Alanya Akademik Bakış Dergisi
Yıl: 2024, C:8, S:3, s.780-790

Alanya Academic Review Journal
Year: 2024, Vol:8, No:3, p.780-790

Validity of Unemployment Hysteresis in European Countries and Türkiye with Fourier Functions

(Research Article)

Fourier Fonksiyonlarla Avrupa Ülkeleri ve Türkiye'de İşsizlik Histerisinin Geçerliliği

Doi: 10.29023/alanyaakademik.1463030

Serhat ALPAĞUT[1]

[1] Asst. Prof. Dr., Agri İbrahim Çeçen University, Eleskirt Vocational School, Department of Finance-Banking and Insurance, salpagut@agri.edu.tr, Orcid No: 0000-0001-7326-4048

Keywords:
Unemployment Hysteresis, Natural Rate of Unemployment, Fourier Unit Root Tests

Received:
01.04.2024

Accepted:
28.06.2024

ABSTRACT

Unemployment hysteresis means that rising unemployment does not return to the average over time. This situation underlines that unemployment in countries is not temporary but permanent. In the case of unemployment hysteresis, economists argue for intervention in the economy. The existence of unemployment hysteresis is therefore important for the applicability of economic policy. This issue, which is very important for economists, has been analyzed in the literature using different methods. In this study, we use the analyses obtained by adding the recently popular Fourier models to unit root tests. The Flexible Fourier ADF (FF-ADF) test developed by Enders and Lee (2012) and the Fractional Frequency Flexible Fourier ADF (FFFF-ADF) test developed by Omay (2015) are used to investigate the existence of unemployment hysteresis in Türkiye and EU countries. As a result, it is found that the Fourier properties are statistically significant for both Türkiye and the EU and that the series have nonlinear properties. As a result of the tests applied, there is evidence that unemployment hysteresis does not valid for Türkiye and the EU.

Anahtar Kelimeler:
İşsizlik Histerisi, Doğal İşsizlik Oranı, Fourier Birim Kök Testleri

ÖZET

İşsizlik histerezisi, artan işsizliğin zaman içinde ortalamasına dönmediği anlamına gelir. Bu durum ülkelerde işsizliğin geçici değil kalıcı olduğunu vurgulamaktadır. İşsizlik histerezisi durumunda, ekonomistler ekonomiye müdahale edilmesi gerektiğini savunmaktadır. Böylece işsizlik histerisisinin varlığı, ekonomi politikalarının uygulanabilirliğini açısından önemlidir. Ekonomistler için oldukça önemli olan bu konu literatürde farklı yöntemlerle incelenmiştir. Bu çalışmada birim kök testlerine son dönemde popüler olan Fourier modellerinin eklenmesiyle oluşturulan analizleri kullanılmıştır. Enders ve Lee (2012) tarafından geliştirilen Flexible Fourier ADF (FF-ADF) ve Omay (2015) tarafından geliştirilen Fractional Frequency Flexible Fourier ADF (FFFF-ADF) testleri ile Türkiye ve AB ülkelerinde işsizlik histerezisinin varlığını araştırılmıştır. Sonuç olarak, Fourier özelliklerinin hem Türkiye hem de AB için istatistiksel olarak anlamlı olduğu ve serilerin nonlinear özellik taşıdığı tespit edilmiştir. Uygulanan testler sonucunda Türkiye ve AB için işsizlik histerezisinin geçerli olmadığına dair kanıtlar bulunmuştur.

1. INTRODUCTION

Unemployment is an important macroeconomic phenomenon that both developed and developing countries are struggling with. Fighting unemployment is an important policy implementation. In Europe, unemployment increased as a result of the oil shock in the 1970s. (Srinivasan and Mitra, 2012, p. 419; Arestis and Mariscal, 1999, p. 150). The second oil price hike in 1979-1980 led to an increase in unemployment in EU countries. (Omay et al., 2021, p. 875). After the global financial crisis of 2008, a significant increase in unemployment was observed in developed countries such as the US and Japan (Chang, 2011, p. 2208). In the same period, it is observed that unemployment has increased in Türkiye. In these examples, it can be seen that structural changes have a negative impact on unemployment. Some macroeconomic models of this situation argue that unemployment is a steady state or should fluctuate around the natural rate. (Garcia-Cintado et al., 2015: p. 244). However, the lack of a return to this average in some countries has raised the issue of unemployment hysteresis.

