Original scientific paper
UDC: 331.56:519.8>(4-12)
https://doi.org/10.18045/zbefri.2018.2.559

Are unemployment rates stationary for SEE10 countries? Evidence from linear and nonlinear dynamics*[1]

Saša Obradović[2], Lela Ristić[3], Nemanja Lojanica[4]

Abstract

This article aims to answer the questions concerning the dynamics of unemployment rates, including whether there is a subsequent hysteresis in the selected sample of ten countries of the South East Europe. The linear and nonlinear tests have been used to determine the stationarity of unemployment rates. The findings show that in eight out of ten countries, unemployment is a stationary process which implies that the hysteresis hypothesis has not been confirmed. The unemployment rates in Albania, Bulgaria, Slovenia, Croatia, Romania, Greece, Montenegro and Turkey manifest mean reverting behaviour. The movements of unemployment rates in the next period can be forecasted with a relatively high degree of certainty in terms of the mentioned countries. The unemployment in FYR Macedonia and Serbia is a non-stationary process. The results further emphasize the importance of allowing asymmetric adjustment and structural breaks, especially in the case of Romania, Montenegro and Turkey.

Key words: *hysteresis, unemployment rate, non-linearity, stationarity and unit root*

JEL classification: *J08, J21, J64*

* Received: 21-07-2018; accepted: 27-11-2018

[1] This work was supported by the Ministry of Science and Education of the Republic of Serbia under Grant number 179015.

[2] *Full Professor, University of Kragujevac – Faculty of Economics, Djure Pucara 3, 34000 Kragujevac, Serbia. Scientific affiliation: macroeconomics, applied econometrics. Phone: +381 34 303 550. E-mail: sobradovic@kg.ac.rs.*

[3] *Associate Professor, University of Kragujevac – Faculty of Economics, Djure Pucara 3, 34000 Kragujevac, Serbia. Scientific affiliation: sustainable agricultural and rural development, agribusiness management, economic development. Phone: +381 34 303 552. E-mail: lristic@kg.ac.rs. (corresponding author).*

[4] *Teaching assistant, University of Kragujevac – Faculty of Economics, Djure Pucara 3, 34000 Kragujevac, Serbia. Scientific affiliation: macroeconomics, applied econometrics, globalization and transition. Phone: +381 34 303 508. E-mail: nlojanica@kg.ac.rs*.

1. Introduction

The ten countries of South East Europe (SEE10: Albania, Montenegro, FYR Macedonia, Bulgaria, Turkey, Romania, Serbia, Slovenia, Croatia and Greece) share the same geographical region. One of the most significant problems for some countries, which are dealing with creating economic policy, is a relatively high unemployment rate. Thus, one of the most important tasks for them is to solve the unemployment issues. The question is in the focus of both academic and professional circles and also wider communities. Numerous empirical studies have examined unemployment dynamics. All of them have been conducted in either a linear or non-linear frame. The initial research was predominantly conducted in a linear frame, even though unemployment rate can manifest rather non-linear behaviour due to circular dynamics of business operations (Cancelo, 2007).

The hysteresis of unemployment has been an issue of debate in macroeconomic literature for decades. The precise definition of unemployment hysteresis is practically not available since the term is not uniquely defined in the current literature (Amable et al., 1995). It can be roughly explained as an assumption that long periods of real unemployment result in stability of unemployment rates. This means that unemployment dynamics is not only under the influence of input values, but that past changes also have an impact. Non-accelerating rate of unemployment is another related concept and it refers to unemployment with relatively stable inflation. In summary, two basic hypothesis have been formulated based on the previous research and both have been examined in the literature in order to explain the unemployment behaviour. The first refers to natural rate of unemployment and the other to unemployment hysteresis. The main question to be answered is: Is there unemployment hysteresis in the observed countries?

There are two opposite hypothesis that are tested in this paper:

- The unemployment rate fluctuates around the equilibrium level by means of the stationary process;
- The unemployment rate is non–stationary and path dependent with very weak tendency to return to equilibrium.

To the best of our knowledge, there was no previous research on this subject for the given sample of countries. The main contribution of this study is twofold. First, the analysis is dealing with unemployment dynamics on a unique sample of countries. Secondly, the analysis uses a specific unit root tests for examining time series. This study focuses on testing the hypothesis of unemployment hysteresis, i.e. the analysis of unemployment dynamics and potential impacts of shocks which may be permanent or transitory. The specified battery of tests of unit root has been applied to overcome certain methodological issues discussed in more detail in the methodology section.

This article consists of six main sections. It is organized as follows: the subsequent to this introduction is the next section which provides literature review. Section 3 describes an overview of econometric methodology and unit root tests used in the analysis. Then, the empirical data are presented and analyzed in the fourth part. The results are discussed in the section 5. Finally, the concluding remarks are given in the last section.

2. Literature review

The debate about natural unemployment rate hypothesis, i.e. non-accelerating inflation rate of unemployment (NAIRU), follows from the fact that without government interventions the inflation rate behaves as an axis around which unemployment circles in the long run, even though economic cyclic fluctuations affect changes in unemployment in the short run. Natural unemployment rate hypothesis has had an enormous impact on macroeconomic theory and policy (Palley, 2018). According to Palley, this hypothesis has an important role in supporting the agenda that relies on flexibility of labour market. Balanced unemployment does not depend on the current unemployment level based on the effects of labour supply and demand, as well as the impact of labour market institutions. The changes in supply and demand of labour provoke changes, in terms of deviations from balanced unemployment, and consequently they have an effect on natural rate movement. These changes induce changes in inflation rate which evidentially lead to regaining the equilibrium state of unemployment.

The alternative hypothesis which assumes that current and previous increases in unemployment have a direct impact on real unemployment was first developed by Blanchard and Summers (1986a). Transitory shocks can have a permanent impact on unemployment level. High long-term unemployment in Europe has served as a basis for developing two theoretical explanations for hysteresis effects known as membership theories and duration theories (Blanchard and Summers, 1986b). The existence of unemployment hysteresis is a justification for proactive government policies and measures targeted at unemployment reductions especially in recession phases of economic cycle (Smyth, 2003). With hysteresis, there is a state when unemployment not returns to NAIRU level. This is based on the process which can be evaluated as closely non-stationary. This means that in time series which include unemployment, there is a unit root.

In proving the hypothesis of natural rate, the assumption is of opposite nature, i.e. unemployment is included in a stationary process which means that reversal oscillatory movements are relative to the NAIRU. Time series of unemployment do not have a unit root. Persistence is distinguished as a feature of the dynamics of unemployment as a special hypothesis that includes hysteresis. Persistence is more likely based on nonlinearities and the asymmetries (Blanchard, 2018). For some

authors, unemployment persistence is subject to quantile parameter heterogeneity (Andini and Andini, 2018). It means that shocks can change the location and the dispersion of the distribution of the unemployment rates. The framework of the persistence hypothesis assumes that a long period is needed to potentially return unemployment rate to NAIRU. According to this hypothesis, which can be treated as a special cases of unemployment hysteresis, time series of unemployment have characteristics close to unit root. Unemployment hysteresis assumes that there is a equilibrium in unemployment which is defined by the historical movement or, in other words, is basically determined by the path of real rate movement. In other words, the current unemployment rate is determined by past levels of unemployment (Blanchard and Summers, 1986b).

