Unemployment hysteresis in Central Asia

Furuoka, Fumitaka

University of Malaya

30 November 2014

Unemployment hysteresis in Central Asia[1]

Fumitaka Furuoka
Visiting Senior Research Fellow
Asia-Europe Institute
University of Malaya
50603 Kuala Lumpur, Malaysia
Tel: (603)-7967-6902, Fax: (603)-7954-0799
Email: fumitaka@um.edu.my, fumitakamy@gmail.com

Abstract

Unemployment hysteresis is an important but rather controversial issue in applied economics because the existence of hysteresis in unemployment rate poses a challenge to a central building-block of macroeconomic theory. The current paper chooses five Central Asian countries, namely Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, as a case study to examine the unemployment hysteresis for the period of 1991-2012. The number of observation is 22. In order to overcome the insufficient data, this paper uses the Bootstrap method to estimate the critical values (Park, 2003). For the purpose of empirical analysis, this paper uses the SURADF tests (Breuer *et al.*, 2002) and the Fourier ADF tests (Enders and Lee, 2012). The univariate unit root tests indicates that unemployment rate in Kazakhstan, Kyrgyzstan and Tajikistan can be the stationary process and unemployment rates in Turkmenistan and Uzbekistan can be the unit root process. The panel unit root indicates that unemployment rate in the Central Asia can be the stationary process. Overall, the current study concludes that unemployment rates in Central Asia can be best described as stationary process in line with the natural rate hypothesis.

Key words

Unemployment hysteresis, Central Asia, unit root, nonlinear

JEL classification codes:

E24, C22

---

[1] The author is grateful to Professor Jurgen A. Doornik of Oxford University for providing free OxEdit for academic purpose. Data and the OxGauss codes which were used in the current study are available at the website: https://sites.google.com/site/fumitakafuruokaswebpage/data-and-oxgauss-codes/paper-1

1. Introduction

Hysteresis in unemployment is an important but rather controversial issue in empirical and applied economics. It is because the hysteresis hypothesis has challenged a main pillar of macroeconomics, which is known as the natural rate of unemployment (Mitchell, 1993; Song and Wu, 1998). According to the mainstream macroeconomic theory, the unemployment rate would revert to the natural rate (Phelps 1967; Friedman, 1968; Phelps 1968). However, there was a prolonged period of high unemployment in Europe during the 1970s and the 1980s. These unemployment behaviours seem to cast a doubt about the basic prediction of the natural rate hypothesis. Thus, Blanchard and Summers (1986) proposed a new unemployment theory that assumed the unit root process of unemployment dynamics. This new hypothesis effectively denied a mean-reversion characteristic of unemployment rates which is a main tenet of the natural rate hypothesis.

Moreover, hysteresis in unemployment also has important policy implications. According to the natural rate hypothesis, the higher-than-normal level of unemployment rate would revert to the normal level after a recession without government intervention. In other words, the labour market would tend to have an inmate ability to recover from the recession without any assistance from government policy to stimulate the employment. By contrast, the hysteresis hypothesis denied this characteristic of the labour market and stated that the higher-than-normal level of unemployment would tend to prolong after a recession. It means that the policymakers would have a heavy responsibility to reduce the unemployment rate.

In this sense, Blanchard and Summers (1986) has opened a new debate about the nature and behaviour of unemployment dynamics and its crucial policy implication. Since then, numerous researchers have conducted numerous empirical inquiries to examine whether the hysteresis would exist in unemployment rates. However, the previous studies failed to produce consist results and their findings are mixed (Fosten and Ghoshray, 2011; Cheng *et al.*, 2012). Despite its importance in economic theory and policies, hysteresis in unemployment remains as an unsolved puzzles for almost three decades.

Against such backdrop, this paper chooses five Central Asia countries, namely Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, as a case study to examine the hysteresis in unemployment rates. The unemployment dynamics in these countries are depicted in Figure 1. Kazakhstan is a "successful" story among the Central Asian countries. After its independence from the Soviet Union in 1991, the country struggled to transform its economy from the planned economy to the market economy in the 1990s. The unemployment rates in Kazakhstan were relatively high until end of the 1990s. However, the unemployment rate in the country decreased to around 5 percent in the 2010s. By contrast, the economic performances and economic transformation in Kyrgyzstan and Tajikistan are relatively less impressive. The economic developments in these countries were still sustained by the migrant workers' remittances. Kyrgyzstan's unemployment rates increased in the beginning of the 2000s due to poor performance in the mining sector. Tajikistan also still suffered from relatively high unemployment because the country has not fully recovered from its destructive civil war in the 1990s. Turkmenistan and Uzbekistan are relatively natural resources-rich countries and maintained relatively stable economic development since its independents in 1991. However, these countries' unemployment rates in these countries were still high in the 2000s due to a lack of systematic and effective economic management under the market-oriented economy systems.

