Suleyman Bolat, Aviral Kumar Tiwari and Ahmet Utku Erdayi, (2014). Unemployment hysteresis in the Eurozone area: Evidences from nonlinear heterogeneous panel unit root test. Applied Economics Letters, Vol. No. : pp. (DOI:) (Forthcoming)

Unemployment hysteresis in the Eurozone area: Evidences from nonlinear heterogeneous panel unit root test

Suleyman Bolat [a, *], Aviral Kumar Tiwari [b] and Ahmet Utku Erdayi [c]

[a] *Department of Public Finance, FEAS, Cumhuriyet University, Sivas, Turkey*

[b] *Faculty of Applied Economics, Faculty of Management, ICFAI University, Tripura, India*

[c] *Department of Labour Economics and Industrial Relations, FEAS, Cumhuriyet University, Sivas, Turkey*

Our paper tests for hysteresis of unemployment rate for 17 Eurozone countries over the period 2000:1-2013:1 through the use of new nonlinear panel unit root tests by adopting the SPSM method, proposed by Chortareas and Kapetanios (2009) and a nonlinear panel unit root test developed by Ucar and Omay (2009). The results show that the unemployment rates for 17 Eurozone countries are not stationary and conform to the hysteresis hypothesis for both panel unit root tests of Ucar and Omay (2009) and sequential panel selection method (SPSM) method without Fourier. We reported the results of the Panel KSS test with a Fourier function and found that the unemployment rates in 11 countries are stationary and this result is in accord with natural rate hypothesis. On the other hand, unemployment rates in six countries, namely Netherlands, Slovakia, Slovenia, Italy, Portugal, and Cyprus- show hysteresis effect.

Keywords: unemployment; hysteresis effect; nonlinear panel unit root test; Eurozone countries

JEL Classification: C22; C23; E24; J64

I. Introduction

Recently, testing the behaviour of the unemployment rate has gained capital importance for European countries. In the aftermath of the financial crisis of the EU, the importance of the determining whether the unemployment rate follows a mean-reverting process increases day by day. There are two principal hypotheses about the literature on unemployment and these hypotheses focus on the relation between unemployment and the business cycle. The first one is *natural rate hypothesis of unemployment* (or non-accelerating inflation rate of unemployment (NAIRU)) advanced by Phelps (1967) and Friedman (1968), characterizes unemployment dynamics as a mean-reverting process. Unemployment rate converge to a natural rate and deviations from the natural rate are short-lived and will remove at the end. The second hypothesis as named the *hysteresis*[1] *hypothesis* proposed Blanchard and Summers (1986, 1987) represents that cyclical fluctuations or effects of shock will be permanent because of labour market rigidities. This implies that the unemployment rate will not return to its equilibrium in the long run after a shock.

In early studies, these two competing hypotheses are generally examined empirically by using conventional unit root tests on the unemployment rates. Those studies concluded the existence of unemployment hysteresis in the countries they had examined (Brunello, 1990; León-Ledesma, 2002). Conventional linear unit root tests which have a low power have been used for testing unemployment hysteresis and the unemployment rate shows the non-linearity movement (Smyth, 2003; Chang *et al.*, 2005). Many studies used linear univariate unit root tests that do not commonly reject the null hypothesis (Blanchard and Summers, 1986; Gray, 2004). When the span of the data is not adequate, some conventional unit root tests suffer from low power. Panel unit root methods used by Levin *et al.*, (2002), Im *et al.*, (2003) and Christopoulos and Tsionas (2004) are developed for raising the power of the tests. Several works have attempted to examine the presence of hysteresis in unemployment rate with nonlinear unit root tests (Caner and Hansen, 2001; Leon-Ledesma and McAdam, 2004; Camarero and Ordóñez, 2006; Ghosh and Dutt, 2008; Lin *et al.*, 2008; Lee, 2010).

The early studies are examined with linear methods for hysteresis effects in unemployment rate, but these methods are not suitable because these tests do not take into account the cyclical asymmetrics behaviour over the business cycle. Therefore, it is more useful to test with nonlinear models to prevent asymmetric behaviour of

* Corresponding author. Email: bolatsuleyman80@gmail.com

[1] Hysteresis in a labour market context refers to the high degree of dependence of current unemployment upon past unemployment (Smith, 2003).

unemployment rate (Caporale and Gil-Alana, 2007; Valetta and Kuang, 2012). In literature on economics, it has long been argued that major cyclical variables such as the unemployment rate display an asymmetric behaviour over various phases of the business cycle. During recessions, unemployment rate increases rapidly as compared to declines during expansions (van Dijk *et al*., 2002; Caporale and Gil-Alana, 2008). The structure of paper is as the follows. Section 2 overviews the data in the paper and section 3 describes the methodology and section 4 presents the empirical results and finally we present our conclusions in section 5.