Empirical studies on the existence of unemployment hysteresis conclude with an examination of the stationarity of the unemployment series. The absence of a unit root in the series indicates that the effect of shocks is temporary and returns to the mean of the natural rate. (Ghoshray and Stamatogiannis, 2015: p. 74). The unemployment hysteresis hypothesis is when unemployment is in the I(I) process. It shows that shocks affecting the series have a permanent effect. In this case, the unemployment equilibrium shifts from one level to another. (Cheng, et al., 2014, p. 142).

If it is decided that unemployment is permanent, policy makers can intervene in the economy with monetary and fiscal policies. In this sense, the existence of unemployment hysteresis is an indicator for intervention in the economy.

The subject has been studied extensively in the literature. The tests performed with linear and nonlinear unit root tests and their results are given in the literature section. However, this study considers this test again for Türkiye and EU countries with Flexible Fourier ADF (FF-ADF) and Fractional Frequency Flexible Fourier ADF (FFFF-ADF) tests based on the DF test. The FF-ADF test developed by Enders and Lee (2012) is formed by adding Fourier models to the DF test. FFFF-ADF test is formed by using fractional values in FF-ADF test. The FFFF-ADF test is a new test developed by Omay (2015). It has been determined that these tests are used in limited numbers for unemployment hysteresis. It is aimed to contribute to the issue of unemployment hysteresis by using these two tests together.

The global pandemic has had a significant impact on the economies of both Europe and Türkiye. In addition, the influx of Syrian immigrants has contributed to a common economic downturn in both countries. In addition, factors such as the recent coup attempt in Türkiye and natural disasters are important events that economists analyse by including them in their econometric models. Such events represent structural changes and breaks. Structural change is analysed econometrically by adding a dummy variable to the model. However, the large number of existing breaks poses a challenge to the inclusion of so many dummy variables in the models under investigation. Fourier functions, which have recently gained popularity, offer a solution to this challenge by allowing these breakdowns to be included without the need to add external dummy variables to the model. Trigonometric terms, which are added to the model without the need to know the time of fracture, provide a structure that accounts for all of these fractures. In this study we have attempted to overcome this difficulty by using Fourier functions.

Türkiye and European Union countries are significant trading partners with close economic relations. Despite their similar economic structures, their economies focus on different sectors and have different dynamics in their labor markets. Türkiye's young population creates a distinct unemployment dynamic compared to the aging workforce of European Union countries. Additionally, Türkiye is currently engaged in the process of becoming a full member of the European Union, which involves economic integration efforts. The harmonization of Türkiye's economic and labor markets with European standards necessitates the development and implementation of common policies to combat unemployment. Consequently, it is crucial to assess the prevalence of unemployment hysteresis in Türkiye and European Union countries.

The study has two main questions. The first is whether unemployment has nonlinear characteristics in Türkiye and EU countries. The second is whether the hypothesis of unemployment hysteresis is valid in Türkiye and EU countries.

2. LITERATURE

Studies investigating unemployment hysteresis are generally based on univariate and unit root analysis tests. In the early periods, studies were carried out with unbreakable unit root tests. Blanchard and Summers (1986b); Mitchell (1993); Jaeger and Parkinson (1994); Røed (1996) studies are pioneering studies in the literature. These studies provide evidence of the existence of unemployment hysteresis in European countries, as a result of the analysis they made with tests that do not take into account structural breaks. Perron (1989) states that if there are

structural breaks in a series and they are not taken into account, the analysis may lead to accepting the null hypothesis of the unit root. After the unit root test, the structural breaks developed for this purpose were determined by Song and Wu (1998); Arestis and Mariscal (1999); Camarero et al. (2006); Lee and Chang (2008) studies found evidence for the existence of the natural rate hypothesis. These results support the assumption made by Phelps (1994) that the majority of shocks to unemployment are temporary.