This paper aims to contribute to the existing literature on unemployment hysteresis in three ways. First of all, this study is the first in its kind to examine the unemployment dynamics in Central Asia. Previous studies focused on the developed countries in North America, Western Europe and the OECD member countries. There is lack of empirical analysis on the developing economies, especially transition economies, such as the Central Asian countries. Secondly, this paper employs the Seemingly Unrelated Regression (SUR) based the SURADF test for the empirical analysis. Increasingly robust economic and business ties among the five countries in Central Asia are accompanied by a higher interdependence and a deeper integration of their labour markets. Therefore, using the SURADF tests could yield better empirical results because these tests employ the SUR method that can take into account the contemporaneous cross-correlations of the error terms (Breuer *et al*. 2002). Thirdly, it also uses the Fourier approximation function based the Fourier ADF (FADF) test to examine the behaviour of unemployment rates in the Central Asian countries. The FADF test also is expected to produce better findings because it could take into account the unknown nonlinearity in the time-series data. According to Enders and Lee (2012), a Fourier approximation could be used to capture unknown structural breaks or unattended nonlinearity in the deterministic component of the model. Thus, methods that incorporate a Fourier function into unit root tests have generated interest among researchers. For example, Becker *et al*. (2006) used a nonlinear KPSS-type stationarity test; Rodrigues and Taylor (2012) used the DF-GLS de-trending method, and Enders and Lee (2011) employed a Lagrange Multiplier de-trending method.

Following this introductory section, Section 2 explains the hysteresis hypothesis from a theoretical and economic perspective. Section 3 is the literature review and the following section explains the data collection and the research methods. Section 5 reports the findings. Final section offers concluding remarks.

2. Theoretical and econometric perspective

Unemployment hysteresis is a much discussed and rather controversial topic in macroeconomics. Thus, there has been an ongoing debate whether hysteresis would exist in the unemployment rates. The opinions are divided between two contradictory schools of thought, namely the natural rate hypothesis and the hysteresis hypothesis. The natural rate hypothesis assumes that equilibrium unemployment would be determined by labour market institutions and would be not affected by actual unemployment. Furthermore, unexpected movements in labour demand and supply would lead to deviations from the equilibrium unemployment and change the situation with the actual unemployment. These deviations trigger changes in the rate of inflation which eventually would lead to the return to the equilibrium level of unemployment or the non-accelerating inflation rate of unemployment (NAIRU) (Phelps 1967; Friedman, 1968; Phelps 1968). In other words, cyclical fluctuations in the economy can influence unemployment in the short run but if there is no government intervention the unemployment rate would eventually revert to the NAIRU in the long run (Smyth 2003).

On the other hand, under the hysteresis hypothesis equilibrium unemployment is considered to be dependent on the past trends in the actual unemployment rate. Blanchard and Summers (1986) observed that between the mid-1970s and the mid-1980s actual unemployment in the European labour market went up in tandem with equilibrium unemployment as estimated by the Phillips Curve relationship. They argued that this phenomenon supported the alternative theory of unemployment or the hysteresis hypothesis. Unemployment hysteresis simply means that the equilibrium level of unemployment would tend to depend on the actual path of unemployment and that the equilibrium rate of unemployment is *path-dependent* (Carlin and Soskice 1990). In other words, under the unemployment hysteresis hypothesis cyclical fluctuations in the economy would have permanent effects on the level of unemployment (Smyth 2003). This implies that without government interventions to address the unemployment problem the high unemployment rates would not revert to the NAIRU in the long-run.

Among the most apt theories to systematically explain unemployment hysteresis are membership theories (Lindbeck and Snower 1985; Blanchard and Summers 1986; Gregory 1986). The membership theories assume that the wage setting would be mainly determined by insiders in a firm rather than by outsiders. The employment function could be expressed as:

$$n_t = n_{t-1} + (m - em) \quad (1)$$

where n_t is employment in the year t, m is the nominal money, em is the expected nominal money.

In other words, employment at a certain time is equal to employment in the previous period plus a random disturbance. In Equation (1) the disturbance is equal to the unanticipated movement in the nominal money. An implication of this equation is quite drastic as the formula indicates that employment would follow a random walk (Blanchard and Summers 1986).

From an econometric perspective, unemployment hysteresis could be seen as unit root process where the level of unemployment would not reverse to the NAIRU. This means that there exists a unit root in the unemployment time series. On the other hand, the natural rate hypothesis assumes that the unemployment rate is a stationary process in which the level of unemployment would eventually reverse to the NAIRU. This means that the unemployment time series do not have a unit root.

3. Literature Review

Based on their observation of the prolonged high unemployment in Europe during the 1970s and the 1980s, Blanchard and Summers (1986) posed a question on the natural rate hypothesis and proposed a new theory on unemployment dynamics which is known as the hysteresis hypothesis. The new hypothesis effectively denies the mean-reversion tendency of unemployment rates was denied and it attributes the main determinant of unemployment behaviour to the hysteresis effects. Furthermore, Blanchard and Summers defined unemployment hysteresis as a situation in which current unemployment rate was determined mainly by the past unemployment. In other words, they asserted that unemployment dynamics can be described best as the unit root process, rather than the stationary process.

Since then, numerous empirical inquires have examined whether hysteresis would exist in unemployment time. In the 1990s, researchers examined the hypothesis by using mainly univariate unit root tests, such as the ADF test or PP test (Neudorfer, *et al.* 1990; Brunello, 1990; Mitchell, 1993; Røed, 1996). For example, Neudorfer, *et al.* (1990) detected a unit root in the time series in Austria. Brunello (1990) found the existence of unemployment hysteresis in Japan. Mitchell (1993) pointed out that unemployment rates in Europe and the United States were the unit root process. By contrast, Røed (1996) claimed the existence of hysteresis in unemployment rate in Europe.