II. Data

This empirical analysis covers the unemployment rate for 17 Eurozone countries, namely Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain. We use annual data drawn from the Eurostat Database and all data span from 2000:1 to 2013:1. These countries have been selected according to the data available.

III. Methodology

Ucar and Omay (2009) nonlinear panel unit root test

Ucar and Omay (2009) test aims to combine the nonlinear panel unit root test of Kapetanios *et al.,* (2003) and the procedure of the of panel unit root test of Im *et al.* (2003). In Ucar and Omay (2009) test, the data is generated by process of order one panel exponential smooth transition (PESTAR). However, by applying first-order Taylor series approximation to the PESTAR specification they derived following auxiliary regression

$$\Delta y_{i,t} = \alpha_i + \delta_i y_{i,t-1}^3 + \varepsilon_{i,t} \quad (1)$$

where $\delta_i = \theta_i \gamma_i$. $y_{i,t}$ is the series of interest, α_i and δ are parameters estimated. Under this framework the null hypothesis and alternative hypotheses are expressed as $\delta_i = 0$ (nonstationarity) against $\delta_i < 0$ (nonlinear stationarity). They proposed a panel unit root test which is computed through taking the simple average of individual KSS statistics ($t_{i,NL}$). For a fixed T, they defined as

$$\bar{t}_{NL} = \frac{1}{N}\sum_{i=1}^{N} t_{i,NL} \quad (2)$$

which is invariant average statistic when $t_{i,NL}$ is invariant with respect to initial observations $y_{i,0}$ heterogeneous moments σ_i^2 and σ_i^4 if $y_{10} = 0$ for all i = 1, 2,..., N. To compare results of UO test with Im *et al*. (2003) we report results of both tests.

SPSM and panel KSS unit root test with a Fourier Function

The main feature of panel unit root tests is the ability to exploit coefficient homogeneity under unit root null hypothesis for all series. However, under the alternative hypothesis of heterogeneous panel unit root tests at least one series being stationary, the results are not explicit enough. If the unit root hypothesis is rejected, it is impossible to know series that caused the rejection. Rejecting the null hypothesis, the researcher is in a difficult situation with distinguishing the stationary from non-stationary series in a panel. Although one knows that the null hypothesis of aggregate panel can be rejected, he cannot identify the series that caused the rejection. In order to avoid this problem, Chortareas and Kapetanios (2009) applied a new procedure for PPP literature that allow them to distinguish the set of series into a group of stationary and a group of non-stationary series (Chortareas and Kapetanios, 2009; Lee, 2010; Chang, 2011; Pan *et al.*, 2012; Chang and Chang, 2012; Zhang *et al.*, 2013).

Main steps of SPSM method proposed by Chortareas and Kapetanios (2009) are as follows:

- The KSS test without and with Fourier function is performed on the all unemployment rates in the panel. If the unit root null is not rejected, the procedure is stopped. Thus, all the series in the panel are nonstationary. On the other hand, if the null hypothesis is rejected, go to the step 2.
- Remove the series with the minimum KSS statistic, because it is defined as being stationary.
- Return to step 1 for the remaining series or stop the procedure if all the series are removed from the panel.

The final result is a separation of the all panel into the sets of stationary and non-stationary variables.

Suleyman Bolat, Aviral Kumar Tiwari and Ahmet Utku Erdayi, (2014). Unemployment hysteresis in the Eurozone area: Evidences from nonlinear heterogeneous panel unit root test. Applied Economics Letters, Vol. No. : pp. (DOI:) (Forthcoming)

IV. Empirical Results

For comparison, we examine firstly the results of the linear and nonlinear unit root analysis of Ucar and Omay (2009) and Im *et. al* (2003). Table 1 reports the results of the linear and nonlinear unit root analysis on the unemployment rates for 17 Eurozone. Both the linear and nonlinear panel unit root tests are unable to reject the null hypothesis of linear nonstationarity characteristics of the study variable in the models with only intercept and with intercept-trend.

