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ARE UNEMPLOYMENT RATES IN THE POST-COMMUNIST ECONOMIES STATIONARY? EMPIRICAL EVIDENCE FROM CENTRAL ASIA[2]

Hysteresis of unemployment is a crucial element to understand the nature and characteristic of the labour market in the post-communist economy. However, previous empirical inquiries mainly focused on unemployment hysteresis in the post-communist economies in Europe and there is little systematic analysis on the former communist countries in Asia. To fill this research gap, this paper chooses five Central Asian republics of the former Soviet Union, namely Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, and examines the unemployment hysteresis in these post-communist economies. For the purpose of empirical analysis, this paper uses several different unit root tests, such as the SURADF test, the Fourier ADF test and the panel Fourier IPS test. The univariate unit root tests indicate that unemployment rate in Kazakhstan, Kyrgyzstan and Tajikistan can be characterised as the stationary process. The panel unit root tests indicates that unemployment rate in the Central Asia can be stationary process. Overall, the current study concludes that unemployment rates in the post-communist economies in Central Asia can be best described as stationary process in line with the natural rate hypothesis.
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1. Introduction

Unemployment hysteresis is a crucial element to understand the nature and characteristic of the labour market in the post-communist economy. There was officially no unemployment problem in the centrally planned economy. The workers in the communist economies were said to enjoy the life-long employment without fear of the unemployment. However, an unemployment problem was hidden in the Soviet labour market. Despite no official

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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

statistics for unemployment rate, it was estimated that there were around 3-6 million unemployed workers in the Soviet Union in the end of the 1980s (Standing, 1991). At fact, the state enterprises in the centrally planned economy reduced unnecessary workforce under the name of the "release of workface" (In Russian, *высвобождение рабочей силы*).

Nevertheless, the economic transition from a planned economy to a market economy has inevitably created a serious unemployment problem. In other words, the high unemployment problem in the post-communist economy could be seen as an unwelcomed side-effect of the social and economic transformation process. On the other hand, the standard unemployment theory predicts that higher rates of unemployment in the transition process would be a "temporary" problem. It is because the mainstream macroeconomic model tends to make an implicit assumption that the higher-than-normal level of unemployment rates would revert to the equilibrium level at the steady state. In other words, the neoclassical macroeconomic theory defines an economic transition as a path from a steady state (i.e. centrally planned economy) to another steady state (i.e. market economy) (Senjur, 2009). The hypothetical market-clearing mechanism of the labour market under the market economy is known as the natural rate hypothesis (Phelps 1967; Friedman, 1968; Phelps 1968).

Contrary to the prediction of the natural rate hypothesis, the higher-than-normal level of unemployment rates in the post-communist economies does not seem to revert to the equilibrium levels. It means that initial economic shocks in the economic transformation processes have "permanent" effects on the unemployment rates (Cuestas et al., 2011). In this sense, the unemployment hysteresis in the former communist economy is the crucial issue in the labour market because the existence of hysteresis in unemployment rate may prove that the market-clearing mechanism of the labour market does not work well in the country. Or, the post-communist economy could fail to create a robust labour market which could absorb any economic shocks.[3]

From a historical perspective, Blanchard and Summers (1986) are among the first researchers who systematically examined and detected the persistently high rates of unemployment in Europe. They observed and pointed that there had been prolonged periods of high unemployment in Europe since the 1970s. These unemployment behaviours seem to cast a doubt about an important pillar of the mainstream economic theory (Mitchell, 1993; Song and Wu, 1998). Blanchard and Summers proposed a new unemployment hypothesis that was based on the unit root process of unemployment dynamics. In other words, the hysteresis hypothesis effectively denied a mean-reversion characteristic of unemployment dynamics which is a main tenet of the natural rate hypothesis.

[3] Eamets (2004) argued that the labour market flexibility have strong impact on the unemployment rates in the post-communist economies. If a post-communist economy could create a flexible labour market, the country would not suffer from high unemployment rate. It means that there is a negative association between labour market flexibility and unemployment rates. According to Eamets, there are three types of the labour market institutions which would determined the flexibility of the labour market, namely, labour legislation, labour policy and trade unions. These labour market institutions would jointly determine the wage flexibility.

Besides of its importance in the economic theory, the unemployment hysteresis also has some important policy implications for the post-communist economy. According to the natural rate hypothesis, the labour market under the market economy would tend to have an innate ability to recover from any economic crisis. It means that relatively higher rates of unemployment in the transition process in the post-communist economy would revert to the natural rates without policymakers' interventions to stimulate the employment. By contrast, the hysteresis hypothesis denies the market-clearing mechanism of the labour market and asserts that the higher-than-normal level of unemployment would tend to persist without a policy intervention. It means that the policymakers in the post-communist economies would have a heavy responsibility to deal with the unemployment problem.