Empirical studies in this field are abundant and in most cases are based on univariate or panel analyses. The sample and the length of time period under examination varies. For example, Gustavsson and Österholm (2011) observed quarterly periods for unemployment rates in the USA ranging from the 1stquarter 1948 to the 4th quarter 2005. They determined that this rate can be best described through mean reverting process by using bootstrapped out of sample method. The results of applying traditional tests as ADF (Dickey and Fuller, 1979) and KPSS (Kwiatkowski et al., 1992) gave inconsistent results, i.e. different results which are insufficient for drawing conclusions for short-term time intervals. During the 90s of the previous century, studies mainly used the battery of traditional tests, predominantly ADF and PP (Phillips and Perron, 1988) tests (Furuoka, 2015). The typical examinations with unit root tests were conducted in a linear frame due to linear theoretical models, the easiness of performing suchlike studies and the fact that nonlinear tests are relatively new (Gustavsson and Österholm, 2006). The sequential panel selection method on the data from 17 Euro zone countries (from 2000 – 2013) was used to test the hysteresis hypothesis through nonlinear panel unit root (Bolat et al., 2014). The results of the panel KSS (Kapetanios-Shin-Snell) test with Fourier function confirmed the hypothesis in six cases while in the remaining countries the stationary rates were confirmed, i.e. the natural rate hypothesis of unemployment was confirmed.

The empirical data about yearly unemployment rates for so called PIIGS countries for the period from 1960 to 2011 was tested using the Fourier transformations to control unknown nature of structural breaks (Cheng et al., 2014). The flexible Fourier unit root proved to be advantageous with respect to traditional linear method when the unemployment data were generated through nonlinear process of unknown forms and with the existence of structural breaks. With the exception of Spain and Portugal, the existence of hysteresis was confirmed in the remaining countries with possible permanent influence of fiscal stabilization policy on unemployment rate. Furuoka (2016) incorporated cross-dependency, unknown structural breaks and unnoticed non-linearity in time series of data from five

European countries and the hysteresis hypothesis was rejected in case of Spain. The dynamics of unemployment rates in France, Great Britain, Italy and Germany was not inconsistent with this hypothesis which was proved in studies using conventional tests of unit root. Furuoka (2017) also examined the unemployment hysteresis in the case of four Nordic countries. Findings suggest that there is no unemployment hysteresis, considering the results of the FADF-SB test. The empirical significance of the natural rate hypothesis with multivariate method was confirmed in case of the USA while in the series of data from Japan and Great Britain, there was still a higher order of integration present (Caporale et al., 2016). The application of univariate method did not reject mean reversion in these economies. The linear and non-linear tests and a test which examined non-normal errors for 14 OECD countries showed that shocks have permanent effects on unemployment in 11 countries (Meng et al., 2017). The unemployment hysteresis was confirmed in 4 countries (from 1983Q1-2013Q3).

In a study of 17 OECD countries for time period from 1960 – 2009, the hysteresis hypothesis was confirmed for most of these economies (Chang, 2011). This empirical study used a stationary test with Fourier function which had been recommended by Becker et al. (2006). The results were not consistent with the previous study on 16 OECD economies, where a weak version of natural rate hypothesis was confirmed (Song and Wu, 1998). However, similar results were obtained in numerous studies which were consistent with assumptions about unemployment hysteresis for most European countries (Leon-Ledesma, 2002; Camarero and Tamarit, 2004; Chang et al., 2005). The studies focusing on Eastern Asian and Pacific region revealed the existence of unemployment hysteresis in ten countries (Furuoka, 2012). New Zealand and South Korea were exceptions. The authors claimed that unemployment rates did not return on their natural level in the long run due to insufficiently efficient labour market. As a response to economic difficulties, most of the economies from this sample experienced relatively high unemployment rates. Only in these two economies the labour markets were enough flexible and robust to deal with negative impacts of economic difficulties.

The dynamics of unemployment was examined in eight countries of Central and East Europe which joined EU in 2004 (Cuestas et al., 2011). The tests which allow fraction integration showed that shocks are highly persistent which implies slow rate of convergence based on the natural rate of unemployment. The unemployment was least persistent in Hungary and Slovenia while the extreme persistence was present in Poland. The rate of different persistency reflects different levels of economic and institutional development and the potential role of government interventions. Considering the case of 9 Eastern European countries, for period (200M1-2016M8), using the Quantile unit root tests, the unemployment hysteresis was confirmed in only two countries (Xie et al., 2018). According to these findings, only in the case of Hungary and Romania, fiscal or monetary stabilization policy

could potentially have permanent effects on the unemployment rate. The use of Kalman's filter in natural rate model was tested with respect to unit root model for Germany and France (Srinivasan and Mitra, 2012). The unit root hypothesis was rejected and the high share in unemployment in these two countries was attributed to natural rate growing.

Fourier test of unit root was improved by Enders and Lee (2012) to test unemployment in PIIGS countries from 1960 – 2011 (Li et al., 2017). With the exception of Greece, the hypothesis of unit root was not confirmed. The study implies that fiscal stabilization policy does not have permanent positive effects on unemployment rates. The systematic empirical analysis of 13 Latin American countries observed the dynamic behaviour of unemployment using the battery of statistical tests on one series and panel series of data for time period from 1980 to 2005 (Mednik et al., 2012). The study showed that aggregate unemployment can be described through the confirmation of unit root hypothesis for majority of these countries.

Nonlinear behaviour of unemployment has been documented in literature and it frequently serves as a justification for not using linear unit root tests. Thus, nonlinear panel test of unit root developed by Ucar and Omay (2009) was used to analyze unemployment in 29 OECD countries by Lee (2010). This study used sequential method of panel selection, suggested by Chortareas and Kapetanios (2009), to classify whole panel into two groups of countries. Empirical results favoured the natural rate hypothesis in 23 out of 29 cases. Unemployment rate was described as non-linear stationary process for most countries observed in the analysis.

The data on unemployment hysteresis in the USA covered the long period, ranging from 1928 to 2014. Conventional test of single unit root rejected the hypothesis as well as the Kolmogorov-Smirnov test (Jiang and Chang, 2016). The authors claimed that their empirical results did not support economic stabilization policies in the USA because they did not have a potential permanent effect on unemployment rates. On the other hand, short-term models which take equilibrium of output and unemployment are probably too powerless when effects of stabilization policy interventions are analyzed (O'Shaughnessy, 2011). Cheng et al. (2012) examined stochastic nature of unemployment rate in case of USA states panel by using identification of mutual and idiosyncratic component. Their most significant findings refer to non-stationary mutual component in the data from the recent recessions and the persistency of natural rate of unemployment.

Regional unemployment examinations of Greek unemployment rates and its stochastic nature revealed the existence of unit root by using panel tests with structural breaks and cross dependency. The data of time series of unemployment in Greek regions were nonstationary when structural breaks were present (Bakas and Papapetrou, 2014). On the other hand, contrary to previous studies, characterization

of regional unemployment in Italy was determined as stationary, but nonlinear process, liable to multiple equilibriums (Lanzafame, 2010). This supports the so called structural hypothesis advanced by Phelps (1994). The examination of unemployment rate for Australia from 1978 to 2010 showed that the process was nonlinear which supports the structural hypothesis (Tiwari, 2014).

The application of nonlinear techniques did not confirm the hysteresis hypothesis in case of Turkey (Guris et al., 2017). The study was conducted with nonlinear tests of unit root developed by Kapetanios et al. (2003) and Kruse (2011). In other words, the natural unemployment hypothesis was valid in case of Turkey. Akdogan (2017) used alternative, linear and nonlinear tests of unit root in testing the hypothesis for 31 European countries, USA and Japan taking into consideration possible structural breaks. The hysteresis hypothesis was rejected in 60% of countries under examination and a special advantage of the study is that it showed applicability of nonlinear models during economic cycles for some countries. The presence of multiple structural breaks has an impact on mean level on employment (Akdogan, 2017).Previous studies have provided essential insights into linear and nonlinear dynamics of unemployment trends.

