production	PPI	CPI	M1	Nominal Spr.	Real Spr.
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
Czech	0.66	0.89	0.91	0.87	0.95	0.78
Estonia	0.82	0.92	0.91	0.94	0.72	0.80
Hungary	0.03	0.93	0.93	0.93	0.96	0.83
Poland	0.77	0.91	0.89	0.93	0.93	0.84
Slovenia	0.77	0.92	0.92	0.81	0.91	0.84
<i>t-ave.</i>	-3.11	-2.23	-2.47	-2.59	-2.59	-2.04
<i>z-stat.</i>	-2.76***	-0.33	-1.01	-1.34*	-2.79***	0.18

<i>Table 11: IPS Results for the Second-round Candidate Countries (convergence to EU standard)</i>				
	<i>Industrial Production<sup>1</sup></i>	<i>PPI</i>	<i>CPI</i>	<i>M1</i>
	<i>Coeff.</i>	<i>Coeff.</i>	<i>Coeff.</i>	<i>Coeff.</i>
<i>Bulgaria</i>		0.93	0.93	0.94
<i>Latvia</i>	0.83	0.88	0.97	0.90
<i>Lithuania</i>	0.82	0.94	0.97	0.78
<i>Romania</i>	0.91	0.86	0.94	0.89
<i>Slovak</i>	0.52	0.79	0.91	0.97
<i>t-ave.</i>	-2.13	-2.69	-2.27	-2.42
<i>z-stat.</i>	-0.05	-1.61 <sup>*</sup>	-1.95 <sup>**</sup>	-0.87

Notes: Interest rate results are not reported due to lack of data for Romanian interest rates.

<sup>1</sup>Bulgaria is omitted from the estimation due to large breaks in the data.

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Zentrum für Europäische Integrationsforschung  
Center for European Integration Studies  
Rheinische Friedrich-Wilhelms-Universität Bonn

Walter-Flex-Strasse 3  
D-53113 Bonn  
Germany

Tel.: +49-228-73-1732  
Fax: +49-228-73-1809  
[www.zei.de](http://www.zei.de)