Since the middle of the 1980s, 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; Furuoka, 2014b). Despite its prominence in theory and practices, the unemployment hysteresis remains as an unsolved economic puzzle for almost three decades. In other words, researchers are still wondering whether hysteresis would exist in the unemployment dynamics. In order to offer an additional insight on this important topic, this paper aims to examine the unemployment hysteresis in the five Central Asian republics of the former Soviet Union, namely Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

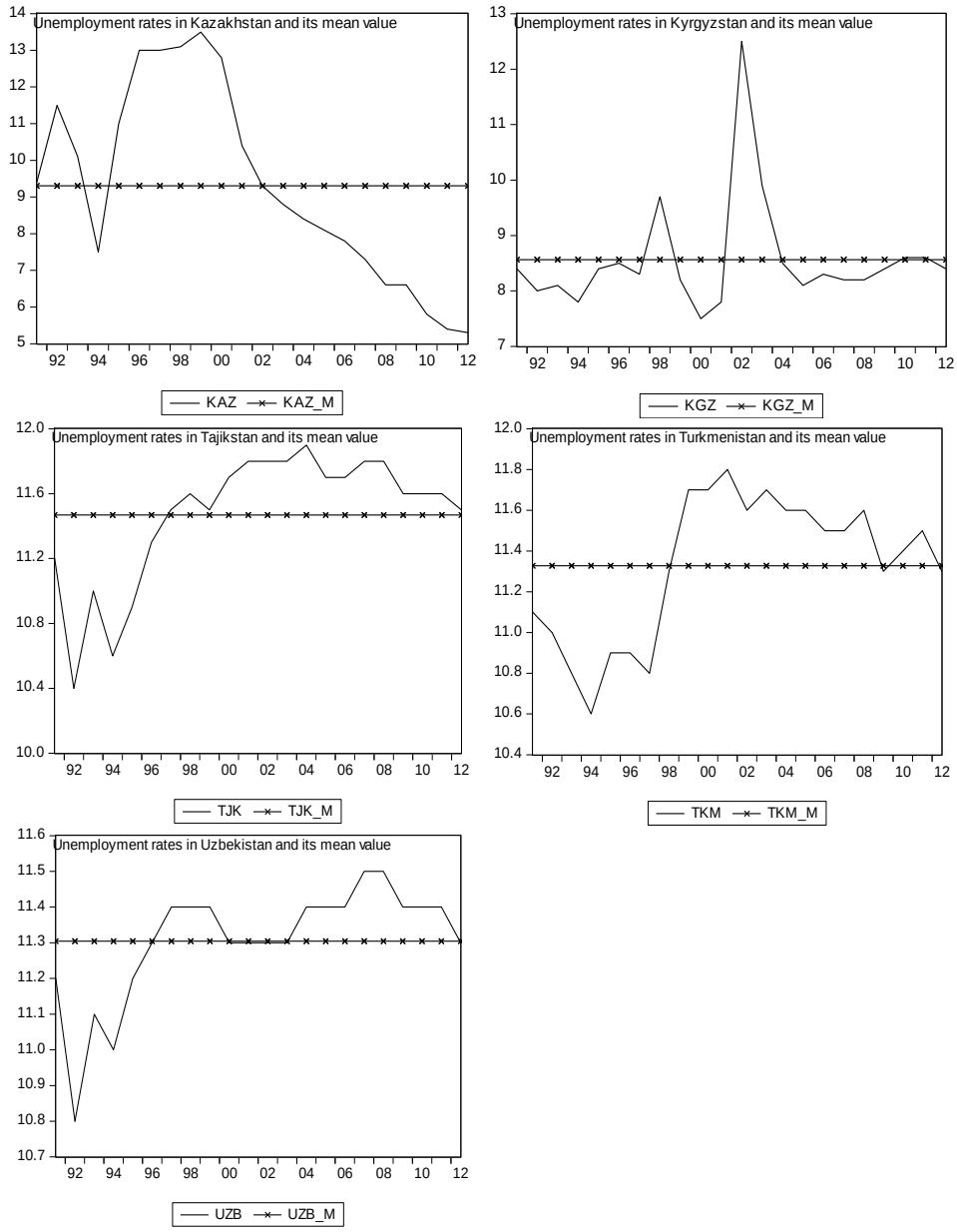
The unemployment dynamics in these post-communist economies in Central Asia are depicted in Figure 1. Kazakhstan is a "successful" story among the Central Asian countries. After the end of the Soviet Union in 1991, the country struggled to transform its economy from the planned economy to the market economy in the 1990s. The unemployment rates in Kazakhstan were relatively high until end of the 1990s. However, the unemployment rate in this country decreased to around 5% 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 natural resources-rich countries and maintained relatively stable economic development since its independents in 1991. However, unemployment rates in these economies were still relatively high in the 2000s due to a lack of systematic and effective economic management under the market economy.