Nonlinear unit root tests have developed with the inclusion of Fourier terms in unit root tests, along with the discussions on whether the variables are linear or not. With the increase in the use of these tests, different Fourier unit root models were formed and applied. Adding structural breaks to the model as dummy variables beforehand accepts these variables as exogenous. It is also assumed that the ruptures occur suddenly. Fourier models have smooth transitions. Thus, it is not necessary to follow sudden breaks (Chang, 2011, p. 2209; Omay et al., 2021, p. 875). In addition, in tests with structural breaks, the number and location of breaks must be known, but these breaks are mostly estimated. This leads to preselection bias (Cheng et al., 2014, p. 143). However, there is no need to know the date and number of such breaks in Fourier models. This is an important advantage of Fourier models. Since Fourier models are new, there are limited studies in the literature. In the analyzes made with the developed Fourier models, the results support the existence of unemployment hysteresis for some EU countries and the existence of the natural rate hypothesis for others (Chang, 2011; Chang et al., 2014; Dursun, 2017). However, the existence of unemployment hysteresis is generally accepted.

Studies investigating unemployment hysteresis for Türkiye mostly applied traditional unit root tests. In some literature studies summarized in Table 1, studies that analyse Türkiye with Fourier models are given. It is seen that there are few studies available. Among these studies, Dursun (2017); Yazgan et al. (2019); Bayat et al. (2020); Belliler and Demiralp (2021); It was concluded that the Fourier function used in the studies of Çiçen (2021) is significant and that the unemployment series has nonlinear characteristics in Türkiye. Kahyaoğlu et al. (2016) and Tekin (2018) studies, on the other hand, found that the Fourier features are statistically insignificant for Türkiye and have serial linear features. Sigeze et al. (2019) concluded that the unemployment hysteresis hypothesis is valid for other EU countries and Türkiye except Latvia, Belgium, Cyprus and Sweden. Yaya et al. (2022) concluded that the Fourier features are meaningless for EU countries and the series is linear. In general, there is evidence for the existence of unemployment hysteresis in studies on Türkiye. Only the results of the Belliler and Demiralp (2021) study support the natural rate hypothesis. However, there is no consensus on the validity of the unemployment hysteresis hypothesis.

Table 1. Summary of Literature

Author(s)	**Countries and Period**	**Empirical Method**	**Conclusion** Unemployment hysteresis does exist (+), Unemployment hysteresis does not exist (-)	**Result As Functional Form**
Blanchard and Summers (1986b)	France, England, Germany, USA (1953-1984)	DF, ADF	France, Germany, and UK (+) USA (-)	linear
Brunello (1990)	Japan (1955-1987)	ADF, GLS	(+)	linear
Mitchell (1993)	15 OECD countries (1961-1984)	ADF, PP	(+)	linear
Jaeger and Parkinson (1994)	4 developed countries (1961-1990)	ADF	Canada, Germany, and UK (+) USA (-)	linear
Røed (1996)	16 OECD countries (1970.1-1994.4)	ADF	USA, Finland, and Sweden (-) other countries (+)	linear
Song and Wu (1998)	15 OECD countries (1961-1984)	Panel ADF, IPS	(+)	linear
Arestis and Mariscal (1999)	26 OECD countries ($1960Q_1$-$1997Q_2$)	Structural fracture panel unit root test	Austria, Canada, Japan (-), USA (+)	linear
Camarero et al. (2006)	19 OECD countries (1956-2001)	Structural fracture panel unit root test	(-)	linear
Christopoulos and León-Ledesma (2007)	12 EU Countries ($1988Q_1$-$1999Q_4$)	Panel unit root tests	(-)	linear
Lee and Chang (2008)	19 OECD Countries	Structural fracture panel unit root test	(-)	linear

