Unemployment and common smooth transition trends in Central and Eastern European Countries

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ABSTRACT

In this paper we analyse whether the apparent comovement of unemployment rates for some of the Central and Eastern EU new members can be explained by a common force, possibly linked to the process of economic integration. For this purpose we test for nonlinear unit roots as a first step to testing for common nonlinearities. Our results show that for five countries, out of eight, unemployment dynamics appear to be well described as a stationary process around highly persistent structural changes. Furthermore, we find evidence of a common nonlinear component driving the unemployment rates.

1 Introduction

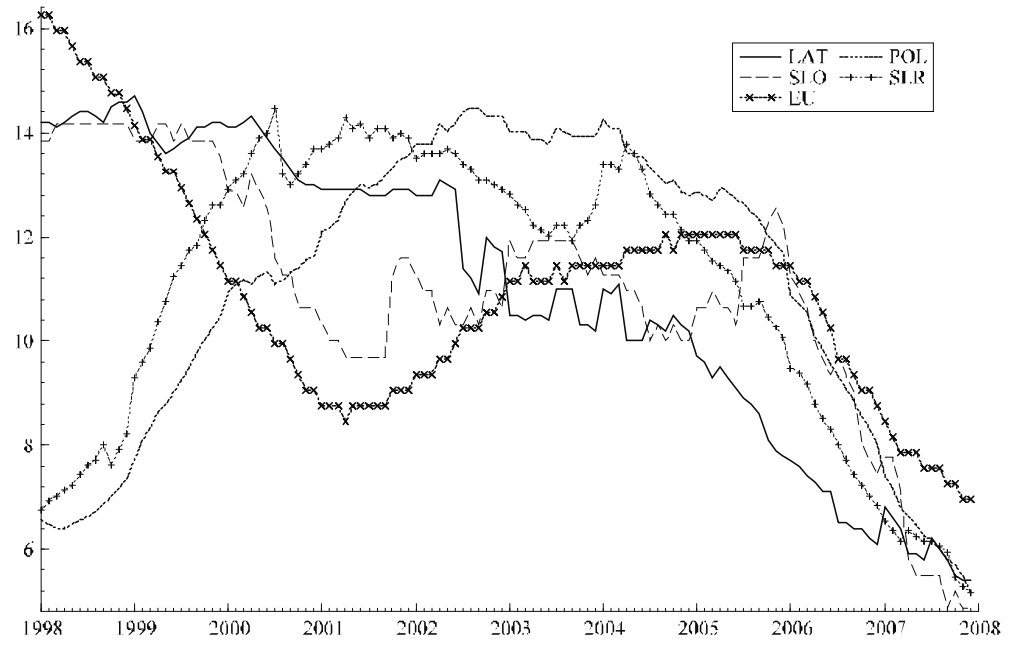
Enlargement is one of the key issues on the European Union (EU) agenda. The EU expanded its membership from 15 to 25 in May 2004[2] and from 25 to 27 in January 2007.[3] Three candidates, Croatia, the former Yugoslav Republic of Macedonia and Turkey, have applied for membership. In order to prepare for accession, candidates are required to meet the so-called Copenhagen Criteria which establish the existence of a functioning market economy and the capacity to cope with competitive pressure and market forces within the Union. The macroeconomic stabilisation measures that these countries had to accomplish in order to meet the requirements for joining the EU are likely to have caused important shocks to output, prices and unemployment. Thus, within the context of economic integration, unemployment is one of the key variables facilitating the adjustment process through macroeconomic equilibrium.

In this paper we analyse whether the apparent comovement of the unemployment rates for the Central Eastern and European Countries (CEEC)[4] can be explained by a common force, possibly linked to the process of economic integration.

The CEECs were in transition from communism to market economies until at least the late 1990s. Unemployment in these countries initially increased due to the rapid labour market reforms during the transition period. Accordingly, the creation of new jobs in the private sector was slow compared with job destruction (Boeri and Terrell, 2002). As a result, a significant proportion of total unemployment is structural in character (León-Ledesma and McAdam, 2004).

Figures 1 and 2 present the time path for our target CEECs unemployment rates,[5] and the EU unemployment average. With the exception of Hungary, comovement is clear at least from 2004 when these countries joined the EU. To test for comovement we need first to assess the order of integration of unemployment rates. If unemployment rates are non-stationary, comovement can be explained in terms of cointegration. On the contrary, if unemployment rates are stationary, something else is going on. We show that the observed common behaviour of the unemployment rates analysed can be explained by the existence of a common nonlinear component.