Researchers started using the panel unit root test for their empirical inquiries since the end of the 1990s (Song and Wu, 1998; Strazicich *et al.,* 2001; Smyth, 2003; Christopoulos and Leon-Ledesma, 2007; Romero-Avila and Usabiaga, 2007). For instance, Song and Wu (1998) used the LLC test to examine unemployment in fifteen OECD countries and claimed the stationary process of unemployment rate in these countries. Strazicich *et al.* (2001) used the panel LM test to examine hysteresis in unemployment in seventeen OECD countries and pointed out that there were no hysteresis effects in these OECD countries. Smyth (2003) employed the LLC and the IPS test to examine the unemployment hysteresis in Australian states and asserted the stationary process of unemployment dynamics in these Austrian states. Christopoulos and Leon-Ledesma (2007) applied to the second generation panel unit root test to study the existence of unemployment hysteresis in twelve EU countries and they also pointed out that there were no hysteresis effects in these EU countries. Furthermore, Romero-Avila and Usabiaga (2007) conducted empirical researches to examine the unemployment hysteresis hypothesis for the US states by using the panel LM test. Romero-Avila and Usabiaga concluded that the unemployment rates in the US states can be best characterised as the stationary process.

It should be noted that the panel data method is still a widely used method to analyse the unemployment hysteresis (Lee *et al.,* 2009; Ener and Arina, 2011; Dritsaki and Dritsaki, 2013). For example, Lee *et al.* (2009) examined the unemployment hysteresis hypothesis in the 19 OECD countries for the period of 1960-2004. They used the panel Lagrange Multiplier (LM) unit root tests with heterogeneous structural break in which two structural breaks were incorporated into analysis. Their findings from the panel LM test rejected null hypothesis of unemployment hysteresis. They concluded that the shocks to unemployment rate were temporary and unemployment rates would revert back to the natural rates of unemployment in the long-run. Ener and Arina (2011) analyzed the hysteresis hypothesis in the 15 OECD countries for the period of 1985-2004. They employed the second generation unit root test that allow for the cross-sectional dependency and another panel unit root test with structural breaks. The findings from the former panel unit root test indicated that unemployment rates in these countries can be described as nonstationary process. By contrast, the findings from the latter panel unit root test indicated that these time series data can be described as stationary process. They concluded that their findings provided empirical support to the natural rate hypothesis where unemployment rate would revert back to equilibrium level in the long-run. Dritsaki and Dritsaki (2013) used the first generation panel unit root test to examine the hysteresis hypothesis in three European countries for the period of 1984-2010. They pointed that there was no hysteresis effect in the unemployment rate in these EU countries.

Since the middle of the 2000s, some researchers applied the SURADF test for their analysis (Camarero and Tamarit, 2004; Chang *et al.,* 2005). For example, Camarero and Tamarit (2004) have employed the MADF test and the SURADF test to examine unemployment hysteresis in nineteen OECD countries for the period 1956-2001. They concluded that unemployment rates were stationary and there had been an absence of unemployment hysteresis in the majority of these OECD countries. Chang *et al.* (2005) employed the SURADF test to examine unemployment hysteresis in Europe between 1961 and 1999. Their findings indicated that the unemployment hysteresis hypothesis was supported in the case of all countries, with the exception of Belgium and the Netherlands. Furthermore, other researchers applied the Fourier unit root test for their analysis in the 2010s, (Chang, 2011; Furuoka, 2014). For instance, Chang (2011) employed a stationary test with a Fourier function to examine the hysteresis in unemployment for 17 OECD countries. He detected the hysteresis effects in unemployment rates in these countries. Furthermore, Furuoka (2014) used the ADF-type unit root test with a Fourier function to analyse unemployment hysteresis in five countries in Asia-Pacific region. He rejected the null hypothesis of hysteresis in these countries.

The hysteresis in unemployment has been still a popular topic in the recent years (Ari *et al.* 2013; Bakas and Papapetrou, 2014; Kula and Aslan, 2014). For example, Ari *et al.* (2013) employed the stationary panel unit root test to examine the unemployment hysteresis in seven countries in Asia-Pacific region. They asserted that there is no hysteresis effect in unemployment rate in these countries. Furthermore, Bakas and Papapetrou (2014) employed the panel LM test with cross-section dependency to examine the unemployment hysteresis in 15 OECD countries for the period of 1977-2009. They detected the hysteresis effects in unemployment rate in these OECD countries. Kula and Aslan (2014) employed the one-break LM test and the two-break LM test for the analysis of hysteresis effects in unemployment rate in Turkey for the period of 1989-2008 by using. They detected that the hysteresis in unemployment rates in Turkey.

4. Data and Research Method

This paper examines the unemployment hysteresis in five Central Asian countries, namely Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, for the period of 1991-2012. This paper uses the annual data of unemployment rates in these five countries which were obtained from the World Bank (2014). The number of observation is 22. In order to overcome the insufficient data, this paper uses the Bootstrap method to estimate the critical values (Park, 2003). It also uses the panel data methods to increase power of statistical test. In other words, findings from panel data are used to confirm the findings from other three univariate unit root tests which are used in this paper.

With regard data analysis, current study employed four different econometric methods, 1) the ADF test, 2) the URADF test, 3) the FADF test and 4) the panel unit root tests, for this purpose. In other words, besides of usage of conventional linear unit tests, the current research also employed more powerful unit root test, namely, the Seemingly Unrelated Regression (SUR) based the SURADF test and the Fourier function based the FADF test, to examine the behaviour of unemployment rates in the Central Asian countries. Due to insufficient number of observation, the lag length in all unit root tests is set to one in this paper.