3. Methodology

The first step of the analysis is to determine the adequate model for given time series. The standard testing assumes the application of two models – linear and nonlinear model. Linearity test (Harvey et al., 2008) used here has advantages over similar tests (e.g. Terasvirta, 1994 and Luukkonen et al., 1988). The standard tests are based on the assumption of the stationarity of the series under investigation. The validity of an I(0) behaviour is a questionable assumption. Harvey et al. test (2008) is applicable when the order of integration of data is unknown. It is superior in comparison to the test of Harvey and Leybourne (2007) even though the latter does not require previous knowledge of the order of integration. This test also uses multiplicative scaling factor modification to overcome limits of null distribution of Wald statistic. The analysis of Harvey et al. (2008) is consistent with studies of Kapetanios et al. (2003) and Sollis (2009).

Harvey et al. (2008) developed two parallel regression models considering the time series U_t. Both of them are derived from Taylor series expansion.

$$U_t = \beta_o + \beta_1 U_{t-1} + \beta_2 U_{t-1}^2 + \beta_2 U_{t-1}^3 + \varepsilon_t \quad (1)$$

The second one is the first difference model:

$$\Delta U_t = \lambda_1 \Delta U_{t-1} + \lambda_2 (\Delta U_{t-1})^2 + \lambda_3 (\Delta U_{t-1})^3 + \varepsilon_t \quad (2)$$

For the first regression, the null hypothesis of linearity is satisfied when $\beta_2=\beta_3=0$. Alternative hypothesis $\beta_2 \neq 0$ and/or $\beta_3 \neq 0$ signifies nonlinearity. Thus, we can derive the equation for the first model:

$$U_t = \beta_o + \beta_1 U_{t-1} + \varepsilon_t \quad (3)$$

Standard Wald statistics (W_o) follows asymptotic distribution under the null hypothesis. For the second model, we test:

$$H_0: \lambda_2 = \lambda_3 \quad (4)$$

against the alternative:

$$H_a: \lambda_2 \neq 0 \text{ and/or } \lambda_3 \neq 0 \quad (5)$$

where:

$$\Delta U_t = \lambda_1 \Delta U_{t-1} + \varepsilon_t \quad (6)$$

W_1 statistics will follow the distribution under the null, where the hypothesis under assumption U_t is I(1). Weighted average statistics can be represented respectively as:

$$W_\lambda = \{1-\lambda\} W_0 + W_1 \quad (7)$$

Function λ converges in probability from 0 to 1 depending on the order of integration for U_t. When nonlinearity is present, traditional unit root tests do provide enough precision in determination of time series stationarity. The power of the proposed statistics for nonlinear models exceeds those of the traditional tests (Enders and Granger, 1998). In the literature dealing with the analysis of time series, a significant place is reserved for nonlinear models of unit root. Nonlinear tests are better solution when a data process has underlying nonlinearities. It is often the case that the nonlinear behaviour has been detected in economic variables peculiarly unemployment.

Nonlinear adjustment in the ESTAR (exponential smoothing transitional autoregressive) model means that the mean reverting properties are best examined by nonlinear unit roots. Smooth transition autoregressive model is a basis for Kapetanios et al. (2003) unit root test (henceforth, KSS test). It is considered to be a nonlinear model of the Augmented Dickey Fuller (ADF) test for testing nonlinear stationarity (Bahmani-Oskooee and Hegerty, 2009). The ESTAR model is based on a univariate smooth transition autoregressive of order 1, namely STAR(1) model. It is as follows:

$$U_t = \beta U_{t-1} + \gamma U_{t-1} \Theta(\theta; U_{t-d}) + \varepsilon_t \quad t = 1,\ldots,T \quad (8)$$

in which β and γ are unknown variables and $\varepsilon_t \sim iid\ (0, \sigma^2)$. U_t is a series under investigation. This implies the following exponential function:

$$\Theta(\theta; U_{t-d}) = 1 - \exp(-\theta U_{t-d}^2) \quad (9)$$

where $\theta \geq 0$, and $d \geq 1$. This function is continuous. The transition function is bounded between zero and one. These formulae provide the following ESTAR model reparametrisation:

$$\Delta U_t = \phi U_{t-1} + \gamma U_{t-1}[1 - \exp(-\theta U_{t-d}^2)] + \varepsilon_t \quad (10)$$

where $\phi = \beta - 1$. In (10), positive θ determines the speed of transition to mean reversion. The modelling of different series dynamics is performed in accordance with deviations from equilibrium. If $\phi \geq 0$ then, for the process to be globally stationary, the following condition must be fulfilled: $\gamma < 0$ and $\phi + \gamma < 0$. Geometric ergodicity is a consequence of stable dynamics for large U_{t-d}^2. With ESTAR process KSS test has power opposite to standard ADF test.

In ESTAR model we may assume that $\phi = 0$ (Michael et al., 1997). Kapetanios et al. (2003) in case of $\phi = 0$ and $d = 1$ presented specific ESTAR model as:

$$\Delta U_t = \gamma U_{t-1}[1 - \exp(-\theta U_{t-1}^2)] + \varepsilon_t \quad (11)$$

There are two main hypotheses which focus on parameter θ. The unit root null hypothesis H_0: $\theta = 0$ stands against alternative H_1: $\theta > 0$. Parameter γ is unknown under the null hypothesis. Kapetanios et al. (2003) derive t-type statistics to overcome this obstacle. The transition function is replaced with first-order Taylor series approximation for $\theta = 0$. It yields the following regression:

$$\Delta U_t = \sigma U_{t-1}^3 + \varepsilon_t \quad (12)$$

Expression ε_t contains error term from Taylor approximation. The null hypothesis in this case is:H_0: $\sigma = 0$, against the alternative H_1: $\sigma < 0$, based on t – statistics as follows:

$$t_{NL} = \hat{\sigma} / \text{s.e.}(\hat{\sigma}) \quad (13)$$

OLS estimate of σ is $\hat{\sigma}$ and s.e. is standard error of $\hat{\sigma}$. Kapetanios et al. (2003) obtained the asymptotic critical values for t_{NL} for three cases via stochastic simulations with $T = 1000$ and 50000 replications. Auxiliary regression may be extended assuming the more general case, where errors are serially correlated:

$$\Delta U_t = \Sigma_{j=1}^{p} pj \Delta U_{t-j} + \sigma U_{t-1}^3 + \varepsilon_t \quad (14)$$

The second type of test allows symmetric or asymmetric nonlinearity based on the combination of an exponential and logistic function (Sollis, 2009). The AESTAR (asymmetric exponential smoothing transitional autoregressive) model for unemployment variable can be presented as:

$$\Delta U_t = [1 - \exp(-\theta_1 U_{t-1}^2)][(1 + \exp(-\theta_2 U_{t-1}))^{-1} p_1 + \\ + (1 - (1 + \exp(-\theta_2 U_{t-1}))^{-1} p_2] U_{t-1} + \varepsilon_t \quad (15)$$

where ε_t is an error term, and θ_1, $\theta_2 \geq 0$.

This model can represent higher order dynamics by extension:

$$\Delta U_t = [1 - \exp(-\theta_1 U_{t-1}^2)][(1 + \exp(-\theta_2 U_{t-1}))^{-1} p_1 + \\ + (1 - (1 + \exp(-\theta_2 U_{t-1}))^{-1} p_2] U_{t-1} + \Sigma_{i=1}^{k} K_i \Delta U_{t-1} + \varepsilon_t \quad (16)$$

Unit root hypothesis can be tested as follows: H_0: $\theta_1 = 0$. Unidentified parameters under H_0 are θ_2, p_1 and p_2. In order to solve this problem, an approximation is used to develop further model which results in the augmented version:

$$\Delta U_t = \lambda_1 U_{t-1}^3 + \lambda_2 U_{t-1}^4 + \Sigma_{i=1}^{k} K_i \Delta U_{t-1} + \varepsilon_t \quad (17)$$

The null hypothesis H_0: $\theta_1 = 0$ transforms into H_0: $\lambda_1 = \lambda_2 = 0$. If alternative hypothesis of stationary symmetric or asymmetric ESTAR nonlinearity has been accepted then symmetric ESTAR nonlinearity can be tested against the alternative of asymmetric ESTAR nonlinearity (H_0: $\lambda_2 = 0$ against H_1: $\lambda_1 \neq 0$). For testing the null hypothesis H_0: $\lambda_1 = \lambda_2 = 0$, asymptotic distribution of an F test is derived as a specific function.