Figure 1: Unemployment rates for Slovak Republic (SLR), Latvia (LAT), Poland (PO), Slovenia (SLO) and the EU average.



Unit root tests have traditionally been used in the empirical literature on unemployment to test for the natural rate hypothesis, against either the hysteresis or the structuralist view. Hysteresis in unemployment states that

unemployment shocks have permanent effects over the long run path of the variable, therefore the variable will be well-characterised as a unit root process; that is, unemployment rate will never come back to the equilibrium after a shock. There are a number of possible justifications for explaining unemployment hysteresis. Examples include the existence of unions with high negotiation power, soft protection schemes, too high real wages and the social stigma of being unemployed long term (Phelps, 1972; Blanchard and Summers, 1986, 1987; Clark, 2003, and Layard *et al.*, 2005, amongst others). Also, it is possible to observe a slow speed of adjustment towards the equilibrium (or even moving equilibrium) of unemployment rates. This is the so-called 'persistence' hypothesis which implies that the unemployment rate may be characterised as a near unit root or as a fractional integrated process (Gil-Alana, 2001, 2002, amongst others). That is that unemployment needs a long period of time to return to the equilibrium after a shock. On the other hand, the structuralist view implies that most shocks cause temporary movements of unemployment around the natural rate, but occasional shocks might cause permanent changes in the natural rate itself. Unemployment fluctuations are therefore characterised by movements around a shifting natural rate. The structuralist view implies that unemployment is stationary around a process that is subject to structural breaks (Papell *et al.* 2000).

Figure 2: Unemployment rates for Czech Republic (CZE), Estonia (EST), Lithuania (LIT), Hungary (HUN) and the EU average.

In recent contributions, Camarero and Ordóñez (2006) and Franchi and Ordóñez (2008) have examined whether there is a common trend amongst EU

unemployment rates, applying Bierens' (2000) and Anderson and Vahid's (1998) common nonlinearities methodology. Both investigations find that there is a common nonlinear trend that drives EU unemployment rates. To the best of our knowledge, the present paper is the first attempt to analyse this issue for a group of CEECs. However, the issue of whether CEEC unemployment fulfils the natural rate or the hysteresis hypothesis has received some attention recently. For instance, León-Ledesma and McAdam (2004) and Camarero *et al.* (2005) find evidence against the hysteresis hypothesis, applying unit root tests with structural breaks. In addition, Camarero *et al.* (2008), testing for the order of integration of CEECs' unemployment rates using panel data taking into account structural changes, find evidence in favour of the structuralist hypothesis.

The contribution of this paper is twofold. First, we apply unit root tests that take into account two sources of nonlinearities, in the deterministic components and in the autoregressive parameter; and second, we test whether there is a common nonlinear trend between those stationary unemployment rates.

The remainder of this paper is organised as follows. In the next section we present a summary of the econometric methodology applied to test for unit roots and common nonlinear trends. We apply the Leybourne *et al.* (1998) unit root test which takes into account the existence of structural changes approximated by nonlinear smooth transition trends. In addition, in order to capture the possibility of an asymmetric adjustment towards the equilibrium along with nonlinear trends, we apply the Kapetanios *et al.* (2003) (KSS) test which generalises the alternative hypothesis to a global stationary nonlinear exponential smooth transition autoregression (ESTAR) process. Section 3 presents the results and the final section summarises the main conclusions.

2 Econometric methodology

In order to test for the existence of common trends among CEECs unemployment rates, we first need to test for unit roots in the data.

A number of authors have provide supportive evidence that traditional (linear) unit root tests may suffer from power problems when the data generating process (DGP) is nonlinear. Nonlinearities may be present in the DGP in two different, though not exclusive, ways. First, nonlinearities may affect the variable in the form of structural changes in the deterministic components (see Phillips and Perron, 1988, and West, 1987 among others). This supports the structuralist view of unemployment rates, i.e. changes in the fundamentals may shift the natural rate of unemployment in a permanent way. However, a broken time trend is a particular case of a nonlinear deterministic trend. Following Leybourne *et al.* (1998) and Bierens (1997), amongst others, even unit root tests that control for structural changes may tend to overaccept the null hypothesis of a unit root when the deterministic components in the