First of all, the SURADF tests and FADF test could be considered as an extension of the ADF test. The linear ADF test is based on the following regression (Dickey and Fuller, 1979):

$$\Delta y_t = \alpha + \rho y_{t-1} + \sum_{j=1}^{p} \delta_j \Delta y_{t-j} + \varepsilon_t \qquad (2)$$

where Δ is difference operator, α is intercept, ρ and δ_j are the slope coefficients, p is the lag order of the autoregressive process and ε_t is the error term.

Secondly, the SURADF tests employ the seemingly unrelated regression (SUR) to estimate a system of the ADF equations. In this study, the system of the ADF equations can be expressed as (Breuer *et al.* 2001):

$$\Delta y_{1,t} = \alpha_1 + \rho_1 y_{1,t-1} + \sum_{j=1}^{p} \delta_j \Delta y_{2,t-j} + \varepsilon_{1,t}$$

$$\Delta y_{2,t} = \alpha_2 + \rho_2 y_{2,t-1} + \sum_{j=1}^{P} \delta_j \Delta y_{2,t-j} + \varepsilon_{2,t}$$

•

•

•

$$\Delta y_{N,t} = \alpha_N + \rho_N y_{N,t-1} + \sum_{j=1}^{p} \delta_j \Delta y_{N,t-j} + \varepsilon_{N,t}$$

where ρ_i is the autoregressive coefficient for series i. Breuer *et al.* (2001) suggested that one lagged augmentation was sufficient to address any problem arising from the serial correlation. Therefore, the lag length is set to be one in the current study. In the SURADF procedure, the significance of each ρ_i can be tested. They maintained that the SURADF test could examine the unit-root null hypothesis for each individual panel member. The present study estimates critical values for the individual ADF tests and the SURADF test by using 10,000 replications of the Bootstrap simulation.

Thirdly, Enders and Lee (2012) have developed an ADF-type unit root test that uses a selected frequency component of a Fourier function to approximate the deterministic component of the model. Enders and Lee (2012) suggested using a Fourier approximation to capture unknown structural breaks or unattended nonlinearity in the deterministic component of the model. The nonlinear Fourier ADF statistic (τ_{DF}) is based on the following equation (Enders and Lee, 2012):

$$\Delta y_t = \alpha + \rho y_t + \gamma_1 \sin(\frac{2\pi kt}{T}) + \gamma_2 \cos(\frac{2\pi kt}{T}) + \sum_{j=1}^{p} \delta_j \Delta y_{t-j} + \varepsilon_t \tag{3}$$

where k is the selected frequency for the Fourier approximation, γ are the parameters for the Fourier approximation, t is the trend term, T is the number of observations, $\pi = 3.1416$. The Fourier ADF statistic (τ_{DF}) is the t-statistic for the null hypothesis $\rho = 0$ in Equation 3. To compare the two tests, clearly the standard ADF test is a special case of the Fourier ADF test in which the trigonometric terms are set as zero (i.e. $\gamma_1 = \gamma_2 = 0$). According to Enders and Lee (2012), the usual F-statistic can be used to test whether the trigonometric terms should be included into the model. The linearity test or the F statistic can be calculated as follows:

$$F(k) = \frac{(SSR_0 - SSR_1)/q}{SSR_1/(T-s)} \tag{4}$$

where SSR_1 is the sum of squared residuals (SSR) from Equation 3, SSR_0 is the SSR from the regression without the trigonometric terms, q is the number of restrictions, and s is the number of regressors in the regression.

As Equation 3 shows, the *FADF* statistic depends on the frequency (k) and the lag length (l). Following a suggestion of Enders and Lee (2012) that a Fourier function using $k = 1$ or $k = 2$ can serve as a reasonable approximation to capture many types of unknown structural breaks, the maximum frequency ($k_{\max}$) was set as 2 in this study. The optimal frequency ($\tilde{k}$) was selected by the data-driven method. The optimal frequency is a selected frequency that produces the smallest sum of the squared residuals (SSR) among the different specifications in Equation 3.

Finally, this paper uses the panel data analysis in order to increase the power of statistical analysis. It will employ the heterogeneous panel unit root test or the Im-Pesaran-Shin (*IPS*) test suggested by Im *et al.* (2003). These researchers proposed a dynamic heterogeneous panel unit root test which is based on the mean value of individual unit root statistics. The *IPS* test is based on the following equation (Im *et al.,* 2003):

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + \sum_{j=1}^{p} \delta_{j,i} \Delta y_{t-j} + \varepsilon_{i,t} \tag{5}$$

where Δ is difference operator, y is the variable of interest, α is intercept, ρ and δ are slope coefficients, p is the lag length for lagged difference and ε is error term. Due to the insufficient number of observation, the lag length is set as one. The IPS test will estimate the following *tbar* statistic:

$$tbar = \frac{1}{N}\sum_{i=1}^{N} t_i \qquad (6)$$

where t_i is the t-statistic estimated from equation 5 and N is number of countries. Moreover, this paper also suggests using the Fourier IPS (*FIPS*) test in order to take account of nonlinearity in the unemployment rates in these five regions in Estonia. The *FIPS* test can be based on the following equation:

$$\Delta y_{t,i} = \alpha + \rho y_{t-1,i} + \gamma_{1,i}\sin(\frac{2\pi kt}{T}) + \gamma_{2,i}\cos(\frac{2\pi kt}{T}) + \sum_{j=1}^{p}\delta_{j,i}\Delta y_{t-j,i} + \varepsilon_{t,i} \qquad (7)$$