This paper aims to contribute to the existing literature in five ways. First of all, this paper is the first systematic research to choose the five Central Asian republics of the former Soviet Union and to examine the unemployment hysteresis in these countries. Previous studies focused on the post-communist economies in Central and Eastern Europe (CEE) and there is little systematic analysis on this topic in the Asian republics of the former Soviet Union. Secondly, insufficient data on unemployment rates is the main reason why researchers are unable to conduct a meaningful and systematic empirical analysis of unemployment hysteresis in Central Asia. More generally, the lack of sufficient data has become a

hindrance to conduct empirical study in the post-communist economies because these economies started their transition process in the beginning of the 1990s.

Figure 1

Unemployment rates and its mean values in Central Asia



Source: World Bank, 2014.

In order to overcome this serious methodological issue, this paper uses the Bootstrap method to estimate the critical values (Park 2003). The Bootstrap method is expected to produce better critical values for the empirical analysis of the unemployment behaviours with limited number of observations. The current paper also uses the panel unit root test to increase the power of statistical tests. Thirdly, this paper proposes to use the Fourier Im-Pesaran-Shin (FIPS) to examine the unemployment dynamics in the region. This new panel unit root test is a Fourier function-based extension of the IPS test (Im, et al., 2003). The advantage of FIPS test is that this test is based on the Fourier approximation method to capture the unknown structural breaks or unattended nonlinearity in the deterministic component of the panel member countries. Fourthly, this paper employs the Seemingly Unrelated Regressions Augmented Dickey-Fuller (SURADF) test for the empirical analysis. Increasingly robust economic and business ties among the five post-communist economies 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 Seemingly Unrelated Regressions (SUR) method that can take into account the contemporaneous cross-correlations of the error terms (Breuer et al., 2002). Finally, it also uses the Fourier function-based the Fourier ADF (FADF) test to examine the behaviour of unemployment rates in the Central Asian economies. 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 Kwiatkowski-Phillips-Schmidt-Shin (KPSS)-type stationarity test; Rodrigues and Taylor (2012) used the Dickey-Fuller Generalised Least Squares (DF-GLS) de-trending method, and Enders and Lee (2011) employed a Lagrange Multiplier (LM) de-trending method.

More importantly, this paper seeks to serve a preliminary study to examine the behaviour of unemployment rates in the post-communist economies. Existing literature on unemployment hysteresis seems to focus on former communist countries in Europe. Since the middle of the 2000s, there are several studies on the EU members of the post-communist economies (Camarero et al., 2005; Cuestas et al., 2011; Furuoka, 2014b). By contrast, there is a serious lack of empirical analysis on the post-communist economies in non-European countries. To fill this research gap, the main goal and task of paper is to choose five Central Asian republics of the former Soviet Union and to examine the behaviour of unemployment rates in these post-communist economies. The main research question is: whether the unemployment dynamics in the five post-communist economies in the Central Asia could be described as the stationary process in line with the natural rate hypothesis? Or, unemployment rates in these post-Soviet states could be described as nonstationary process? The research objective in this paper is to examine whether the hysteresis exists in their unemployment dynamics in the Asian post-communist economies. The main limitation of the current study is the lack of reliable data on the unemployment dynamics in these countries. The future study may use longer and more reliable data set for the study on this important topic.

This paper consists of five sections. Following this introductory section, Section 2 is the literature review and the following section explains the data collection and the research methods. Section 4 reports the findings. Final section offers concluding remarks.