auxiliary regressions are not properly specified. This makes economic sense bearing in mind that some macroeconomic variables, such as unemployment rates, may shift smoothly rather than suddenly between different equilibrium values. Therefore, in this article we follow the approach of Leybourne *et al.* in order to approximate a nonlinear trend for the unemployment rates for the CEECs. From an economic point of view, the fact that unemployment was a stationary process around a nonlinear deterministic trend implies a time varying equilibrium unemployment rate. Leybourne *et al.* developed a unit root test against the alternative hypothesis of stationarity around a logistic smooth transition (LSTR) nonlinear trend, that is:

$$H_0 : u_t = u_{t-1} + \varepsilon_t$$

versus the alternative:

$$H_1 : u_t = \alpha_1 + \alpha_2 S_t(\gamma,\tau) + \beta_1 t + \beta_2 t S_t(\gamma,\tau) + v_t$$

The function S_t is logistic:

$$S_t = \frac{1}{1+e^{-\gamma(t-\tau T)}} \qquad (1)$$

where u_t is the unemployment rate and v_t is an IID stationary process, t is time and T is the total number of observations. Note that equation (1) implies the existence of two regimes, and the shifts between regimes are smooth rather than sudden. This makes sense from an economic perspective provided that, at the aggregate level, agents do not tend to make decisions simultaneously (Leybourne *et al*, 1998). In particular, workers' behaviour need not be the same bearing in mind that different individuals may have different job hunting skills, depreciation rates, etc. Further, firms' decisions about hiring/firing workers are not necessarily taken simultaneously, reflecting the fact that this decision is normally taken with respect to the marginal revenue product of the labour force, which is likely to differ between different companies.

In order to perform this test, Leybourne *et al.* propose a procedure that involves two steps. In the first step, the series are detrended by means of a Nonlinear Least Squares regression, i.e. $u_t = \hat{\alpha}_1 + \hat{\alpha}_2 S_t(\hat{\gamma},\hat{\tau}) + \hat{\beta}_1 t + \hat{\beta}_2 S_t(\hat{\gamma},\hat{\tau}) + \hat{v}_t$. The second step consists of applying the Augmented Dickey-Fuller (ADF) test to the residuals $\hat{v}_t$. Given that the ADF test is applied to the detrended series, Leybourne et al. obtain the critical values by Monte Carlo simulations.

The second type of nonlinearity is related to the possibility of an asymmetric speed of adjustment towards equilibrium, i.e. the further the variable deviates from its fundamental equilibrium, the faster will be the speed of mean reversion.[6] Intuitively, and in the case of unemployment rates, this implies that the unemployment rate may be a unit root process for a given threshold

of values (inner regime), but a unit root when the variable reaches the outer regime. However, given that there are costs associated to hiring/firing workers, firms will not change their staff for small changes in the fundamentals (policy measures) (see Kapetanios *et al.*, 2003, among others), and the variable behaves as a unit root in the inner regime.

In order to take into account the possibility of an asymmetric speed of adjustment towards equilibrium when testing for unit roots, we apply the KSS unit root test to the detrended[7] series $\hat{v}_t$. These authors propose a unit root test that takes into account the possibility of smooth transitions between regimes. Thus, the null hypothesis of unit root is tested against the alternative of a globally stationary exponential smooth transition autoregressive (ESTAR) process, i.e.:

$$x_t = \beta x_{t-1} + \phi x_{t-1}(1 - e^{-\theta x_{t-1}^2}) + \varepsilon_t \tag{2}$$

where $\varepsilon_t \sim iid(0,\sigma^2)$. Equation (2) can be reparameterised as:

$$\Delta x_t = \alpha x_{t-1} + \gamma x_{t-1}(1 - e^{-\theta x_{t-1}^2}) + \varepsilon_t. \tag{3}$$

KSS impose $\alpha = 0$, implying that the variable is a nonstationary process in the central regime. In order to test the null hypothesis of a unit root H_0: $\theta = 0$ against H_1: $\theta > 1$ outside of the threshold,[8] KSS propose a Taylor approximation of the ESTAR model since, in practice, the coefficient γ cannot be identified under H_0. Thus, under the null, the model becomes:

$$\Delta x_t = \delta x_{t-1}^3 + \eta_t \tag{4}$$

where η_t is an error term. Now, it is possible to apply a *t*-test to analyse whether x_t is a nonstationary process, H_0: $\delta = 0$, or whether it is a nonlinear stationary process, such that H_0: $\delta < 0$. Given that the critical values for the KSS test are not valid for the detrending series using the nonlinear specification, we have obtained the critical values by Montecarlo simulations. By means of applying the KSS test for the detrended series, we are taking into account nonlinearities in the deterministic components and in the autoregressive parameter at the same time.