where γ is slope coefficient, k is the frequency, t is the deterministic trend, T is the number of observations, $\pi = 3.1416$. Due to the insufficient number of observation, the lag length for lagged difference is set as one. The optimal frequency is the rounded mean values of individual frequency. The mean value is 1.80. Thus, the optimal frequency is set as two. The FIPS test would estimate the Fourier *tbar* (*ftbar*) statistic:

$$ftbar = \frac{1}{N}\sum_{i=1}^{N} ft_i \qquad (8)$$

where ft_i is the Fourier t-statistic estimated from equation 7. The linearity test or the Fourier F (*FF*) statistic is based on:

$$FF(k) = \frac{1}{N}\sum_{i=1}^{N}\frac{(SSR_{0,i} - SSR_{1,i})/q_i}{SSR_{1,i}/(T_i - s_i)} \qquad (9)$$

where SSR_1 is the SSR from Equation 7, SSR_0 is the SSR from the regression without the trigonometric terms, q is the number of restrictions, and s is the number of regressors in the equation 7.

Six steps must be implemented in order to test the behaviour of the unemployment rates in the five Central Asian countries. In the first step of the analysis, the ADF test would be used to examine a stationary process in the unemployment rates. In the second step, the SURADF test would be employed for the empirical analysis. The SURADF test is expected to yield better empirical results because these tests employ the Seemingly Unrelated Regression (SUR) to capture the economic interdependency among five countries in Central Asia. The third step of the analysis determines the optimal frequency ($\tilde{k}$). The optimal frequency is selected by using the RSS from Equation 3. In the fourth step of analysis, after the frequency and the lag length are selected, the F-test can be applied to analyze whether the trigonometric terms should be incorporated into the model in the fourth step. If the F-test rejects the null hypothesis of linearity, nonlinear FADF can be an appropriate method of the analysis. Otherwise, standard linear unit root test should be used. In the fifth step of the analysis the FADF test is applied to analyze whether unemployment can be described as a stationary process by using an appropriate modelling to capture unknown structural breaks or unattended nonlinearity in the model. In the final step of analysis, the panel methods are used to confirm those from the univariate unit root tests.

5. Empirical Results

The present paper study chose five countries in Central Asia as case studies to examine the unemployment hysteresis hypothesis. For this purpose it employed four different econometric methods, 1) the linear ADF test, 2) the Seemingly Unrelated Regression (SUR) based the SURADF test, 3) Fourier function-based the FADF test and 4) the panel unit root test. In the first step of analysis, the ADF test is used to examine whether unemployment rates in the five countries in Central Asia can be described as a stationary process. Empirical findings from the ADF are reported in Table 1. As table showed, the ADF tests rejected null hypothesis of hysteresis for three countries in Central Asia, namely Kyrgyzstan, Tajikistan, and Uzbekistan. By contrast, the ADF test failed to reject the null hypothesis for the remaining two countries, Kazakhstan and Turkmenistan.

In the second step of the analysis, the Seemingly Unrelated Regression (SUR) based the SURADF tests are used to examine whether there is hysteresis in unemployment rates in these Central Asian countries. Findings from the SURADF test are reported in Table 2. As Table 2 clearly indicated, the SURADF could reject the null hypothesis of hysteresis in unemployment in Kyrgyzstan, Tajikistan, and Uzbekistan. It failed to reject the null hypothesis for Kazakhstan and Turkmenistan. It means that findings from the SURADF test uniformly confirm those from the ADF test.

In the third step of the analysis, the optimal frequency ($\tilde{k}$) was determined by using the RSS from Equation 3. The optimal frequency, the RSS and Akaike statistics are reported in Table 3. As Table 3 indicated, the optimal frequencies for four Central Asian countries, namely Kazakhstan, Kyrgyzstan, Tajikistan, and Turkmenistan, could be set as one. By contrast, the optimal frequency for Uzbekistan could be set as two.

In the fourth step of the empirical analysis, the *F*-test was used to test the null hypothesis $\gamma_1 = \gamma_2 = 0$ in Equation 3. The findings from the *F*-test are reported in Table 4. As Table 4 indicated, the *F*-test failed to reject the null hypothesis of linearity for three countries, namely Kyrgyzstan, Tajikistan and Turkmenistan. It means that the linear unit root tests, such as the ADF test or the SURADF test, should be used for the analysis of unemployment hysteresis in these three countries. The ADF test and the SURADF test rejected the null hypothesis of unit root in unemployment rate in Kyrgyzstan and Tajikistan. These findings indicate that the unemployment rates in Kyrgyzstan and Tajikistan could be the stationary process. Both the ADF test and SURADF test failed to reject the null hypothesis in Turkmenistan. It means that unemployment rates in Turkmenistan could be the unit root process.

In the fifth stage of analysis, the FADF test is used to capture unknown structural breaks or unattended nonlinearity in the deterministic component of the model. The empirical findings from the FADF test are reported in Table 5. The FADF test rejected the null hypothesis of hysteresis in unemployment rate for two countries, namely Kazakhstan and Kyrgyzstan. On the other hand, the FADF failed to reject the null hypothesis for the Tajikistan, Turkmenistan and Uzbekistan. However, as Table 4 showed, the *F*-test also rejected the null hypothesis of linearity for Kazakhstan and Uzbekistan. It means that the nonlinear FADF test is appropriate method to examine the unemployment hysteresis in these two countries. In other words, the findings from the FADF test indicated that the unemployment rates in Kazakhstan could be the stationary process. By contrast, the findings implied that the unemployment rates in Uzbekistan could be the unit root process.