Chang (2011)	17 OECD countries (1960-2009)	FKSS Becker vd., (2006)	Australia, Canada, Finland, France, Sweden, and USA (+), other countries (-)	nonlinear
Chang et al. (2014)	PIGGS Counties (1960-2011)	FADF	Portugal and Spain (-), Ireland, Italy, Greece (+)	nonlinear
Dursun (2017)	7 EU Countries ($2000Q_1$-$2016Q_2$)	FADF, FADF-SB	Romania, Türkiye Hungary, Poland (+) other countries (-)	nonlinear
Yilanci et al. (2020)	G7 countries (1991-2019)	FADF Christopoulos and León-Ledesma (2011) F-TUR	While all countries are nonlinear according to the FADF test, data from Canada, Japan and the USA are nonlinear according to the FTUR test. (+)	nonlinear
Omay et al. (2021)	14 EU, 9 OECD Countries (1960-2016)	F-EO, F-UO	(+)	nonlinear
Caporale et al. (2022)	27 EU Countries ($2000Q_1$-$2020Q_4$)	Fractional integration methods	(+)	nonlinear
Yaya et al. (2022)	5 EU Countries (1983-2018)	ADF–SB, FADF–SB, ARNN	Fourier features are statistically insignificant (linear) in European countries. (+)	linear
Yılmaz (2023)	15 and 28 EU Countries (2001 Q1-$2019Q_4$)	FFFF-ADF	(+)	nonlinear
		Fourier Studies for Türkiye		
Kahyaoğlu et al. (2016)	Türkiye and EU ($2001Q_1$-$2015Q_4$)	FADF, FIPS	Fourier features are statistically insignificant (linear) (+)	linear
Tekin (2018)	Türkiye (2005-2017)	FADF, FKPSS	Fourier features are statistically insignificant (linear) According to the ADF test result (+)	linear
Yazgan et al. (2019)	Türkiye ($2005M_1$-$2018:M_{12}$)	FADF, FGLS, FKPSS	unemployment hysteresis in the agricultural sector (-) unemployment hysteresis in the non-agricultural sector (+)	nonlinear
Sigeze et al. (2019)	Türkiye and EU (1991-2016)	Panel F-KPSS	Latvia, Belgium, Cyprus and Sweden (-) other EU countries and Türkiye (+)	nonlinear
Bayat vd. (2020)	Türkiye (1923-2019)	FADF Christopoulos and León-Ledesma (2011)	(+)	nonlinear
Belliler and Demiralp (2021)	Türkiye (1923-2021)	Hepsağ (2021)	(-)	nonlinear
Çiçen (2021)	Türkiye (2005-2014)	FKPSS	Unemployment hysteresis was evaluated according to gender and age divisions. Regarding the presence of hysteresis, different results were obtained for both age and gender. (+)	nonlinear

3. ECONOMETRIC METHODOLOGIES

In this section, ADF unit root test and new unit root tests that are formed by adding Fourier functions will be explained.

3.1. Augmented Dickey Fuller (ADF)

The long-run characteristics of a series depend on the relationship between the lagged values of the variables in that series and the current period.

$$Y_t = \lambda Y_{t-1} + u_t \quad (1)$$

In Equation (1), Y_t is the current value of the variable in period t; Y_{t-1} is previous period value; λ represents the elasticity coefficient and u_t represents the error terms. In this regression developed by Dickey and Fuller (1979), it is stated that when the coefficient of λ is equal to zero, the current period value of the variable will be equal to the errors, so that stationarity will be achieved. If the value of λ is equal to 1, the existence of a unit root can be mentioned. If the value of λ takes a value between 0 and 1, it means that the shocks experienced by the variable in the past period will gradually disappear even if there are effects of a certain period in time (Tari, 2015, p. 387).

$$\Delta Y_t = (\lambda - 1)Y_{t-1} + u_t \quad (2)$$

Equation (2) is obtained when the term Y_{t-1} is added to both sides of the equation in Equation (1). Expression ΔY_t denotes operation ($Y_t - Y_{t-1}$). Thus, the take difference operation ΔY_t is obtained.

$$\Delta Y_t = \theta Y_{t-1} + u_t \quad (3)$$

Equation (3) is obtained when the expression (λ-1) in Equation (2) is abbreviated with the expression θ. Since the difference operator and error terms will be equal when θ is zero, it is stated that the ($\Delta Y_t = u_t$) series is stationary in difference (Tari, 2015, p. 388).