2. Literature review

Based on their observations of the persistently high unemployment in European labour markets since the 1970s, Blanchard and Summers (1986) questioned the natural rate hypothesis and proposed a new unemployment theory which is known as the hysteresis hypothesis. They defined unemployment hysteresis as a situation in which the long-run trend of unemployment rates would be determined by the actual level of unemployment. It means that the hysteresis effects could change the nature of unemployment behaviour and could create a situation in which unemployment rate would be path dependent. In other words, Blanchard and Summers asserted that unemployment dynamics could 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. However, researchers failed to produce consistent evidence and their empirical findings are mixed. Table 1 reports the summary of major empirical findings on the unemployment hysteresis. As the table shows, some researchers supported the natural rate hypothesis (Song and Wu, 1998; Smyth, 2003; Camarero and Tamarit, 2004; Camarero et al., 2005; Christopoulos and Leon-Ledesma, 2007; Romero-Avila and Usabiaga, 2007; Lee et al., 2009; Ari et al. 2013; Furuoka, 2014) and other researchers substituted the hysteresis hypothesis (Neudorfer et al. 1990; Brunello, 1990; Mitchell, 1993; Røed, 1996; Chang et al., 2005; Chang, 2011; Cuestas et al. 2011; Dritsaki and Dritsaki, 2013; Bakas and Papapetrou, 2014; Kula and Aslan, 2014).

Table 1

Summary of major findings on unemployment hysteresis

Authors (Year)	Countries	Variables	Data Source	Methods	Findings
Neudorfer et al. (1990)	Austria	Quarterly unemployment (1951-1986)	nil	1. the ADF test	Hysteresis
Brunello (1990)	Japan	Monthly, Quarterly and Annual unemployment (1955-1987)	nil	1. the ADF test	Hysteresis
Mitchell (1993)	15 OECD countries	Quarterly unemployment (1960Q2-1991Q3)	Main economic indicators, OECD	1. the ADF test 2. the PP test	Hysteresis
Røed (1996)	16 OECD countries	Quarterly unemployment (1970Q1-1994Q4)	Main economic indicators, OECD	1. the ADF test	Hysteresis
Song and Wu (1998)	15 OECD countries	Quarterly unemployment (1960Q1-1992Q2)	Main economic indicators, OECD	1. the LLC test	Natural rate
Smyth (2003)	8 Australian	Quarterly	Australian Bureau	1. the LLC test	Natural

	states	unemployment (1982Q2-2002Q1)	of Statistics	2. the IPS test	rate
Camarero and Tamarit (2004)	19 OECD countries	Annual unemployment (1955-2001)	Labour force statistics, OECD	1. the MADF test 2. the SURADF test	Natural rate
Chang et al. (2005)	10 European countries	Annual unemployment (1961-1999)	AREMOS database, Ministry of Education, Taiwan	1. the SURADF test	Hysteresis
Camarero et al. (2005)	9 transition economies in Europe	Monthly unemployment (1991M1-2003M11)	Eurostat	1. the unit root test with structural break	Natural rate
Christopoulos and Leon-Ledesma (2007)	12 EU countries	Quarterly unemployment (1988Q1-1991Q4)	nil	1. the second generation panel unit root test	Natural rate
Romero-Avila and Usabiaga (2007)	51 US states	Monthly unemployment (1976M1-2004M12)	US Department of Labour	1. the panel LM test	Natural rate
Lee et al. (2009)	19 OECD countries	Annual unemployment rate (1960-2004)	Global Finance Database	1. the panel LM test	Natural rate
Chang (2011)	17 OECD countries	Annual unemployment rate (1960-2009)	AMECO Online Database	1. the Fourier KPSS test	Hysteresis
Cuestas et al. (2011)	8 transition economies in Europe	Monthly unemployment (1998M1-2007M12)	Eurostat	1. the KSS test 2. the Kruse test 4. the BBC test	Hysteresis
Dritsaki and Dritsaki (2013)	3 EU countries	Annual unemployment rate (1984-2010)	IMF	1. the first generation panel unit root test	Hysteresis
Ari et al. (2013)	7 Asia-Pacific countries	Annual unemployment rate (1985-2011)	World Development Indicators, World Bank	2. the panel stationary test	Natural rate
Furuoka (2014a)	5 Asia-Pacific countries	Annual unemployment rate (1980-2009)	1. World Bank 2. Economic and Development Authority, Philippines	1. the Fourier ADF test	Natural rate
Bakas and Papapetrou (2014)	15 European countries	Annual unemployment rate (1977-2009)	Labour force statistics, OECD	1. the panel LM test with cross-sectional dependency	Hysteresis
Furuoka (2014b)	4 European countries	Quarterly unemployment rate (1998Q1-2013Q3)	1. Eurostat database	1. the Fourier ADF test	Hysteresis
Bakas and Papapetrou (2014)	15 European countries	Annual unemployment rate (1977-2009)	Labour force statistics, OECD	1. the panel LM test with cross-sectional dependency	Hysteresis

Some discrepancies in the empirical findings can be explained by the differences in the methods. The univariate unit root tests tend to fail to reject the null hypothesis of unit root process in the unemployment rates while the panel unit root tests tend to reject the null hypothesis. In the 1990s, researchers examined the hypothesis by using mainly univariate unit root tests, such as the augmented Dickey-Fuller (ADF) test or the Phillip-Perron (PP) test. These studies offered evidences to support the hysteresis hypothesis (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.