Linear unit roots can be applied when we have linear adjustment. A standard ADF test is based on regression:

$$\Delta U_t = \beta_0 + \beta_1 U_{t-1} + \Sigma_{i=1}^{k} \beta_i \Delta U_{t-i} + \varepsilon_t \quad (18)$$

where β_0 is intercept and k is the lag length. The H_0: $\beta_1 = 0$ can be tested against alternative hypothesis: $\beta_1 < 0$. The initial model does not have to follow conventional order. It can be derived thorough asymptotic results and simulations of critical values with autoregressive dependent variable through specified lag length (Dickey and Fuller, 1981).

On the other hand the structural breaks can have an impact on determining stationarity which has been proved through the existence of the same in the series which were claimed to be nonstationary even though the opposite was the case. Peron (1989) determined it for macroeconomic variables in case of the USA, reexamining the data with introduction of structural breaks.

The testing of unemployment rates with linear dynamics is first performed with a test with one structural break when the break point period is unknown in order to avoid the limitations of the traditional tests. This analysis uses Zivot and Andrews (1992) test with one structural break. Z-A test is presented through two models which are formulated as the following regression equations:

Model with intercept:

$$U_t = \mu^A + \theta^A DA_t(\lambda) + \beta^A t + \alpha^A u_{t-1} + \Sigma_{j=1}^{k} c_j^A \Delta u_{t-j} + \varepsilon_t \quad (19)$$

Model which includes an intercept and a trend:

$$U_t = \mu^c + \theta^c DA_t(\lambda) + \beta^c t + \alpha^c u_{t-1} + \Sigma_{j=1}^{k} c_j^C \Delta u_{t-j} + \gamma^c DT_t(\lambda) + \varepsilon_t \quad (20)$$

where $DA_t(\lambda) = 1$ if $t > T\lambda$, 0 otherwise; $DT_t(\lambda) = t - T\lambda$ if $t > T\lambda$, 0 otherwise. Parameters λ comply to the values of the break fraction. There are no breaks under the unit root null and critical values are derived based on it. The endogenous procedure of this test is based on detecting one unknown breakpoint.

Finally the existence of two structural breaks on the variable of interest is tested through Lagrange Multiplier unit root test developed by Lee and Strazicich (2003). LM unit root test tests null hypothesis:

$$H_0: U_t = \mu_0 + d_1 B_1 t + d_2 B_2 t + U_{t-1} + \varepsilon_{1t} \quad (21)$$

Against an alternative hypothesis:

$$H_A: U_t = \mu_1 + d_1 D_1 t + d_2 D_2 t + \gamma \cdot t + \varepsilon_{2t} \quad (22)$$

where ε_{1t} and ε_{2t} are error terms; $Bjt = 1$ for $t = T_{Bj} + 1$, $j = 1, 2$, 0 otherwise. The hypotheses are based on Data Generating Process and the following model:

$$U_t = \sigma' Z_t + \varepsilon_t \quad (23)$$

where Z_t is a vector of exogenous variables formulated by $[1, t, D_1 t, D_2 t]$' where $D_{jt} = 1$ for $t > T_{Bj} + 1$, $j = 1,2$ and 0 otherwise. The LM unit root test allows structural breaks under both hypotheses, so that it has better power compared to Z-A unit root test with one break.

If the series are stationary, then the past behaviour of the observed variables can provide valuable information for forecasting (Shahbaz et al., 2013). Automatic forecasts are often used for univariate time series modelling (Hyndman and Khandakar, 2008). In the case of unemployment persistence, it is reasonable to use internal properties of the series itself for prediction. The standard ARIMA models were applied with up to 4 lags for AR and MA components. These models tend to have better accuracy comparing to others (Gerunov, 2016).

Through specified tests of time series for unemployment, the study aims at determining effectiveness and robustness with respect to a set of mutually reinforcing models.

4. Empirical data and analysis

Econometric analysis is based on quarterly data on unemployment in SEE10 from 2005q1 to 2017q3, which was originally collected from the International Monetary Fund (IMF Data). The number of observations is fifty one. Basic characteristics and patterns of unemployment rates for ten selected countries are presented in Table 1. Based on the data, unemployment rates in some countries are relatively high. For instance, the average unemployment rates are extremely high for FYR Macedonia, Serbia, Montenegro and Greece. FYR Macedonia has the highest average unemployment. The lowest unemployment rate is in Slovenia and Bulgaria. Turkey and Romania have the least volatile unemployment among selected countries, while Greece has the highest unemployment volatility. None of the these countries can be classified as a country with a low unemployment rate, based on the characteristics concerning this parameter.

Table 1: Summary statistics: quarterly unemployment rate

Part A

Country / Variable	Albania	Bulgaria	Greece	FYR Macedonia	Montenegro	Turkey
Mean	14.489	9.278	17.153	30.770	18.253	10.052
Maximum	18.170	13.800	27.900	38.600	29.250	14.530
Minimum	12.620	5.000	7.300	22.100	13.190	7.700
Std. Dev.	1.552	2.435	7.660	4.363	3.595	1.468
Skewness	0.959	0.006	0.057	-0.361	1.366	0.879
Kurtosis	2.477	1.836	1.282	2.236	4.607	3.541
Jarque-Bera	8.400	2.877	6.297	2.347	21.364	7.197

Part B

Country / Variable	Slovenia	Croatia	Romania	Serbia
Mean	7.375	13.028	6.557	18.859
Maximum	11.130	19.330	8.600	25.460
Minimum	4.100	7.670	4.170	11.760
Std. Dev.	1.859	3.087	0.850	3.407
Skewness	-0.022	0.224	-0.788	-0.148
Kurtosis	2.075	2.098	4.118	2.204
Jarque-Bera	1.820	2.157	7.946	1.531

Source: Authors' calculations

The linearity test developed by Harvey et al. (2008) was used to determine the unemployment dynamics in observed countries. The unemployment series in seven countries proved to be nonlinear. The unemployment series for Turkey, Serbia and FYR Macedonia follow linear dynamics. When linearity hypothesis is rejected, nonlinear tests should be applied next. This study uses nonlinear unit root tests such as the KSS for an exponential smoothing transitional autoregressive (ESTAR) and the Sollis test for asymmetric exponential smoothing transitional autoregressive (AESTAR) process. The results of the linear unit root tests are presented in Table 2.

Table 2: Linearity test results

Countries	Statistics	Prob. value	Result
Albania	5.976***	0.025	Nonlinear
Bulgaria	12.866*	0.000	Nonlinear
Greece	21.623*	0.000	Nonlinear
FYR Macedonia	1.816	0.201	Linear
Montenegro	7.642**	0.010	Nonlinear
Turkey	1.977	0.186	Linear
Slovenia	6.179**	0.022	Nonlinear
Croatia	58.939*	0.000	Nonlinear
Romania	9.360*	0.004	Nonlinear
Serbia	1.195	0.402	Linear

Note: The symbols *, ** and *** mean rejection of the null hypothesis of linearity at the 1%, 5% and 10% respectively. Harvey et al. (2008) test critical values, 9.21, 5.99 and 4.60 respectively.
Source: Authors' calculations

Table 3 presents the findings of the KSS and Sollis test. As can be seen in the table, both tests clearly show that the null hypothesis of hysteresis in the case of five countries is rejected. Based on the results, the unemployment rates in Albania, Bulgaria, Croatia, Slovenia and Greece indicate a stationary process. In short, there is an evidence of mean reversion property for the unemployment rates, which clearly confirms the natural rate hypothesis. On the other hand, in case of unemployment rate in Montenegro and Romania, the hypothesis of hysteresis is rejected based on the AESTAR test results. This test has more power than the KSS test since the data generating process is asymmetric. The table also includes the critical values for these two tests. The findings suggest that the unemployment rates are stationary in Albania and Greece, even though the rate is relatively high in both cases.