At the end of the first order autoregressive process created by adding the dependent variable to the model, the error terms will not be a clean sequence and autocorrelation problem will be encountered. Thus, the Dickey and Fuller (1979) method described above will be invalid. For this reason, the autocorrelation problem is tried to be solved by adding an error term, (u_t=θY_(t-2) +⋯+θY_(t-n) + υ_t), in which different lags of the variable are added.

After all, a series has multiple lags, not just the first lag. Equation (4) will be obtained when the added lagged value is substituted (Çınar and Sevüktekin, 2017, p. 335).

$$Y_t = \theta Y_{t-1} + \theta Y_{t-2} + \theta Y_{t-3} + \cdots + \theta Y_{t-n} + u_t \quad (4)$$

Equation (4) is the case of adding the lagged value of the variable to the Dickey and Fuller (1979) test. This new form is called Augmented Dickey Fuller (ADF). After this stage, the stationarity of the test after the level and difference process follows the same processes as the Dickey Fuller (DF) test.

Since lagged values are included in the model in the ADF test, it is important to determine which lag is the appropriate lag. If the appropriate number of lags cannot be determined correctly, the power of the test will decrease, and if it is chosen larger than it should be, it becomes inclined with the estimation. There are several ways to do this. The first is done using Akaike Information Criteria (AIC) and Schwarz Information Criteria (SIC).

$$\begin{array}{c} \text{Condition 1: } p^3/T \to \infty \text{ and } \quad p \to \infty,\ T \to \infty \\ \text{Condition 2: } c.k > T^{d/r} \quad \text{and } c > 0,\ r > 0 \end{array} \quad (5)$$

In Equation (5), p represents the number of lags and T represents the sample size. It is known that if Condition 1 is met, Condition 2 is also automatically met (Çınar and Sevüktekin, 2017, p. 335).

Another approach in determining the number of lags is the general-to-specific and specific-to-general approach. Of these two approaches, the general-to-specific approach is based on the statistical significance of the lags in the model. Starting with the most general model with the highest number of lags, statistically significant lag is tried to be found. If no significance is found in the highest lags, a lag is reduced and a statistically significant lags is determined (Çınar and Sevüktekin, 2017, p. 335).

3.2. Flexible Fourier ADF (FF-ADF)

Effects that start in any period and continue for a certain period are seen in macroeconomic variables. These effects are called structural changes. ADF and other traditional unit root tests do not consider such structural changes. When there is a structural break in a series, ignoring this situation leads to inclined results. For this reason, single structural break models were developed by Zivot-Andrews (1992) and two structural breaks models were developed by Lee-Strazicich (2003, 2004) studies. In these studies, it makes predictions by adding dummy variables to the model by accepting the structural changes as exogenous (Cai and Omay, 2021, p. 448). These tests capture sudden changes in fractures. Changes in macroeconomic variables are sometimes not sudden but spread over time and occur softly. Since Fourier functions can detect such breaks, they have been added to unit root tests.

The Flexible Fourier ADF test, developed with Enders and Lee (2012), does not require the determination of the number of structural breaks, the dates of the fractures, and the fracture pattern (Yilanci and Eris, 2013, p. 210).

$$\alpha\,(t) = \alpha_0 + \sum_{k=1}^{n} \alpha_k \sin\left(\frac{2\pi kt}{T}\right) + \sum_{k=1}^{n} \beta_k \cos\left(\frac{2\pi kt}{T}\right) \quad (6)$$

The trigonometric functions specified in Equation (6) are added to the ADF model shown in Equation (3). In Equation (6), n is the number of frequencies; k is a particular frequency value, t is the trend; T represents the number of observations (Enders and Lee, 2012, p. 197).