Finally, in order to test for common logistic smooth transition autoregression (LSTAR) nonlinearities, we apply Anderson and Vahid's (1998) approach, which consists with the following. Let:

$$y_t = \pi_{A0} + \pi_A(L)y_t + F(z_t)[\pi_{B0} + \pi_B(L)y_t] + \varepsilon_t \tag{5}$$

be the multivariate version of a smooth transition autoregression (STAR)(p) model, where y_t is the **5x1** vector of unemployment rates, $\pi_i(L)$, $i = A,B$, is a matrix polynomial of degree p in the lag operator, ε_t is *IID*, and $F(Z_t)$ is a diagonal matrix containing the transition functions $S_t(\gamma, \tau)$ for each series. Testing for common nonlinearities implies testing whether there exists an α such that $\alpha' y_t$ is linear in mean. The test statistic is based on canonical correlations and is asymptotically distributed as $\chi^2_{(3p-1)5s+s^2}$; non-rejection of the null hypothesis provides evidence of the presence of at most n-s common nonlinearities.

3. Empirical results

3.1 Unit root analysis

In this section we analyse whether the unemployment rates for our target group of CEECs (the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic and Slovenia) are stationary processes around a nonlinear trend. In this paper we have used the monthly harmonised and seasonally adjusted unemployment rates for 1998:1-2007:12 from *Eurostat*.

Table 1: Estimated models

Czech Republic

$$u_t = \underset{[22.40]}{5.11} + \underset{[9.70]}{0.19}\,t + \underset{[14.98]}{4.21}\,S_t(\underset{[2.34]}{0.34}, \underset{[5.61]}{0.174}) - \underset{[-10.99]}{0.21}\,tS_t(\underset{[2.34]}{0.34}, \underset{[5.61]}{0.174})$$

Estonia

$$u_t = \underset{[24.93]}{2659.80} + \underset{[59.44]}{8.07}\,t - \underset{[-26.78]}{6719.89}\,S_t(\underset{[32.75]}{0.004}, \underset{[55.68]}{0.73}) + v_t$$

Hungary

$$u_t = \underset{[87.77]}{9.24} - \underset{[-5.34]}{0.17}\,t - \underset{[5.00]}{0.16}\,tS_t(\underset{[8.39]}{0.03}, \underset{[4.50]}{0.32}) + v_t$$

Latvia

$$u_t = \underset{[192.20]}{15.12} - \underset{[-33.84]}{0.06}\,t - \underset{[-12.94]}{2.42}\,S_t(\underset{[4.35]}{0.24}, \underset{[104.31]}{0.78}) + v_t$$

Lithuania

$$u_t = \underset{[60.19]}{14.51} - \underset{[-3.71]}{0.32}\,t + \underset{[32.86]}{9.22}\,S_t(\underset{[11.78]}{0.18}, \underset{[12.81]}{0.17}) + \underset{[1.75]}{0.15}\,tS_t(\underset{[11.78]}{0.18}, \underset{[12.81]}{0.17}) + v_t$$

Poland

$$u_t = -\underset{[21.88]}{81.27} - \underset{[-7.89]}{0.81}\,t + \underset{[41.34]}{206.46}\,S_t(\underset{[9.86]}{0.02}, \underset{[4.74]}{0.10}) + v_t$$

Slovak Republic

$$u_t = \underset{[11.34]}{669.18} + \underset{[3.53]}{18.68}\,t - \underset{[-13.40]}{2141.15}\,S_t(\underset{[39.95]}{0.007}, \underset{[401.01]}{0.97}) + v_t$$

Slovenia

$$u_t = \underset{[131.09]}{7.67} - \underset{[-7.64]}{0.04}\,t + \underset{[4.51]}{14.86}\,S_t(\underset{[8.07]}{0.06}, \underset{[20.27]}{0.74}) - \underset{[-4.57]}{0.109}\,tS_t(\underset{[8.07]}{0.06}, \underset{[20.27]}{0.74})$$

Note: Standard errors in parentheses

First, we apply Leybourne *et al.*'s (1998) unit root test. In Table 1, we display the estimated models for the deterministic components under the alternative hypothesis. Note that in the majority of cases (Estonia, Latvia, Poland and Slovak Republic) the drift needs to be modelled as a nonlinear process, whereas for the Czech Republic, Lithuania and Slovenia both the trend and drift need to be modelled as a nonlinear function. Only for Hungary are the deterministic components modelled as a nonlinear time trend.