Table 3: Nonlinear unit root tests results

Countries	KSS test		Sollis test	
	Raw	Demeaned	Raw	Demeaned
Albania	-2.339**	-3.325**	3.749**	6.297*
Bulgaria	-2.689**	-2.717***	5.490*	5.385**
Greece	-2.887*	-2.800***	7.536*	5.931**
Montenegro	-2.324**	-1.263	7.205*	4.089***
Slovenia	-2.553**	-2.787*	3.059**	4.070***
Croatia	-3.026*	-2.873*	5.999*	5.506**
Romania	-3.087*	-1.744	11.790*	11.266*
Critical value				
1 %	-2.82	-3.48	4.241	6.236
5 %	-2.22	-2.93	2.505	4.557
10 %	-1.92	-2.66	1.837	3.725

Note: *, ** and *** mean rejection of the null hypothesis of unit root at the 1, 5 and 10 % respectively.

Source: Authors' calculations

The results of ADF test (Table 4) indicate that the observed unemployment rates indicate nonstationary processes. This test can give misleading results, when there is a structural break in the series. It is biased towards acceptance of the unit root hypothesis when structural break is present in the data (Perron, 1989). Therefore, in our research, we have applied additional two different unit root tests. In order to take into account one structural break, the Z-A test has been carried out (Zivot and Andrews, 1992). The null hypothesis of nonstationary has been tested against a single break. The critical values have been derived assuming no break present under the null. This assumption can give misleading results when unit root with structural breaks is present.

Table 4: Linear unit root test results

Variable	ADF		Z-A test	
	Intercept	Trend and Intercept	Intercept	Trend and Intercept
Umk	-0.039(0)	-1.764(0)	-3.404 2015Q3	-4.154 2011Q4
D(Umk)	-6.468(0)	-6.634(1)	-7.259 2009Q4	-7.159 2009Q4
Utr	-2.233(5)	-2.183(5)	-5.111** 2011Q3	-5.292** 2011Q3
D(Utr)	-3.554(4)	-3.458* (4)	-4.663* 2009Q4	-4.878* 2009Q4

Variable	ADF		Z-A test	
	Intercept	Trend and Intercept	Intercept	Trend and Intercept
Use	-1.003(0)	-1.122(0)	-3.741 2011Q1	-4.277** 2011Q1
D(Use)	-7.030(0)	-1.965* (3)	-4.062 2008Q3	-3.959 2008Q3

Notes: The numbers in the parentheses indicate the optimal lag length suggested by the Schwarz Information Criterion (SIC).**indicates significance at the 5% level; *indicates significance at the 10% level.

Source: Authors' calculations

In order to overcome the problem of endogenous break in a unit root test, we have applied the test which is unaffected by breaks under the null. This second test is Lee and Strazicich (2003) test which uses the Lagrange multiplier test statistics (Table 5). Stationary property of the data was further tested for presence of two structural breaks. The findings from the tests indicate that the unemployment rate in FYR Macedonia and Serbia were nonstationary while the unemployment rate in Turkey was stationary.

Table 5: Results for LM unit root test with two breaks

Country	LM stat.	B_{t1}	Bt_2	T_{B1}	T_{B2}
FYR Macedonia	-0.206 (-2.580)	0.799 (1.723)	1.092 (2.351)	2008Q3	2011Q3
Turkey	-0.695 (-5.731)	2.190 (3.044)	1.895 (2.462)	2011Q1	2011Q4
Serbia	-0.177 (-2.607)	4.282 (2.789)	1.946 (1.342)	2012Q1	2015Q2

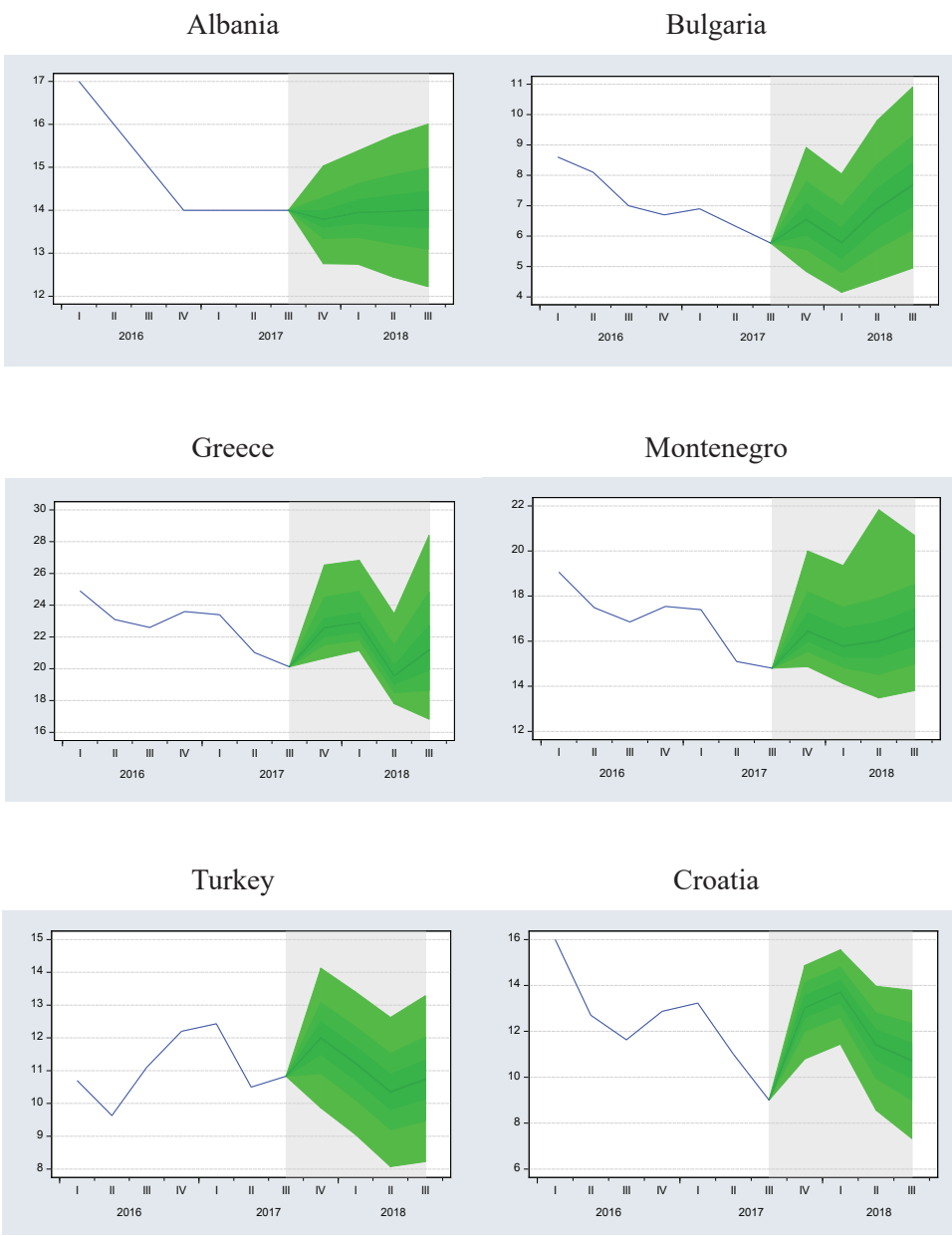
Notes: Figures in parentheses are t values. T_{B1} and T_{B2} are the breakpoints. B_{t1} and Bt_2 are the dummy variables for the structural breaks in the intercept.