Table 1. Results of linear and nonlinear unit root analysis for 17 Eurozone

intercept	$\bar{t}*_{NL}$	$\overline{Z}*_{ANL}$	$t*_{NBAR}$	$W*_{NBAR}$
Lag 1	-0.814 (0.963)	3.955 (0.963)	-0.671 (0.972)	4.262 (0.972)
Lag 2	-0.984 (0.912)	3.132 (0.912)	-0.755 (0. 949)	3.844 (0.949)
Lag 3	-1.041 (0.873)	2.853 (0.873)	-0.878 (0. 890)	3.237 (0.890)
Lag 4	-1.041 (0.873)	2.853 (0.873)	-0.878 (0.890)	3.237 (0.890)
intercept and trend	$\bar{t}*_{NL}$	$\overline{Z}*_{ANL}$	$t*_{NBAR}$	$W*_{NBAR}$
Lag 1	-1.341 (0.147)	4.202 (0.147)	-1.320 (0.930)	4.964 (0.930)
Lag 2	-1.403 (0.128)	3.866 (0.128)	-1.377 (0.905)	4.644 (0.905)
Lag 3	-1.403 (0.128)	3.866 (0.128)	-1.377 (0.905)	4.644 (0.905)
Lag 4	-1.403 (0.128)	3.866 (0.128)	-1.377 (0.905)	4.644 (0.905)

Notes: p-values in parenthesis are computed with 10.000 bootstrap replications. While $t*_{NBAR}$ and $W*_{NBAR}$ are the statistics of Im et al. (2003), $\bar{t}*_{NL}$ and $\overline{Z}*_{ANL}$ are the statistics of Ucar and Omay (2009).

Table 2 investigates the results of the SPSM using the panel KSS unit root test on unemployment rates. It gives a sequence of the panel KSS statistics with their bootstrap p-values on a reducing panel, the individual minimum KSS statistic and the stationary series are identified by this procedure each time. The null hypothesis of hysteresis is not rejected, when the UO test is first applied to the whole panel, producing a value of −1.402 (with a *p*-value (0.132). Normally, the procedure continues until the UO test failed to reject the unit root null at the 10% significance level. These results show that the unemployment rates for 17 countries are not stationary and conform to the hysteresis hypothesis. If the panel KSS test[2] is applied to each series, results from Individual KSS test show that only three countries unemployment rates are mean-reverting.

[2] The results of the panel KSS unit root test only reject the null of three countries, namely Luxembourg, Estonia and Malta.

Suleyman Bolat, Aviral Kumar Tiwari and Ahmet Utku Erdayi, (2014). Unemployment hysteresis in the Eurozone area: Evidences from nonlinear heterogeneous panel unit root test. Applied Economics Letters, Vol. No. : pp. (DOI:) (Forthcoming)

Table 2. Panel KSS unit root test

Sequence	UO Statistic	Minimum KSS statistic	Series
1	-1.402 (0.132)	-3.636	Luxembourg
2	-1.263 (0.153)	-3.610	Estonia
3	-1.106 (0.199)	-3.018	Malta
4	-0.970 (0.299)	-2.491	Finland
5	-0.853 (0.560)	-2.467	Ireland
6	-0.718 (0.514)	-2.409	Austria
7	-0.565 (0.484)	-2.380	Germany
8	-0.383 (0.574)	-2.069	France
9	-0.196 (0.791)	-1.852	Belgium
10	0.011 (0.817)	-1.723	Spain
11	0.259 (0.879)	-1.535	Netherlands
12	0.558 (0.941)	-1.457	Slovakia
13	0.961 (0.991)	-0.560	Greece
14	1.341 (0.989)	0.448	Slovenia
15	1.639 (0.996)	0.809	Portugal
16	2.054 (0.995)	1.232	Italy
17	2.876 (0.999)	2.876	Cyprus

Notes: UO statistic is the constant average KSS statistic. The maximum lag is set to be 8. The numbers in parenthesis stand for *p*-values and are computed by means of the bootstrap replications which are 10.000. The critical values for individual *t*-statistics are organized in KSS's (2003) table 1. The critical values in their paper are -2.66, -2.93 and -3.48 in significance at 10%, 5% and 1%, respectively. ***, ** and * indicate significance at 1, 5 and 10% levels, respectively.