By contrast, the panel unit root tests tend to reject the null hypothesis of unit root process of unemployment dynamics. Since the end of the 1990s, researchers started using the panel unit root test for their empirical inquiries. These panel studies, except the study by Dritsaki and Dritsaki (2013), offered to empirical proofs to support the natural rate hypothesis (Song and Wu, 1998; Smyth, 2003; Christopoulos and Leon-Ledesma, 2007; Romero-Avila and Usabiaga, 2007; Lee et al., 2009). For instance, Song and Wu (1998) used the Levin-Lin-Chu (LLC) test to examine unemployment in fifteen OECD countries and claimed the stationary process of unemployment rate in these countries. Smyth (2003) employed the LLC and the Im-Pesaran-Shin (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. Furthermore, Lee *et al.* (2009) examined the unemployment hysteresis hypothesis in the 19 OECD countries for the period of 1960-2004 by using the panel LM test. 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. By constrast, 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 were hysteresis effects in the unemployment rate in these EU countries.

Furthermore, some advanced statistical methods, such as the SURADF test and the FADF test, tend to produce the mixed results. Since the middle of the 2000s, researchers have applied the SURADF test to take account of the cross-sectional dependency (Camarero and Tamarit, 2004; Chang et al., 2005). In the 2010s, researchers started employing the Fourier unit root test to take account of nonlinearity (Chang, 2011; Furuoka, 2014). Some researcher offered the evidence to support the natural rate hypothesis (Camarero and Tamarit, 2004) and other researchers denied the hypothesis (Chang et al., 2005; Chang, 2011). For example, Camarero and Tamarit (2004) have employed 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 ten European countries for the period of 1961-1999. Their findings indicated that the unemployment hysteresis hypothesis was supported in these countries. Furthermore, 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. Furuoka (2014a) 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.

There is a still ongoing debate whether the hysteresis would exist in the unemployment and more research efforts are devoted to examine the topic in the recent year (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 the 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-sectional 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.

It should be noted that few researchers conducted empirical inquiries to examine the unemployment hysteresis in the post-communist economies. Notable except are two in-depth empirical inquiries on unemployment hysteresis in the post-communist economies in the Central and Eastern Europe (Camarero et al., 2005; Cuestas et al., 2011; Furuoka, 2014b). In their pioneer studies, Camarero et al. (2005) employed the unit root tests with structural break, such as the Lumsdaine-Papell test, for their empirical analysis and examined the unemployment hysteresis in nine post-communist economies in the CCE region, including the three Baltic republics of the former Soviet Union, namely Estonia, Latvia and Lithuania, for the period of 1991-2003. These unit root tests with structural breaks showed that unemployment rates in these economies were stationary process. By contrast, Cuestas et al. (2011) used several advanced unit root tests which would allow for nonlinearities, such as the Kapetanios-Shin-Snell (KSS) test, the Kruse test and the Bec-Ben Salem-Carrasco (BBC) test, and analysed the unemployment dynamics in eight post-communist economies in the CCE regions, including these three Baltic economies, for the period of 1998-2007. However, these unit root tests detected the existence of unemployment hysteresis in these countries. Furuoka (2014b) used the nonlinear FADF test to examine the behaviour of unemployment hysteresis in the four post-communist countries in Central Europe, namely Czech Republic, Slovakia, Poland and Hungary, for the period of 1998-2013. He found the unit root process of unemployment dynamics in these former communist countries in Europe.