In the final stage of analysis, the panel data method is used to increase the power of empirical tests. Findings from the panel data tests are reported in Table 6. As the table showed, the IPS test rejected the null hypothesis of hysteresis in Central Asia. Moreover, the *FF* test failed to reject the null hypothesis of linearity. It means that the IPS test, rather than the Fourier IPS test, is more suitable method to examine the hysteresis in Central Asia. On the other hand, the FIPS test also failed to reject the null hypothesis of hysteresis in Central Asia. These findings from the panel unit root test indicated that unemployment rates in Central Asia can be the stationary process.

In short, the current study employed four different types of unit root tests to examine the unemployment hysteresis in five countries in Central Asia. The univariate unit root tests indicated that unemployment rate in Kazakhstan, Kyrgyzstan and Tajikistan could be the stationary process and unemployment rates in Turkmenistan and Uzbekistan could be the unit root process. Furthermore, the panel unit root indicated that unemployment rate in the Central Asia could be the stationary process. Overall, the current study concludes that unemployment rates in five Central Asian countries can be best described as the stationary process.

6. Conclusion

The existence of unemployment hysteresis is an important issue in macroeconomics. The present article chose five Central Asian countries as case studies to examine the hysteresis in unemployment. For this purpose it employed the ADF test, the SURADF test, the FADF test and the panel data tests. As a conclusion, the unemployment rates in Central Asia could be best described as stationary process in line with the natural rate hypothesis. In other words, the unemployment rates in these Central Asian countries exhibited a strongly tendency to return to the equilibrium level.

The empirical findings from current study also offer some policy discussions about the unemployment problem in Central Asia. According to the empirical results, higher-than-normal level of unemployment rate would not prolong after the economic crisis in Central Asia. These empirical facts suggest that unemployment rates in these five Central Asian countries tend to revert to the natural rate without any government intervention. For example, in the case of the global financial crisis in the end of the 2000s, unemployment rates in these five countries went to higher level. It means that the unemployment rate could become higher than the natural rate of unemployment rate in the short-run. However, the findings from current study suggested that these discrepancies between the natural level and actual level of unemployment rate could be considered as temporary deviations. It means that unemployment rates in Central Asia have a tendency of the mean-reversion. The important policy implication is that policymakers in these Central Asian countries should take account of this important characteristic of the labour market in these regions. In other words, policymakers should not pay too much attention to the transit nature of the short-run deviations in unemployment rates. It could be a better policy option that policymaker in these Central Asian countries would make efforts to improve the labour market foundations, such as the employment regulations, human resource conditions, demographic tendencies, in order to improve the efficacy and functionality of labour market in long-run.

Furthermore, this paper offered a detailed procedure to analyse the unemployment hysteresis. These empirical methods could be applied to examine the unemployment hysteresis in other regions, such as the transition economies in Europe, Middle-East, Africa and Latin America. Due to data constraints, the current study chose used the annual data of unemployment from 1991 to 2011 to test the hysteresis hypothesis in the Central Asia. Future studies on unemployment hysteresis may use longer period of time series data. In the future study, researchers may employ advanced methods, such as unit root test with structural break for their studies. The findings from such studies would give much needed insights on the issue of unemployment hysteresis and would add better perspectives to the policy implications for unemployment problem in Central Asia.

References

Ari, A., Zeren, F. and Ozcan, B. (2013). Unemployment hysteresis in East Asian and Pacific countries: A panel data approach. *Marmara University Journal of Economic and Administrative Sciences,* 35(2): 105-121.

Bakas, D. and Papapetrou, E. (2014). Unemployment by Gender: Evidence from EU countries. *International Advances in Economic Research,* 20(1): 103-111.

Becker, R., Enders, W. and Lee, J. (2006). A stationarity test in the presence of an unknown number of smooth breaks. *Journal of Time Series Analysis,* 27:381-409.

Blanchard, O.J. and Summers, L.H. (1986). Hysteresis in unemployment. *NBER Working Paper*, No.2035.

Brunello, G. (1990). Hysteresis and the Japanese experience: A preliminary investigation. *Oxford Economic Papers*, 42: 483-500.

Camarero, M. and Tamarit, C. (2004). Hysteresis vs. natural rate of unemployment: New evidence for OECD countries. *Economics Letters*, 84: 413-417.

Chang, T. (2011). Hysteresis in unemployment for 17 OECD countries: Stationary test with a Fourier function. *Economic Modelling*, 28(5): 2208-2214.

Chang, H. L., Liu, D.C. and Su, C.W. (2012). Purchasing power parity with flexible Fourier stationary test for Central and Eastern European countries. *Applied Economics*, 44: 4249-4256.

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: 881-886.

Cheng, K.M., Durmaz, N., Kim, H. and Michael L. Stern, M.L. (2012). Hysteresis vs. natural rate of US unemployment. *Economic Modelling,* 29(2): 428-434.

Christopoulos, D.K. and Leon-Ledesma, M.A. (2007). Unemployment hysteresis in EU countries: What do we really know about it? *Journal of Economic Studies*, 34: 80-89.

Dickey, P. A. and Fuller, W. A. (1979). Distribution of the estimators for autoregressive time-series with a unit root. *Journal of American Statistical Association,* 74: 427-431.

Dritsaki, C. and Dritsaki, M. (2013). Hysteresis in unemployment: an empirical research for three member states of the European Union. *Theoretical and Applied Economics* 20(4): 35-46.