Table 2: Leybourne *et al.* (1998) unit root tests results

Country	*Lags*	*ADF*(*t*)
Czech Republic	12	-2.06
Estonia	2	-2.63
Hungary	9	-3.17*
Latvia	9	-3.28**
Lithuania	5	-2.61
Poland	5	-5.07***
Slovak Republic	0	-2.18
Slovenia	0	-2.90(*)

Note: The order of lag to compute the test has been chosen using the AIC. The critical values are at the 10%, 5% and 1% levels: -2.94, -3.29 and -3.89. Rejection of the null hypothesis at the 10%, 5% and 1% significance level is given by *, **, and ***, respectively. The critical values for the above tests have been computed by Monte Carlo simulation based upon 10,000 replications.

In Table 2 we display the results of the Leybourne *et al.* (1998) unit root test. According to these results, we find evidence of stationarity around a nonlinear trend for Hungary, Latvia, Poland and Slovenia. We regard these results as evidence in favour of a structuralist explanation of unemployment dynamics in the presence of highly persistent structural changes. As noted previously, we have applied the KSS test for the remaining countries, bearing in mind that not taking into account the possibility of an asymmetric speed of adjustment may affect the power of the test. In Table 3 we summarise our results and find evidence of a globally stationary process around a nonlinear trend only for the Slovak Republic.

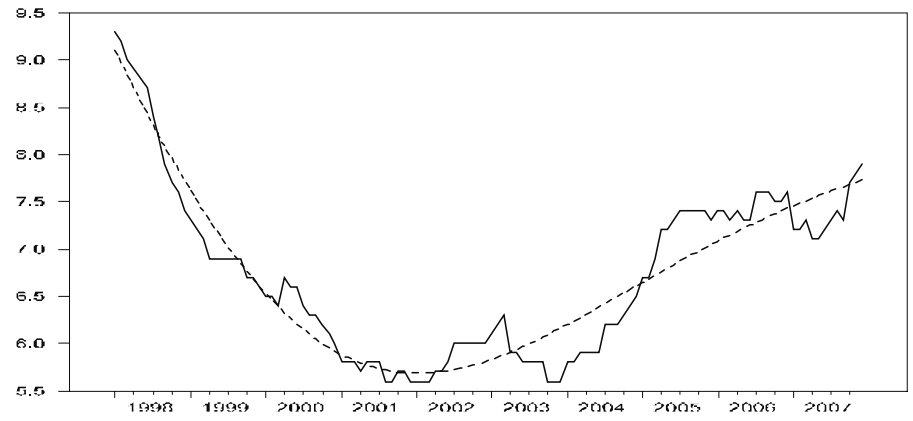
Table 3: Kapetanios *et al.* (2003) nonlinear unit root test results over the residuals

Country	*Lags*	*KSS*(*t*)
Czech Republic	12	-1.42
Estonia	4	-2.69
Lithuania	0	-2.02
Slovak Republic	12	-4.20**

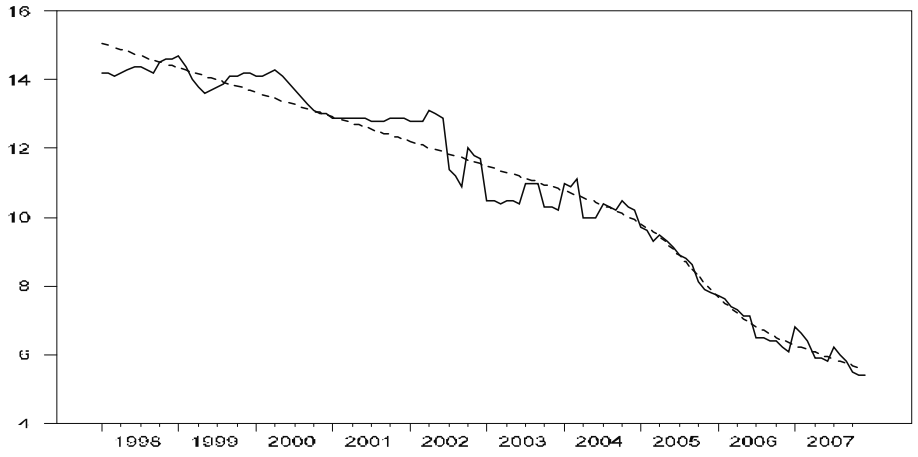
Note: The order of lag for the auxiliary regression has been selected by the AIC. Critical values at the 10%, 5% and 1% levels for the KSS(t)test are -3.55, -4.19 and -5.49, respectively and have been computed by Monte Carlo simulation with 10,000 replications. Rejection of the null hypothesis at the 10%, 5% and 1% significance level are given by *, **, and ***, respectively.