Despite its great merits, existing literature on unemployment hysteresis seems to suffer from three main shortcomings, namely a narrow geographical focus, a lack of sufficient

data and a methodological limitation. It could be unproductive for any researchers to conduct empirical research on this topic without dealing with these limitations. In other words, these limitations have become obstacles to draw an appropriate assessment and a relevant evaluation on the behaviours of the unemployment rates. First limitation is that previous studies tend to focus on the unemployment hysteresis in developed countries in Europe, North America and OECD countries. The empirical findings from the developed countries could not be generalised to under the nature of unemployment dynamics in developing countries or transition economies. This is because these advanced countries could have a tendency to have more efficient labour markets in which the unemployment rates could exhibit the stationary process. By contrast, developing countries and transitions economies could have a tendency to have less efficient labour markets in which economic shocks could have permanent impact on the labour market. In other words, current understandings of the unemployment hysteresis could be exclusively based on the findings from the developed countries. These findings could be biased because there is still lack of systematic research on this important topic in other developing countries, including some post-communist economies. Especially, there are a few empirical studies on unemployment hysteresis in the former Soviet republics and there is no systematic inquiry on the Asian republics of the former Soviet Union.

The second limitation is the lack of sufficient data on unemployment rates. This problem could be closely related to the first limitation. There has been no systematic analysis on this topic in the former communist countries mainly due to lack of sufficient data. The fall of communist regimes took place in the end of the 1980s. There could be no sufficient data on unemployment rate, especially annual data, in the post-communist economies. Some researchers have overcome this data constraint by using the monthly data (Camarero et al., 2005; Cuestas et al., 2011) or the quarterly data (Furuoka, 2014b). However, there is neither quarterly data nor monthly data on unemployment rates in non-EU members of the former communist countries. The lack of insufficient data could continue to be a serious problem to examine this important topic in the former communist countries in Southern Caucasus or Central Asia.

The final limitation is that previous studies to employ the linear unit root methods. As Table 1 indicated, over-majority of previous studies on this topic employed various kinds of the linear unit root tests, such as the ADF test, the PP test, the LLC test, the IPS test and so on. However, the nonlinearity could be hidden in the unemployment rates time-series. There is a need to use the nonlinear unit root test to detect the hidden nonlinearity of unemployment dynamics (Furuoka, 2014b). Only since the 2010s, researchers started employing a nonlinear unit root tests, such as the Fourier KPSS test and the Fourier ADF test, for their analysis (Chang, 2011; Furuoka, 2014b). However, these nonlinear unit studies focused on the developed economies in the OECD or EU member countries. There is little empirical analysis to use the nonlinear method to examine the unemployment hysteresis in other developing countries, including the post-communist economies.

Thus, to overcome these shortcomings, the current paper is a first empirical analysis to choose five Central Asian republics of the former Soviet Union and to examine unemployment hysteresis in these post-communist countries by using the nonlinear method. More precisely, the current study employs the nonlinear FADF test to capture the hidden

nonlinearity in the unemployment rate time-series in these countries. In order to deal with insufficient number of observation in the unemployment time-series, the current study uses the Bootstrap method to estimate the critical values and the panel methods, such as the IPS test or Fourier IPS test, to increase the power of statistical tests.

3. Data and methods

This paper examines the unemployment hysteresis in the five Central Asian republics of the former Soviet Union, 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. All republics of former Soviet Union started their economic transitions in 1991 and there was no official statistics for unemployment rate before the end of the Soviet Union. In other words, researchers would face a serious problem to conduct a research on the unemployment hysteresis in the former Soviet republics due to limited number of unemployment rates. In order to overcome the problem of the insufficient data, this paper uses the Bootstrap method to estimate the critical values (Park, 2003). Park argued that the bootstrap estimation of critical values would have a sample rejection probability which is closer to the asymptotic probability.

For the purpose of empirical analysis, current study employs following six different statistical methods, namely the augmented Dickey-Fuller (ADF) test, the seemingly unrelated regressions ADF test (SURADF) test, the Fourier ADF (FADF) test, the Im-Pesaran-Shin (IPS) test and the Fourier IPS (FIPS) test.[4] In other words, besides of usage of conventional linear unit tests, such as the ADF test, the current research also employs more powerful unit root test, such as the SURADF test which could incorporate cross-country correlation among the Central Asian countries and the FADF test which could take account of the nonlinearity in time-series data of unemployment rates. Furthermore, the current study also use two panel tests, namely the IPS test and the FIPS test, to increase the power of statistical test for the empirical analysis of unemployment dynamics in the post-communist economies in Central Asia. Due to insufficient number of observation, the lag length in all these unit root tests is set to one in this paper.

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 SUR method to capture the economic interdependency among five Central Asian countries. The third step of the analysis determines the optimal frequency ($\widetilde{k}$). The optimal frequency is selected by using the sum of the squared residuals (SSR). In the fourth step of analysis, after the frequency

[4] For more detailed discussion about statistical procedures and their statistical calculations, see Appendix.