Table 3. Panel KSS unit root test with Fourier function

Sequence	UO Statistic	Minimum KSS statistic	Fourier (k)	Series
1	-3.012 (0.000)***	-4.112	5	Luxembourg
2	-2.816 (0.000)***	-3.610	5	Estonia
3	-2.696 (0.000)***	-3.018	5	Malta
4	-2.511 (0.000)***	-2.491	5	Finland
5	-2.222 (0.001)***	-2.467	5	Ireland
6	-2.162 (0.001)***	-2.380	5	Germany
7	-2.054 (0.007)***	-2.147	5	Greece
8	-1.811 (0.042)**	-2.069	5	France
9	-1.838 (0.045)**	-1.852	5	Belgium
10	-1.830 (0.036)**	-1.743	5	Austria
11	-1.731 (0.046)**	-1.723	5	Spain
12	-1.325 (0.205)	-1.535	5	Netherlands
13	-0.898 (0.364)	-1.457	5	Slovakia
14	-0.386 (0.494)	0.448	5	Slovenia
15	0.817 (0.942)	1.232	5	Italy
16	0.518 (0.844)	1.536	5	Portugal
17	-0.275 (0.521)	2.876	5	Cyprus

Notes: UO statistic is the constant average KSS statistic. The maximum lag is set to be 8. The numbers in parenthesis stand for *p*-values and are computed by means of bootstrap simulations using 10,000 replications. Fourier (k) is chosen by minimum sum square of residual for Fourier function. ***, ** and * indicate significance at 1, 5 and 10% levels, respectively.

As a benchmark, we report the results of the Panel KSS test with a Fourier function. Table 3 shows that the null hypothesis of unit root was rejected, when the Panel KSS test was applied to the whole panel, producing a value of –3.012 (*p*-value of nearly 0). After implementing the SPSM procedure, we found Luxembourg is stationary with the minimum KSS value of –4.112 among the panel. Then, Luxembourg was removed from the panel and the Panel KSS test was implemented again to the remaining set of series. After that, we found that the Panel KSS test still rejected the unit root null with a value of -2.816 (*p*-value of nearly 0), and Estonia was found to be stationary with the minimum KSS value of –3.610 among the panel this time. Then, Estonia was removed from the panel and again the Panel KSS test was implemented to the remaining set of series. The procedure was

continued until the Panel KSS test failed to reject the unit root null hypothesis at the 10% significance level. Finally we found that the unemployment rates in 11 countries are stationary and it is in accord with natural rate hypothesis. Checking the robustness of our test, we continued the procedure until the last sequence. The results from panel KSS test show that for only three countries unemployment rates are mean-reverting.

V. Conclusions

We tested the mean-reverting properties of the unemployment rates for 17 Eurozone countries over the period 2000:1-2013:1. Ucar and Omay (2009) and Im *et al.*, (2003) do not reject the null hypothesis of unit root in both models intercept and trend-intercept. However, the SPSM procedure shows that the unemployment rates for 17 Eurozone countries are not stationary and confirm to the hysteresis hypothesis. On the contrary, SPSM procedure with Fourier function indicates that the unemployment rates in 11 countries are stationary and support the natural rate hypothesis.

The results of our empirical study have important policy implications. First, if the shocks on unemployment rates are temporary, the stabilization process of labour and macroeconomic policies do not have long lasting effects on unemployment rates. That is to say, when the unemployment rate is mean-reverting, the series will return to its trend path. Thereby, it is possible to forecast future movements in the unemployment rate based on past behaviour (León-Ledesma, 2002). Second, the unemployment rates are preferably defined as a nonlinear stationary process for most of countries. Therefore, when policy-makers plan to make accurate forecasts on the future unemployment rate, our evidence suggests that the forecasting models had better take into account nonlinearities (Lee, 2010). Third, the global financial crisis in Eurozone area generated a major adverse shock increased unemployment rates in this area.

References

Blanchard, O. and Summers, L. (1986) Hysteresis and the European unemployment, NBER, *Macroeconomics Annual*, **1,** 15–90.

Blanchard, O. and Summers, L. (1987) Hysteresis and unemployment, *European Economic Review*, **31,** 288–95.

Brunello, G. (1990) Hysteresis and the 'Japanese unemployment problem': a preliminary investigation. *Oxford Economic Papers*, **42**, 483–500.

Camarero, M. and Ordóñez, J. (2006) Is there a nonlinear co-movement in the EU countries' unemployment?, *Economics Letters*, **93,** 157−62.

Caner, M. and Hansen, B. E. (2001) Threshold autoregression with a unit root, *Econometrica*, **69**, 1555–96.

Caporale, G. M. and Gil-Alana, L. A. (2007) Nonlinearities and fractional integration in the US unemployment rate, *Oxford Bulletin of Economics and Statistics*, **69**, 521–44.