Source: Authors' calculations

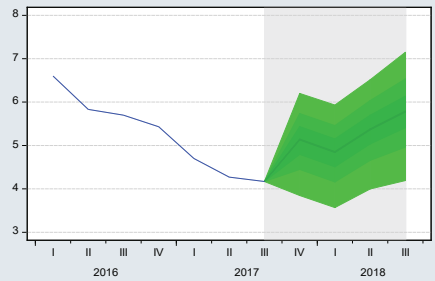
A further extension of the results is possible in the direction of predicting the behaviour of the stationary unemployment rates. The need of labour for economic growth will be more evident, if we know forecasts of unemployment. If unemployment rates are stationary, then it enables policymakers in the forecasts of future employment processes. The forecasting of unemployment is important in formulating reliable policy. In our sample there are seven cases which can be characterized by a nonlinear data – generating processes. It means that we used bootstrapped errors, so our fan chart is not so symmetrical around the mean. In one linear case, we use properties of the normal distribution to build confidence interval and dummy variable for the identified structural breaks. The each model is chosen among a set of alternatives to

minimize the AIC criterion. For the estimated models, all the AR/MA roots are within unit circle. The results of forecasting are presented for four period ahead (Figure 1). Shaded areas reflect different intervals of probability confidence.

Figure 1: Unemployment Forecast



Romania



Slovenia

Source: Authors' calculations

5. Results and discussion

In terms of the previous analysis, it can be noted that neither of the two main hypotheses is fully confirmed considering all the observed countries where the dynamics of unemployment was analyzed. The focus of our attention, however, was the thesis on the existence of unemployment hysteresis in these countries. This hypothesis could not be confirmed in eight out of ten observed cases. The equilibrium level of employment depends on the dynamics of the previous actual rate of unemployment in the case of two countries. In other words, the unemployment rates in these two countries are path dependent, non-stationary defined processes.

There are probably two main reasons considering these results. One refers to the role of trade unions, and the other on unemployment benefits. Strong unions reduce the dynamics of the adjustment on the labour market and reduce labour force mobility, while the prolonged unemployment benefits have an impact in the direction of maintaining unemployment hysteresis. These results are similar to some EU countries. In other words, macroeconomic shocks tend to have permanent effects regarding their impact on the labour market. Reduced labour force mobility and high uncertainty in the labour market make it much harder for individuals to return to the work force (Albulescu and Tiwari, 2018). In the case of the prolonged and high unemployment, even the short-term anti-inflation policy can contribute to keeping such a situation in a vicious circle. Therefore, it is necessary to opt for the two unpopular economic policy measures relating to the further reduction of unemployment benefits and increasing the labour market flexibility by reducing the role of trade unions.

Particularly interesting is the case where the unemployment rates can be characterized as stationary, but where the asymmetric adjustments and structural breaks should be taken into consideration. In such cases, the unemployment rate

shifts temporarily due to structural or asymmetric changes, however, it fluctuates around the equilibrium. The unemployment rate in the case of Turkey shows elements of stationarity around the structural breaks.

In all other cases equlibrium and actual unemployment rate will be adjusted through shocks of transitory nature. The unemployment rate has a strong tendency to return to equilibrium level with mean-reverting behaviour. It means that labour markets in these countries are under more dynamic influences.

6. Conclusions

The basic objective of this study is to determine empirical validity of stationarity status in unemployment rates of SEE10. The stationarity tests occupy a significant place in examinations of econometric applications concerning unemployment rates. Empirical results of such tests have significant implications and a wide spectre of applications primarily in creating adequate economic policies. Time series were tested for the given sample and time period with reference to the review of methodology previously employed in similar studies. The main rule concerning the stationarity of this variable can be defined as follows: if a time series is stationary, then any shock which may occur is transitory or relatively temporary.

On the other hand, if a series is nonstationary, then the effects of a change have a permanent impact. Fluctuations, in stationary series, have only temporary influence which means that unemployment returns to its short-term path and past movements or trends may be used to make predictions about future behaviour. In that case, the projections of effects of separate measures can be made with relative predictability.

The results of this study speak against hysteresis hypothesis in eight out of ten countries. In seven countries, unemployment rates are better described as nonlinear stationary processes. This means that transitory shocks do not have permanent effects on the unemployment rates. In order to make accurate forecasts, policy makers have to take into account perceived nonlinearities in these countries.

We have also found that the analysis of the observed variable depends on the allowance of structural breaks in the case of Turkey. The short term cost of anti-inflation would be very high in FYR Macedonia and Serbia since raising unemployment may lead to unacceptable instability, considering that, this countries already have high level of unemployment. If policy makers in FYR Macedonia do not take appropriate measures to reduce unemployment, it may keep being very high for prolonged time periods. To sum up, the hysteresis in unemployment is not confirmed for Albania, Bulgaria, Croatia, Romania, Slovenia, Greece, Montenegro and Turkey and thus stabilization policy would not have permanent effects on the unemployment rates in these countries.

Future studies could continue to explore the existence of the unemployment hysteresis by extending the research in two directions. The first relates to the expansion of the sample of countries, so as to include the Central and Eastern Europe. In terms of the other mentioned direction, the research should deepen our understanding of the unemployment dynamics based on different sets of panel unit root tests. This method of obtaining information can further contribute to the improvement of information basis for economic policy makers.

References

Akdogan, K. (2017) "Unemployment hysteresis and structural change in Europe", *Empirical Economics,* Vol. 53, No. 4, pp. 1415–1440, doi: 10.1007/s00181-016-1171-8.

Albulescu, C., Tiwari, A. (2018) "Unemployment persistence in EU countries: new evidence using bounded unit root tests", *Applied Economic Letters*, Vol. 25, No. 12, pp. 807–810, doi: 10.1080/13504851.2017.1368979.

Amable, B. et al. (1995) "Hysteresis revisited: a methodological approach". In Cross, R. (ed.) *The natural rate of unemployment: reflections on 25 years of the hypothesis,* Cambridge: Cambridge University Press, pp. 153–180, doi: 10.1017/cbo9780511559631.010.

Andini, C., Andini, M. (2018) "Unemployment Persistence and Quantile Parameter Heterogeneity", *Macroeconomic Dynamics*, Vol. 22, No. 5, pp. 1298–1320, doi: 10.1017/s1365100516000602.

Bahmani-Oskooee, M., Hegerty, S.W. (2009) "Purchasing power parity in less-developed and transition economies: a review paper", *Journal of Economic Surveys*, Vol. 23, No. 4, pp. 617–658, doi: 10.1111/j.1467-6419.2009.00574.x.

Bakas, D., Papapetrou, E. (2014) "Unemployment in Greece: Evidence from Greek Regions using Panel Unit Root Tests", *The Quarterly Review of Economics and Finance,* Vol. 54, No. 4, pp. 551–562, doi: 10.1016/j.qref.2014.03.002

Becker, R., Enders, W., Lee, J. (2006) "A stationarity test in the presence of an unknown number of smooth breaks", *Journal of Time Series Analysis*, Vol. 27, No. 3, pp. 381–409, doi: 10.1111/j.1467-9892.2006.00478.x

Blanchard, O., Summers, L. (1986a) *Hysteresis in Unemployment, Working Paper 2035*, MA: National Bureau of Economic Research, doi: 10.3386/w2035.

Blanchard, O., Summers, L. (1986b) *Hysteresis and the European Unemployment Problem, Working Paper 1950*, MA: National Bureau of Economic Research, doi: 10.3386/w1950.

Blanchard, O. (2018) "Should We Reject the Natural Rate Hypothesis?", *Journal of Economic Perspectives*, Vol. 32, No. 1, pp. 97–120, doi: 10.1257/jep.32.1.97.