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, namely the IPS test and the FIPS test, are used to confirm those from the univariate unit root tests.

4. Empirical Results

The present paper study chooses the five Central Asian republics of the former Soviet Union and examined the hysteresis in unemployment dynamics for the period of 1991-2012. For this purpose it employed five different econometric methods, namely the ADF test, the SURADF test, the FADF test, the IPS test and the FIPS 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 2. As the 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.

Table 2

ADF test statistics 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

In the second step of the analysis, 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 3. As the table 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 ($\widetilde{k}$) was determined by using the sum of the squared residuals (SSR). The optimal frequency, the RSS and Akaike statistics are reported in Table 4. As the findings in the table 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.

Table 3

SURADF test statistics 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 4

Optimal frequency in FADF test

Countries	$\widetilde{k}$	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 ($\widetilde{k}$) was selected by using the data-driven grid-search method in which the frequency minimized the SSR from Equation 3.

In the fourth step of the empirical analysis, the *F*-test was used to test the null hypothesis of linearity. The findings from the *F*-test are reported in Table 5. As the table 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 6. 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 5 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.

Table 5

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 6

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

In the final stage of analysis, the panel data methods, namely the IPS test and the FIPS test, is used to increase the power of empirical tests. Findings from the panel data tests are reported in Table 7. As the empirical findings in the table showed, the IPS test rejected the null hypothesis of hysteresis in Central Asia and the FIPS test failed to reject the null hypothesis of hysteresis in the region. Moreover, the linearity test failed to reject the null hypothesis of linearity in the time-series data of unemployment rates in Central Asia. It means that the IPS test, rather than the FIPS test, is more suitable method to examine the 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 several different types of unit root tests to examine the unemployment hysteresis in the Asian republics of the former Soviet Union. 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 the five post-communist economies in Central Asia can be best described as the stationary process.

Table 7

Panel unit root test and its critical values

IPS test	Statistics	Critical Values		
		1 percent	5 percent	10 percent
τ_{IPS}	-2.424**	-2.494	-2.149	-1.973
Fourier IPS test	Statistics	Critical Values		
		1 percent	5 percent	10 percent
τ_{FIPS}	-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.

5. Conclusion

The current study is the first in its kind to examine an intricate nature of unemployment dynamics in the former communist countries in Central Asia by employing several different types of unit root tests, such as a panel-based SURADF test and the nonlinear FADF test. The methodological advantage of the current study is to employ the Bootstrap method to estimate the critical values and to apply the panel unit root tests, such as the Fourier IPS test, to increase the power of statistical tests. The empirical findings revealed that the unemployment rates in the five post-communist economies 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 former communist countries exhibited tendencies to revert to the equilibrium levels. This means that the market-clearing mechanism of the labour market in these Central Asian countries *do* work well to absorb any economic shocks. This is the most important findings in the current study.

The empirical findings seem to indicate that the behaviours and patterns of unemployment rates in the Central Asia are more similar to those in Asian countries in which unemployment rates also tend to be stationary process (Ari et al., 2013; Furuoka, 2014a) and they are less similar to those in European countries in which unemployment rates tend to be nonstationary process (Cuestas et al., 2011; Dritsaki and Dritsaki, 2013; Bakas and Papapetrou, 2014; Furuoka, 2014b). More importantly, the findings indicate that behaviours of unemployment rates in Central Asia is similar to those in the Baltic republics of the former Soviet Union, such as Estonia, Litvia and Lithuania, in which unemployment rates tend to be stationary process (Camarero et al., 2005; Cuestas et al., 2011). This means that current study on the Asian republics of the former Soviet Union seems to produce additional empirical evidence that unemployment rates in post-Soviet states tends to be stationary process. This is an interesting insight on the situation of labour market in the post-Soviet states.

The empirical findings from current study offer some policy implications. The empirical findings indicate high unemployment problem does not seem to persist in the post-communist economies in Central Asia. It means that initial economic shocks in the transition processes would not have permanent effect on the unemployment rates in these

post-communist economies. In other words, these findings could also suggest that these countries have successfully created a robust labour market in which the higher-than-normal level of unemployment rates in these economies tend to revert to the natural rate without any government intervention. Furthermore, the findings also indicate that policymakers in these Central Asian countries 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 economies would make efforts to improve the fundamentals of the labour market institutions and regulations,[5] such as the wage setting institution, the minimum wage legislation, the social security mechanism, the employment regulation, the employee protection legislation and so on, in order to improve the efficacy and functionality of the labour market in the long-run.[6]