In the application of the FF-ADF test;

a) It is necessary to determine the frequency value to be used in the first stage model. The value of k takes an integer value from 1 to 5. By giving these integer values, the model is estimated by OLS. The frequency value with the smallest residual sum of squares value obtained in the estimation results is chosen as the correct frequency value (Enders and Lee, 2012: 197).

b) It is important to determine the lag length as described in the theoretical part of the ADF test. Appropriate lag length that can be selected with the general-to-specific strategy; First of all, the highest lag length is given, and it is checked whether it is statistically significant. If it is not found to be significant, the number of lags should be reduced and the number of significant lags should be determined.

c) In case of $\alpha_k = \beta_k = 0$, it is suggested that the process is linear and traditional ADF unit root test should be performed (Enders and Lee, 2012, p. 197). This stage expressly expresses the condition of testing the validity of the Fourier function.

$$\Delta Y_t = \rho_{y-1} + C_1 + C_2 + C_3 \sin\left(\frac{2\pi kt}{T}\right) + C_4 \cos\left(\frac{2\pi kt}{T}\right) + u_t \quad (7)$$

In the Fourier ADF regression specified in Equation (7), the F test is applied to the parameters C3 and C4. The resulting statistical value is compared with Table1a (constant) and Table1b (constant and trended) in the study of Enders and Lee (2012). In case of $F_{table} > F_{ist}$, it shows that trigonometric functions are valid and Fourier relations exist in the model. In the case of $F_{table} < F_{ist}$, it is concluded that the ADF test should be applied.

3.3. Fractional Frequency Flexible Fourier ADF (FFFF-ADF)

This unit root test was developed by modifying the methodology and approach specified in Enders and Lee (2012). The determined frequency value, k, allows temporary breaks if taken as an integer. For this reason, it is based on taking the value of k as decimal. It allows permanent structural breaks with the k value taken as decimal. A decimal and small frequency value is more successful in catching soft structural breaks (Omay and Baleanu, 2021, p. 7).

$$\Delta Y_t = \rho_{y-1} + C_1 + C_{2t} + C_3 \sin\left(\frac{2\pi k^{fr} t}{T}\right) + C_4 \cos\left(\frac{2\pi k^{fr} t}{T}\right) + u_t \quad (8)$$

Equation (8) shows the regression model specified in the Omay (2015) study. Said fractional frequency value is denoted by k^{fr}. The limits of this value are $k_{max}=2$ and $0.1 \leq k^{fr} \leq k^{fr}_{max}$. OLS is estimated with fractional frequency values in the given range. $SSR_{min} = k_{est}$ point is the frequency determination point (Omay, 2015, p. 124). The processes are the same as the process followed in the study of Enders and Lee (2012). The final obtained F statistical value is compared with the Omay (2015) table values. If $F_{table} > F_{ist}$ it shows that trigonometric functions are valid and Fourier relations exist in the model. If $F_{table} < F_{ist}$ it is concluded that the ADF test should be applied. The calculation of the F_{ist} statistical value is shown in Equation (9).

$$F(k) = \frac{\frac{SSR_0 - SSR_1}{q}}{\frac{SSR_1(k)}{T-k}} \quad (9)$$

Fist values obtained from Equation (9) are evaluated in Omay (2015) study by comparing them with the table values presented in Table1 for the constant model and Table 2 for the constant and trend model.

4. DATA AND EMPIRICAL RESULTS

Unemployment rate data published by TUIK (Turkish Statistical Institute) was used in the study. The series covers the period 2005m1 and 2022m12 and is seasonally adjusted. The variable used for the EU is the unemployment rate and is the data for 27 European Union member states. Data was obtained from Eurostat (European Union Database) and covers the period 2005m1 and 2022m12. It is seasonally adjusted.