In Figure 3 we display the graphs of the stationary series, along with the estimated nonlinear components. It can be seen that the long run paths of Latvia's and Slovenia's unemployment rates are quite similar. Also, there appears to be a clear comovement between Poland's and the Slovak Republic's rates of unemployment. A different picture appears to emerge from the Hungarian unemployment rate. In the next section we test for the existence of common nonlinearites amongst these five countries.

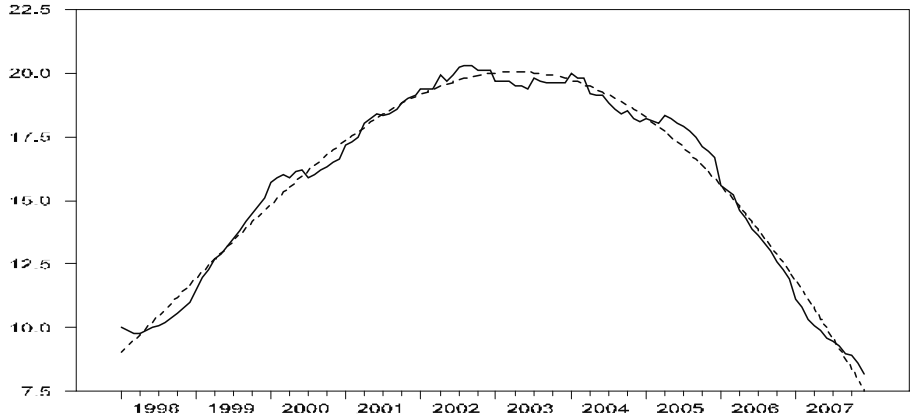
Figure 3: Unemployment rates and nonlinear trends