Enders, W. and Lee, J. (2011). A unit root test using a Fourier series to approximate smooth breaks. *Oxford Bulletin of Economics and Statistics*, doi: 10.1111/j.1468-0084.2011.00662.x

Enders, W. and Lee, J. (2012). The flexible Fourier form and the Dickey-Fuller type unit root tests. *Economics Letters*, 117(1): 196-199.

Fosten, J. and Ghoshray, A. (2011).Dynamic persistence in the unemployment rate of OECD countries. *Economic Modelling,* 28(3): 948-954.

Furuoka, F. (2014). Are unemployment rates stationary in Asia-Pacific countries? New findings from Fourier ADF test. *Economic Research-Ekonomska Istraživanja*, 27(1):34-45.

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

Gregory, R. (1986). Wage policy and unemployment in Australia. *Economica,* 53: S53-S74.

Im, K.S., Pesaran, M.H. and Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, 115(1): 53-74.

Kula, F. and Aslan, A. (2014). Unemployment Hysteresis in Turkey: Does Education Matter? *International Journal of Economics and Financial Issues,* 4(1), 35-39.

Lee, J.D., Lee, C.C. and Chang, C.P. (2009). Hysteresis in unemployment revisited: Evidence from the panel LM unit root test with heterogeneous structural breaks. *Bulletin of Economic Research*, 61: 325-334.

Lindbeck, A. and Snower, D. (1985). Wage setting, unemployment and insider-outsider relations. *American Economic Review,*76:235-239.

Mitchell, William F. (1993). Testing for unit roots and persistence in OECD unemployment. *Applied Econometrics*, 25: 1489-1501.

Neudorfer, P., Pichelmann K. and Wagner, M. (1990), Hysteresis, NAIRU and long term unemployment in Austria. *Empirical Economics*, 15:217-229.

Park, J.Y. (2003). Bootstrap Unit Root Tests. *Econometrica*, 71(6): 1845-1895.

Phelps, E.S. (1967). Phillips curves, expectation of inflation and optimal unemployment. *Economica,* 34:254-281.

Phelps, E.S. (1968). Money-Wage Dynamics and Labour Market Equilibrium. *Journal of Political Economy*, 76(4): 678-711.

Phelps, E. S. (1972). *Inflation and unemployment theory*, London, Macmillan.

Phillips, P.C.D. and Perron, P. (1988). Testing for a unit root in time series regression. *Biometrica,* 75: 335-346.

Røed, K. (1996). Unemployment hysteresis – macro evidence from 16 OECD countries. *Empirical Economics*, 21: 589-600.

Romero-Avila, D. and Usabiaga, C. (2007). Unit root test, persistence and the unemployment rates in the US states. *Southern Economic Journal*, 73: 698-716.

Smyth, R. (2003). Unemployment hysteresis in Australian states and territories: Evidence from panel data unit root tests. *Australian Economic Review*, 36: 181-192.

Song, F.M. and Wu, Y. (1998). Hysteresis in unemployment: Evidence from OECD countries. *Quarterly Review of Economics and Finance*, 38: 181-191.

Strazicich, M. C., Tieslau, M. and Lee, J. (2001). Hysteresis in unemployment? Evidence from panel unit root test with structural change. *University of North Texas Working Paper*, No.01-08.

World Development Bank (2014). "World Development Indicators", http://data.worldbank.org/data-catalog/world-development-indicators