Caporale, G. M. and Gil-Alana, L. A. (2008) Modelling the US, UK and Japanese unemployment rates: fractional integration and structural breaks, *Computational Statistics and Data Analysis*, **52**, 4998–5013.

Chang, T., Lee, K.-C., Nieh, C.-C. and Wei, C.-C. (2005) An empirical note on testing hysteresis in unemployment for ten European countries: panel SURADF approach, *Applied Economics Letters*, **12**, 881–6.

Chang, T. (2011) Hysteresis in unemployment for 17 OECD countries: stationary test with a Fourier function, *Economic Modelling*, **28**, 2208−14.

Chang, C.-K. and Chang, T. (2012) Statistical evidence on the mean reversion of real interest rates: SPSM using the panel KSS test with a Fourier function, *Applied Economics Letters*, **19**, 1299−1304.

Chortareas, G. and Kapetanios, G. (2009) Getting PPP right: identifying mean-reverting real exchange rates in panels, *Journal of Banking and Finance*, **33**, 390–404.

Christopoulos, D. K. and Tsionas, E. G. (2004) Financial development and economic growth: evidence from panel unit root and panel cointegration tests, *Journal of Development Economics*, **73**, 55–74.

Friedman, M. (1968) The role of monetary policy, *American Economic Review*, **58**, 1–17.

Ghosh, D. and Dutt, S. (2008) Nonstationarity and nonlinearity in the US unemployment rate: a re-examination, *Journal for Economic and Educators*, **8**, 43–53.

Gray, D. (2004) Persistent regional unemployment differentials revisited, *Regional Studies*, **38**, 167–76.

Im, K. S., Pesaran, M. H. and Shin, Y. (2003) Testing for unit roots in heterogeneous panels, *Journal of Econometrics*, **115**, 53–74.

Kapetanios, G., Shin, Y. and Snell, A. (2003) Testing for a unit root in the nonlinear STAR framework, *Journal of Econometrics*, **112**, 359–79.

Lee, C.-F. (2010) Testing for unemployment hysteresis in nonlinear heterogeneous panels: international evidence, *Economic Modelling*, **27**, 1097−1102.

León-Ledesma, M.A. (2002) Unemployment hysteresis in the US states and the EU: a panel approach, *Bulletin of Economic Research*, **54**, 95–103.

Suleyman Bolat, Aviral Kumar Tiwari and Ahmet Utku Erdayi, (2014). Unemployment hysteresis in the Eurozone area: Evidences from nonlinear heterogeneous panel unit root test. Applied Economics Letters, Vol. No. : pp. (DOI:) (Forthcoming)

Leon-Ledesma, M.A. and McAdam, P. (2004) Unemployment, hysteresis and transition, *Scottish Journal of Political Economy*, **51**, 377–401.

Levin, A., Lin, C. F. and Chu, C. J. (2002) Unit root tests in panel data: asymptotic finite-sample properties, *Journal of Econometrics*, **108**, 1–24.

Lin, C.-H., Kuo, N.-F. and Yuan, C-D. (2008) Nonlinear vs. nonstationary of hysteresis in unemployment: evidence from OECD economies, *Applied Economics Letters*, **15**, 483–7.

Pan, G., Chang, T., Lee, C.-H. and Liu, W.-C. (2012) Revisiting purchasing power parity for 18 African countries: sequential panel selection method, *Applied Economics Letters*, **19,** 887−81.

Phelps, E. S. (1967) Phillips curves, expectations of inflation and optimal unemployment over time, *Economica*, New Series, **34**, 254–81.

Smith, S. (2003) *Labour Economics*, 2nd Edition, Routledge, London.

Smyth, R. (2003) Unemployment hysteresis in Australian states and territories: evidence from panel data unit root tests, *Australian Economic Review*, **36**, 181–92.

Ucar, N. and Omay, T. (2009) Testing for unit root in nonlinear heterogeneous panels, *Economics Letters*, **104**, 5–8.

Valetta, R. and Kuang, K. (2012) Why is unemployment duration so long?, *FRSF Economic Letter*, **3**, 1–5.

Van Dijk, D., Franses, P.H. and Paap, R. (2002) A nonlinear long memory model, with an application to US unemployment, *Journal of Econometrics*, **110**, 135–65.

Zhang, D., Chang, T., Lee, C.-H. and Hung, K. (2013) Revisiting purchasing power parity for East Asian countries: sequential panel selection method, *Applied Economics Letters*, **20**, 62–6.