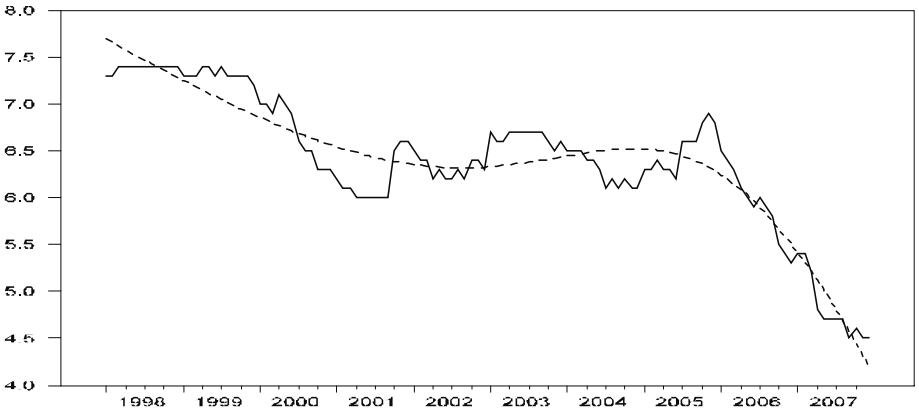
Hungary



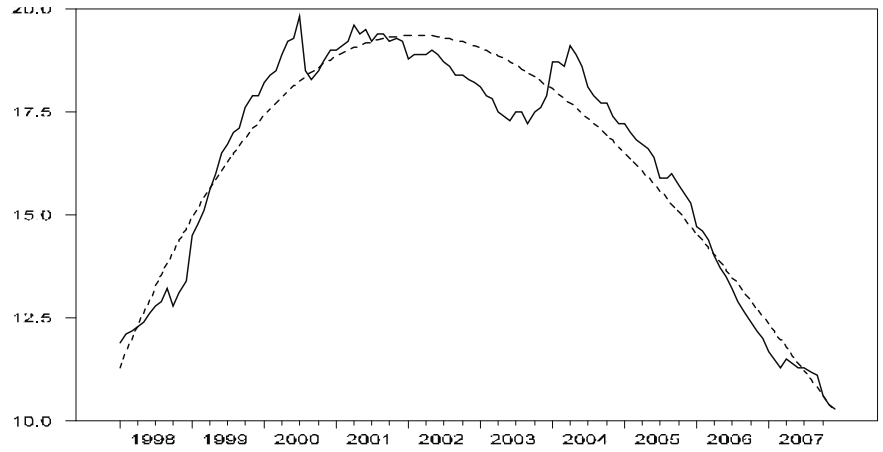
Latvia



Poland



Slovenia



Slovak Republic

3.2 Comovement analysis

In the last section we gave evidence of nonlinear trend-stationary behaviour for five out of eight unemployment rates. Next we test whether the apparent comovement between the observed unemployment rates (see Figure 1) for Latvia, Poland, the Slovak Republic and Slovenia can adequately be described by a common nonlinear component.[9] In order to address this issue we test for common LSTAR nonlinearities following the methodology proposed by Anderson and Vahid (1998).

The results are presented in Table 4 and have been obtained using the trend as the (common) transition variable. The test for common LSTAR nonlinearity rejects the null that there are no nonlinear factors in the system in favor of the alternative of at least one common LSTAR nonlinearity. Furthermore, the test fails to reject the null that there is at most one such a factor at the 5% significance level. Thus, the tests provide evidence that a common force generates nonlinear behaviour in each of the unemployment rates. Our results suggest that unemployment rates in four of five countries (Latvia, Poland, the Slovak Republic and Slovenia) have been driven by common factors, probably by the effect of the economic convergence process towards the EU.

Table 4: Tests for common LSTAR nonlinearities

Null hypothesis	*Alternative hypothesis*	p-value
The system of unemployment rates is linear	At least one of the unemployment rates has an LSTAR nonlinearity	0.001
Unemployment rates have at most 1 common LSTAR nonlinearity	Unemployment rates have at least 2 of these LSTAR nonlinearities	0.983
Unemployment rates have at most 2 common LSTAR nonlinearity	Unemployment rates have at least 3 of these LSTAR nonlinearities	0.977
Unemployment rates have at most 3 common LSTAR nonlinearity	Unemployment rates have at least 4 of these LSTAR nonlinearities	0.963

4. Conclusion

In order to contribute to the empirical literature on the unemployment rate properties of the CEECs, we have analysed (1) whether the unemployment rates in this group of countries are represented as a stationary process around

a nonlinear trend; and (2) whether there is a common nonlinear component amongst those found to be stationary. Our results suggest the possibility of a time varying equilibrium unemployment rate for four out of eight countries, accepting also the hypothesis that these countries share a common nonlinear component which accounts for the observed comovement within them.

ENDNOTES

1. University of Sheffield and University of Bath respectively. Corresponding author: Department of Economics, University of Sheffield, 9 Mappin Street, S1 4DT, Sheffield, UK, e-mail: j.cuestas@sheffield.ac.uk. The authors acknowledge the comments of two anonymous referees and an associate editor, and financial support from the CICYT project ECO2008-05908-C02-01/ECON and Junta de Castilla y León SA003B10-1 grant. The usual disclaimer applies.

2. On 1 May 2004 Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia became members.

3. On 1 January 2007 Romania and Bulgaria became members.

4. We restrict our analysis to the countries that joined EU in May 2004.

5. Unemployment rates are displayed with mean and range matched to ease the comparison.

6. Asymmetric speed of adjustment differs from the concept of asymmetric adjustment. The latter implies the variable reacts in a different manner depending on the sign of the shock. This is a characteristic of logistic smooth transition functions.

7. We use the same LSTR functions for detrending as for the Leybourne et al. (1998) tests.

8. The process is globally stationary provided that $-2 < \phi < 1$.

9. Although the Hungarian unemployment rate exhibits nonlinear trend-stationarity behaviour, it does not show clear comovement with the other countries investigated. For this reason Hungary has been excluded from the analysis of common nonlinearities. Yet, if the Hungarian unemployment rate is included in the analysed set of countries, results do not vary.

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