Bolat, S., Tiwari, A. K., Erdayi, A.U. (2014) "Unemployment Hysteresis in the Euro zone Area: Evidences from Nonlinear Heterogeneous Panel Unit Root Test", *Applied Economics Letters*, Vol. 21, No. 8, pp. 536–540, doi: 10.1080/13504851.2013.872755.

Camarero, M., Tamarit, C. (2004) "Hysteresis vs. natural rate of unemployment: new evidence for OECD countries", *Economic Letters*, Vol. 84, No. 3, pp. 413–417, doi: 10.1016/j.econlet.2004.02.014.

Cancelo, J.R. (2007) "Cyclical asymmetries in unemployment rates: international evidence", *International Advances in Economic Research*, Vol. 13, No. 3, pp. 334–346, doi: 10.1007/s11294-007-9094-y.

Caporale, G.M., Gil-Alana, L.A., Lovcha, Y. (2016) "Testing unemployment theories: A multivariate long memory approach", *Journal of Applied Economics*, Vol. 19, No. 1, pp. 95–112, doi: 10.1016/s1514-0326(16)30004-6

Chang, T. (2011) "Hysteresis in unemployment for 17 OECD countries: Stationary test with a Fourier function", *Economic Modelling*, Vol. 28, No. 5, pp. 2208–2214, doi: 10.1016/j.econmod.2011.06.002.

Chang, T. et al. (2005) "An empirical note on testing hysteresis in unemployment for ten European countries: panel SURADF approach", *Applied Economics Letters,* Vol. 12, No. 14, pp. 881–886, doi: 10.1080/13504850500365871.

Cheng, K.M. et al. (2012) "Hysteresis vs. natural rate of US unemployment", *Economic Modelling*, Vol. 29, No. 2, pp. 428–434, doi: 10.1016/j.econmod.2011.11.012.

Cheng, S.C. et al. (2014) "Flexible Fourier unit root test of unemployment for PIIGS countries", *Economic Modelling*, Vol. 36, pp. 142–148, doi: 10.1016/j.econmod.2013.09.021.

Chortareas, G., Kapetanios, G. (2009) "Getting PPP right: identifying mean-reverting real exchange rates in panels", *Journal of Banking and Finance*, Vol. 33, No. 2, pp. 390–404, doi: 10.1016/j.jbankfin.2008.08.010.

Cuestas, J.C., Gil-Alana, L.A., Staehr, K. (2011) "A Further Investigation of Unemployment Persistence in European Transition Economies", *Journal of Comparative Economics*, Vol. 39, No. 4, pp. 514–532, doi: 10.1016/j.jce.2011.09.002.

Dickey, D.A., Fuller, W.A. (1979) "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", *Journal of the American Statistical Association*, Vol. 74, No. 366, pp. 427–431, doi: 10.1080/01621459.1979.10482531.

Dickey, D.A., Fuller, W.A. (1981) "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root", *Econometrica*, Vol. 49, No. 4, pp. 1057–1072, doi: 10.2307/1912517.

Enders, W., Granger, C.W.J. (1998) "Unit-Root Tests and Asymmetric Adjustment With an Example Using the Term Structure of Interest Rates", *Journal of Business & Economic Statistics*, Vol. 16, No. 3, pp. 304–311, doi: 10.1080/07350015.1998.10524769.

Enders, W., Lee, J. (2012) "A unit root test using a Fourier series to approximate smooth breaks", *Oxford Bulletin of Economics and Statistics,* Vol. 74, No. 4, pp. 574–599, doi: 10.1111/j.1468-0084.2011.00662.x.

Furuoka, F. (2012) "Unemployment hysteresis in the East Asia-Pacific region: New evidence from MADF and SURADF test", *Asia Pacific Economic Literature*, Vol. 26, No. 2, pp. 133–143, doi: 10.1111/j.1467-8411.2012.01351.x.

Furuoka, F. (2015) "Unemployment hysteresis in the "Nordic Kitten": Evidence from five Estonian regions", *Panoeconomicus*, Vol. 62, No. 5, pp. 631–642, doi: 10.2298/pan1505631f.

Furuoka, F. (2016) "A new test for analysing hysteresis in European unemployment", *Applied Economics Letters*, Vol. 24, No. 15, pp. 1102–1106, doi: 10.1080/13504851.2016.1257209.

Furuoka, F. (2017) "A new approach to testing unemployment hysteresis", *Empirical Economics*, Vol. 53, No. 3, pp. 1253–1280, doi: 10.1007/s00181-016-1164-7.

Gerunov, A. (2016) "Automating Analytics: Forecasting Time Series in Economics and Business", *Journal of Economics and Political Economy*, Vol. 3, No. 2, pp. 340–349.

Guris, B., Tiftikcigil, B.Y., Tırasoglu, M. (2017) "Testing for unemployment hysteresis in Turkey: Evidence from nonlinear unit root tests", *Quality and Quantity*, Vol. 51, No. 1, pp. 35–46, doi: 10.1007/s11135-015-0292-z.

Gustavsson, M., Österholm, P. (2006) "Hysteresis and nonlinearities in unemployment rates", *Applied Economic Letters*, Vol. 13, No. 9, pp. 545–548, doi: 10.1080/13504850500401437.

Gustavsson, M., Österholm, P. (2011) "Mean Reversion in the US Unemployment Rate – Evidence from Bootstrapped Out-Of-Sample Forecasts", *Applied Economics Letters*, Vol. 18, No. 7, pp. 643–646, doi: 10.1080/13504851003761855.

Harvey, D.I., Leybourne, S.J. (2007) "Testing for time series linearity", *Econometrics Journal*, Vol. 10, No. 1, pp. 149–165, doi: 10.1111/j.1368-423x.2007.00203.x.

Harvey, D.I., Leybourne, S.J., Xiao, B. (2008) "A powerful test for linearity when the order of integration is unknown", *Studies in Nonlinear Dynamics and Econometrics*, Vol. 12, No. 3, pp. 1–24, doi: 10.2202/1558-3708.1582.

Hyndman, R.J., Khandakar, Y. (2008) "Automatic time series forecasting: the forecast package for R*", Journal of Statistical Software*, Vol. 27, No. 3, pp. 1–22, doi: 10.18637/jss.v027.i03.

IMF (2018) *International Financial Statistics*, Washington (DC): International Monetary Fund. Available at: <https://data.imf.org/> [Accessed: 30 March, 2018]

Jiang, Y., Chang, T. (2016) "Bring Quantile Unit Root Test back in Testing Hysteresis in Unemployment for the United States", *Romanian Journal for Economic Forecasting*, Vol. 19, No. 1, pp. 5–13.

Kapetanios, G., Shin, Y., Snell, A. (2003) "Testing for a unit root in the nonlinear STAR framework", *Journal of Econometrics*, Vol. 112, No. 2, pp. 359–379, doi: 10.1016/s0304-4076(02)00202-6.

Kruse, R. (2011) "A new unit root test against ESTAR based on a class of modified statistics", *Statistical Papers*, Vol. 52, No. 1, pp. 71–85, doi: 10.1007/s00362-009-0204-1.

Kwiatkowski, D. et al. (1992) "Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? ", *Journal of Econometrics*, Vol. 54, No. 1–3, pp. 159–178, doi: 10.1016/0304-4076(92)90104-y

Lanzafame, M. (2010) "The Nature of Regional Unemployment in Italy", *Empirical Economics,* Vol. 39, No. 3, pp. 877–895, doi: 10.1007/s00181-009-0331-5.

Lee, J., Strazicich, M.C. (2003) "Minimum Lagrange multiplier unit root test with two structural breaks", *The Review of Economics and Statistics*, Vol. 85, No. 4, pp. 1082–1089, doi: 10.1162/003465303772815961.

Lee, C.F. (2010) "Testing for Unemployment Hysteresis in Nonlinear Heterogeneous Panels: International Evidence", *Economic Modelling*, Vol. 27, No. 5, pp. 1097–1102, doi: 10.1016/j.econmod.2010.03.010.