Appendix: Figures and Tables

Figure 1: Unemployment rates and its mean values in Central Asia

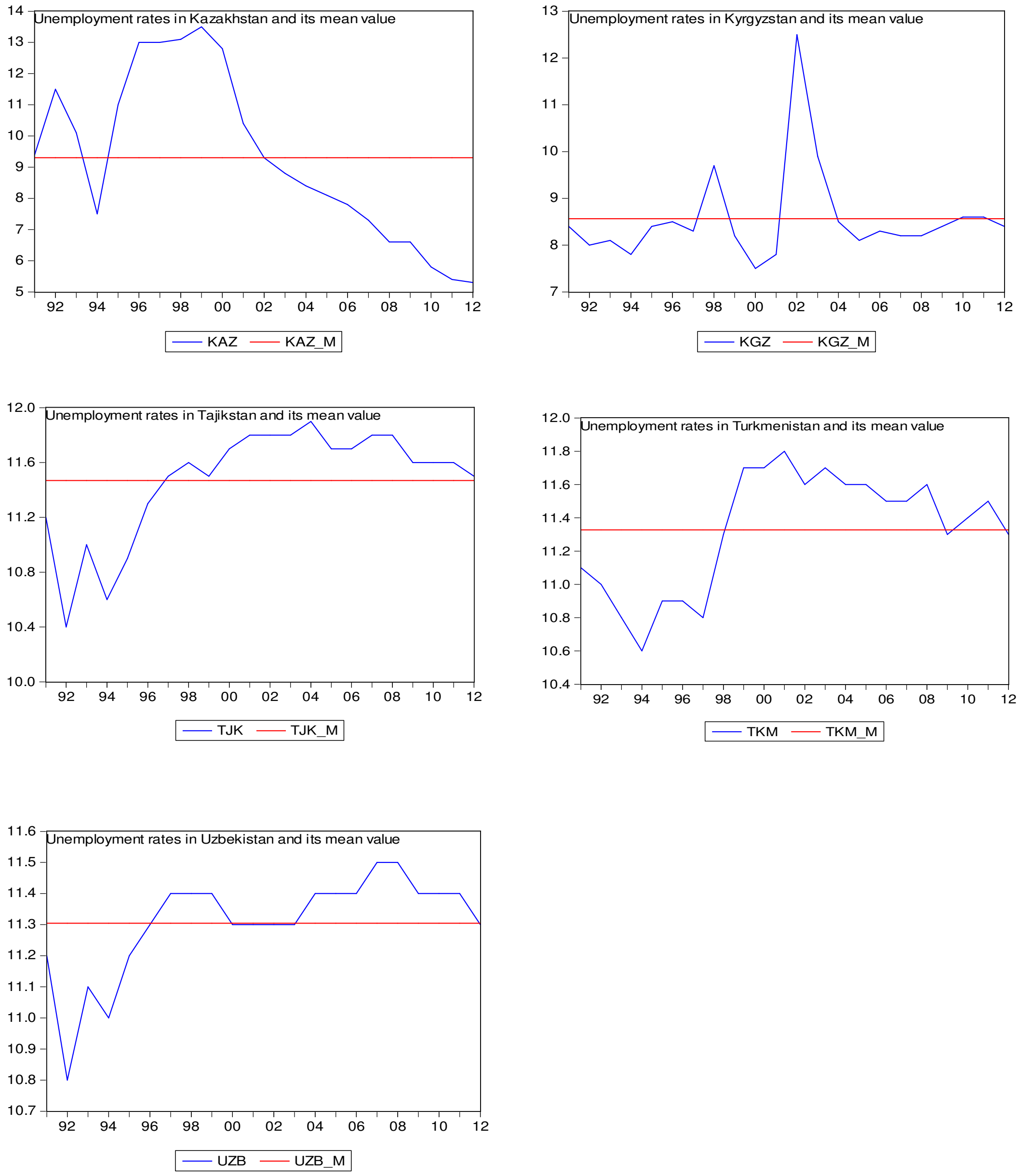

Table 1: ADF test and its critical values

Countries	*ADF Statistics*	*Critical Values*		
		1 percent	*5 percent*	*10 percent*
Kazakhstan	-0.895	-3.704	-2.909	-2.531
Kyrgyzstan	-3.687**	-4.434	-3.036	-2.587
Tajikistan	-2.610*	-3.934	-2.893	-2.483
Turkmenistan	-1.508	-3.923	-3.071	-2.677
Uzbekistan	-3.418**	-3.456	-2.836	-2.534

Notes: Critical values were estimated by 10,000 replications of the Bootstrap simulation
** indicates significant at the 5 percent level.
* indicates significant at the 10 percent level

Table 2: SURADF test and its critical values

Countries	*SURADF Statistics*	*Critical Values*		
		1 percent	*5 percent*	*10 percent*
Kazakhstan	-1.055	-5.051	-3.838	-3.314
Kyrgyzstan	-4.125**	-5.418	-3.953	-3.432
Tajikistan	-3.447*	-5.146	-3.811	-3.284
Turkmenistan	-1.022	-5.204	-4.034	-3.506
Uzbekistan	-4.495**	-4.833	-3.843	-3.378

Notes: Critical values were estimated by 10,000 replications of the Bootstrap simulation
** indicates significant at the 5 percent level.
* indicates significant at the 10 percent level

Table 3: Optimal frequency in FADF test

Countries	$\tilde{k}$	SSR	AIC
Kazakhstan	2	36.947	4.202
Kyrgyzstan	2	51.617	4.536
Tajikistan	2	63.440	4.743
Turkmenistan	2	39.778	4.276
Uzbekistan	1	50.727	4.519

Notes: The optimal frequency ($\tilde{k}$) was selected by using the data-driven grid-search method in which the frequency minimized the SSR from Equation 3.

Table 4: Nonlinearity *F*-test and its critical values

Countries	*F-statistics*	*Critical Values*		
		1 percent	*5 percent*	*10 percent*
Kazakhstan	10.635**	15.813	9.662	7.393
Kyrgyzstan	1.403	14.863	8.633	6.690
Tajikistan	2.226	20.900	12.632	9.395
Turkmenistan	2.950	16.461	10.026	7.575
Uzbekistan	6.265**	10.875	6.013	4.272

Notes: Critical values were estimated by 10,000 replications of the Bootstrap simulation
** indicates significant at the 5 percent level.

Table 5: FADF test statistics and its critical values

Countries	*FADF Statistics*	*Critical Values*		
		1 percent	*5 percent*	*10 percent*
Kazakhstan	-4.517**	-5.302	-4.218	-3.786
Kyrgyzstan	-4.093*	-5.796	-4.203	-3.694
Tajikistan	-1.368	-5.994	-4.599	-4.002
Turkmenistan	-2.255	-5.413	-4.288	-3.840
Uzbekistan	-2.475	-4.168	-3.156	-2.677

Notes: Critical values were estimated by 10,000 replications of the Bootstrap simulation
** indicates significant at the 5 percent level.
* indicates significant at the 10 percent level

Table 6: Panel unit root test and its critical values

IPS test		*Critical Values*		
	Statistics	*1 percent*	*5 percent*	*10 percent*
t-bar	-2.424**	-2.494	-2.149	-1.973
Fourier IPS test		*Critical Values*		
	Statistics	*1 percent*	*5 percent*	*10 percent*
ft-bar	-2.981	-3.675	-3.230	-3.000
ff	3.481	8.922	6.569	5.562

Notes: Critical values were estimated by 10,000 replications of the Bootstrap simulation
** indicates significant at the 5 percent level.