The current study offered an insight to understand an interesting characteristic of the labour market in the post-communist countries in Asia. However, there are several limitations in this study. The most critical shortcoming in current study is lack of reliable data on unemployment rates in the five Central Asian countries. For example, according to Maidyrova *et al.* (2013), official statistics showed that there were 480 thousands of unemployed workers in Kazakhstan in 2013. However, there are additionally 34 thousands of workers that are considered as the "hidden unemployed workers". This fact shows that the official statistics on unemployment rate could not capture or may underestimate the real unemployment conditions in these Central Asian countries. In this sense, the current study aims to serve as a preliminary study to stimulate further future study on this important topics. The future analysis could use more reliable time-series data on the unemployment rates in these countries. Another critical shortcoming is insufficient number of observation. The current study uses the annual data of unemployment rate for the period of 1991-2012. The number of observation is only 22. The future study may use the quarterly data or monthly data to increase the number of observation.

On the other hand, the current study offered a detailed six-step procedure to analyse the unemployment hysteresis in the post-communist economies. This systematic statistical procedure could be also applied to examine the unemployment hysteresis in post-communist economies in other regions, such as Central and Eastern Europe or East Asia. Furthermore, researchers may incorporate some advanced methods, such as the unit root test with structural break for their empirical studies. The findings from such studies would give much needed insights on this issue and would add better perspectives to the policy implications for unemployment hysteresis in the post-communist economies in Central Asia and beyond.

[5] For example, the European Union (EU) recommended the post-communist economies to make efforts to improve several important labour policies, such as labour taxation, unemployment benefits, employment protection, pension system, wage negotiation mechanism and so on (Kajzer, 2007).

[6] According to Feldmann (2005), there are following five important types of labour market institutions in the post-communist economies, namely minimum wages legislation, working-time laws, hiring-firing laws, trade unions regulations and laws on industrial relations. However, it is difficult for researchers to establish the relationship between labour market institutions and labour market outcome. This is mainly because the labour market institutions normally measured by a qualitative approach.

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Appendix: Statistical procedures

This paper employs following five types of statistical test to examine the unemployment hysteresis in the five Central Asian republics of the former Soviet Union, namely the ADF test, the SURADF test, the FADF test, the IPS test and the FIPS test. 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):

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

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 SUR method 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):

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

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

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$$\Delta y_{N,t} = \alpha_N + \rho_N y_{N,t-1} + \sum_{j=1}^{p} \delta_j \Delta y_{N,t-j} + \varepsilon_{N,t} \quad (3)$$

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.

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):

$$\Delta y_t = \alpha + \rho y_t + \gamma_1 \sin(\frac{2\pi kt}{T}) + \gamma_2 \cos(\frac{2\pi kt}{T}) + \sum_{j=1}^{p} \delta_j \Delta y_{t-j} + \varepsilon_t \quad (4)$$

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 (4). 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:

$$F(k) = \frac{(SSR_0 - SSR_1)/q}{SSR_1/(T-s)} \tag{5}$$

where SSR_1 is the sum of squared residuals (SSR) from Equation (4), 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 ($\widetilde{k}$) 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 (4).

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):

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + \sum_{j=1}^{p} \delta_{j,i} \Delta y_{t-j} + \varepsilon_{i,t} \tag{6}$$

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* (τ_{IPS}) statistic:

$$\tau_{IPS} = \frac{1}{N} \sum_{i=1}^{N} t_i \tag{7}$$

where t_i is the *t*-statistic estimated from the Equation (6) 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 countries in Central Asia. The FIPS test can be based on the following equation:

$$\Delta y_{t,i} = \alpha + \rho y_{t-1,i} + \gamma_{1,i} \sin(\frac{2\pi kt}{T}) + \gamma_{2,i} \cos(\frac{2\pi kt}{T}) + \sum_{j=1}^{p} \delta_{j,i} \Delta y_{t-j,i} + \varepsilon_{t,i} \quad (8)$$

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* (τ_{FIPS}) statistic:

$$\tau_{FIPS} = \frac{1}{N} \sum_{i=1}^{N} ft_i \quad (9)$$

where ft_i is the Fourier *t*-statistic estimated from the Equation (8). The linearity test or the Fourier *F* (*FF*) statistic is based on:

$$FF(k) = \frac{1}{N} \sum_{i=1}^{N} \frac{(SSR_{0,i} - SSR_{1,i}) / q_i}{SSR_{1,i} / (T_i - s_i)} \quad (10)$$

where SSR_1 is the SSR from the Equation (8), 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 (8).