Leon-Ledesma, M. A. (2002) "Unemployment hysteresis in the US states and the EU: a panel approach", *Bulletin of Economic Research*, Vol. 54, No. 2, pp. 95–103, doi: 10.1111/1467-8586.00141.

Li, J.P., Ranjbar, O., Chang, T. (2017) "Unemployment hysteresis in PIIGS countries: a new test with both sharp and smooth breaks", *The Singapore Economic Review*, Vol. 62, No. 05, pp. 1165-1177, doi: 10.1142/s0217590815500782.

Luukkonen, R., Saikkonen, P., Terasvirta, T. (1988) "Testing linearity against smooth transition autoregressive models", *Biometrika*, Vol. 75, No. 3, pp. 491–499, doi: 10.1093/biomet/75.3.491.

Mednik, M., Rodríguez, C., Ruprah, I. (2012) "Hysteresis in Unemployment: Evidence from Latin America", *Journal of International Development*, Vol. 24, No. 4, pp. 448–466, doi: 10.1002/jid.1755

Meng, M., Strazicich, M.C., Lee, J. (2017) "Hysteresis in unemployment? Evidence from linear and nonlinear unit root tests and tests with non-normal errors", *Empirical Economics*, Vol. 53, No. 4, pp. 1399–1414, doi: 10.1007/s00181-016-1196-z

Michael, P., Nobay, R.A., Peel, D.A. (1997) "Transactions costs and nonlinear adjustment in real exchange rates: an empirical investigation", *Journal of Political Economy*, Vol. 105, No. 4, pp. 862–879, doi: 10.1086/262096.

O'Shaughnessy, T. (2011) "Hysteresis in Unemployment", *Oxford Review of Economic Policy*, Vol. 27, No. 2, pp. 312–337, doi: 10.1093/oxrep/grr018.

Palley, T. (2018) "Recovering Keynesian Phillips curve theory: hysteresis of ideas and the natural rate of unemployment", *Review of Keynesian Economics*, Vol. 6, No. 4, pp. 473–492, doi: 10.4337/roke.2018.04.07.

Perron, P. (1989) "The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis", *Econometrica,* Vol. 57, No. 6, pp. 1361–1401, doi: 10.2307/1913712.

Phelps, E.S. (1994) *Structural Slumps: The Modern Equilibrium Theory of Unemployment*, Cambridge: Harvard University Press.

Phillips, P.C.B., Perron, P. (1988) "Testing for a Unit Root in Time Series Regressions", *Biometrika,* Vol. 75, No. 2, pp. 335–346, doi: 10.1093/biomet/75.2.335.

Shahbaz, M. et al. (2013) "Are fluctuations in electricity consumption per capita transitory? Evidence from developed and developing economies", *Renewable and Sustainable Energy Reviews*, Vol. 28, pp. 551–554, doi: 10.1016/j.rser.2013.08.007.

Smyth, R. (2003) "Unemployment Hysteresis in Australian States and Territories: Evidence from Panel Data Unit Root Test", *Australian Economic Review*, Vol. 36, No. 2, pp. 181–192, doi: 10.1111/1467-8462.00278.

Sollis, R. (2009) "A Simple Unit root Test Against Asymmetric STAR Nonlinearity with An Application to Real Exchange Rates in Nordic Countries", *Economic Modelling,* Vol. 26, No. 1, pp. 118–125, doi: 10.1016/j.econmod.2008.06.002.

Song, F.M., Wu, Y. (1998) "Hysteresis in unemployment: evidence from OECD countries", *The Quarterly Review of Economics and Finance,* Vol. 38, No. 2, pp. 181–192, doi: 10.1016/s1062-9769(99)80111-2.

Srinivasan, N., Mitra, P. (2012) "Hysteresis in Unemployment: Fact or Fiction?", *Economics Letters,* Vol. 115, No. 3, pp. 419–422, doi: 10.1016/j.econlet.2011.12.070.

Terasvirta, T. (1994) "Specification, estimation, and evaluation of smooth transition autoregressive models", *Journal of the American Statistical Association*, Vol. 89, No. 425, pp. 208–218, doi: 10.1080/01621459.1994.10476462.

Tiwari, A.K. (2014) "Unemployment hysteresis in Australia: Evidence using non-linear and stationarity test with breaks", *Quality & Quantity*, Vol. 48, No. 2, pp. 681–695, doi: 10.1007/s11135-012-9795-z.

Ucar, N., Omay, T. (2009) "Testing for unit root in nonlinear heterogeneous panels", *Economics Letters*, Vol. 104, No. 1, pp. 5–8, doi: 10.1016/j.econlet.2009.03.018.

Xie, H. et al. (2018) "Revisit Hysteresis Unemployment in Eastern European Countries using Quantile Regression", *Ekonomicky Časopis,* Vol. 66, No. 5, pp. 522–537.

Zivot, E., Andrews, D.W.K. (1992) "Further evidence of great crash, the oil price shock and unit root hypothesis", *Journal of Business and Economic Statistics*, Vol. 10, No. 3, pp. 251–270, doi: 10.1080/07350015.1992.10509904.

Jesu li stope nezaposlenosti stacionarni proces u 10 zemalja JIE? Dokazi iz linearne i nelinearne dinamike[1]

Saša Obradović[2], Lela Ristić[3], Nemanja Lojanica[4]

Sažetak

Cilj ovog rada jest odgovoriti na pitanja o dinamici stope nezaposlenosti, uključujući i pitaanje postoji li naknadna histereza u odabranom uzorku od deset zemalja Jugoistočne Europe. Linearni i nelinearni testovi korišteni su za određivanje stacionarnosti stopa nezaposlenosti. Rezultati pokazuju da je u osam od deset zemalja, nezaposlenost stacionarni proces koji podrazumijeva da histereza hipoteza nije potvrđena. Stopa nezaposlenosti u Albaniji, Bugarskoj, Sloveniji, Hrvatskoj, Rumunjskoj, Grčkoj, Crnoj Gori i Turskoj pokazuje povratno ponašanje. Za ove se zemlje s relativnom sigurnošću može predvidjeti kretanje stopa nezaposlenosti u budućem razdoblju. Nezaposlenost u Makedoniji i Srbiji je nestacionaran proces. Rezultati dodatno naglašavaju važnost omogućavanja asimetrične prilagodbe i strukturnih pauza, pogotovo u slučaju Rumunjske, Crne Gore i Turske.

Ključne riječi: *histereza, stopa nezaposlenosti, nelinearnost, stacionarnost i jedinični korijen*

JEL klasifikacija: *J08, J21, J64*

[1] Ovaj rad je podržan od strane Ministarstva znanosti i prosvjete Republike Srbije, broj 179015.

[2] *Redoviti profesor, Sveučilište u Kragujevcu – Ekonomski fakultet, Đure Pucara 3, 34000 Kragujevac, Srbija. Znanstveni interes: makroekonomija, primijenjena ekonometrija. Tel.: +381 34 303 550. E-mail: sobradovic@kg.ac.rs.*

[3] *Izvanredni profesor, Sveučilište u Kragujevcu – Ekonomski fakultet, Đure Pucara 3, 34000 Kragujevac, Srbija. Znanstveni interes: održiva poljoprivreda i ruralni razvoj, menadžment u agrobiznisu, ekonomski razvoj. Tel.: +381 34 303 552. E-mail: lristic@kg.ac.rs. (osoba za kontakt).*

[4] *Asistent, Sveučilište u Kragujevcu – Ekonomski fakultet, Đure Pucara 3, 34000 Kragujevac, Srbija. Znanstveni interes: makroekonomija, primijenjena ekonometrija, globalizacija i tranzicija. Tel.: +381 34 303 508. E-mail: nlojanica@kg.ac.rs*.