As explained in the theoretical part, the regression model created with the terms $\sin\left(\frac{2\pi kt}{T}\right)$ and $\cos\left(\frac{2\pi kt}{T}\right)$ added to the model for the FF-ADF test is applied to determine the frequency value with the OLS estimator. Frequency values are given as integer values as $1 \leq k \leq 5$ and $\Delta k=1$.

Table 2. Frequency Value Determination for FF-ADF Test

	Türkiye		**EU**	
	constant	constant + trend	constant	constant + trend
k	SSR			
1	139.4680	139.4261	**3.430160**	2.720920
2	138.7005	**136.3502**	4.484538	**2.104945**
3	**138.3799**	137.5090	4.504515	3.062715
4	140.5865	139.9547	3.629089	2.449675
5	139.0213	138.0857	4.053703	2.686473
Lag_{opt}	12	12	9	5

In the determination of the frequency value ($k_{est}=SSR_{min}$), the value of the least residual sum of squares is shown in Table 2. For Türkiye, the k value is 3 in the constant model and 2 in the model with constant and trend. In the EU, the k value is 1 in the constant model, and 2 in the model where the constant and trend are together.

Due to the general-to-specific strategy in determining the optimal lag length, the estimation with the largest lag number is performed first. If the result of this estimation is statistically significant, it is accepted. If it is not significant, the smaller lag length is used until it becomes significant. As the data are monthly, $lag_{max}=12$ is used.

Table 3. Test for the Validity of the FF-ADF Model

Countries	**Test**	**Wald test**	**Critical Value** 1% 5% 10%	**Stationary**	
				t stat.	**Dicision**
Türkiye	Constant *F(k)*	1.67	-3.74 -3.06 -2.72	--	--
	Constant and trend *F(k)*	3.87*	-4.62 -4.01 -3.69	-3.06***	**I(0)**
EU	Constant *F(k)*	3.01	-4.37 -3.78 -3.47	--	--
	Constant and trend *F(k)*	5.92***	-4.62 -4.01 -3.69	-3.94***	**I(0)**

Note: *Critical values are taken from Enders and Lee (2012).*

After determining the frequency and optimal lag length, the statistical value obtained as a result of the Wald test for the trigonometric terms is compared with the table in Enders and Lee (2012). The H_0 hypothesis is that the trigonometric terms used have a linear trend. According to Table 3, the result obtained for both Türkiye and EU countries is $F_{table} < F_{ist}$ in the trended model, so it can be said that the series has Fourier properties. As a result, the unemployment series in Türkiye and the EU countries is stationary.

Table 4. Frequency Value Determination for FFFF-ADF Testing

	Türkiye		**EU**	
	constant	constant + trend	constant	constant + trend
k	SSR			
0.1	140.6652	139.5193	2.463303	1.288931
0.2	140.6442	139.5219	2.458603	1.288449
0.3	140.6065	139.5259	2.450165	2.191593
0.4	140.5473	139.5307	2.436999	2.187349
0.5	140.4601	139.5353	2.417571	2.181839
0.6	140.3362	139.5379	2.389747	2.175044
0.7	140.1669	139.5354	2.351034	2.166974
0.8	139.9501	139.5228	2.299731	2.157704
0.9	139.7019	139.4914	2.237935	2.147460
1	139.4680	139.4261	2.176073	2.136773
1.1	139.3108	139.3011	2.132783	2.126752
1.2	139.2555	139.0721	2.120591	2.119305
1.3	139.2489	138.6683	2.126535	2.115378

1.4	139.1863	137.9945	2.116726	2.104663
1.5	138.9786	136.9896	2.075936	2.065887
1.6	138.6289	135.8018	2.038341	2.015485
1.7	138.2856	134.9211	**2.037449**	1.980600
1.8	**138.1551**	**134.8073**	2.068595	**1.969742**
1.9	138.3162	135.4005	2.117437	1.989063
2	138.7005	136.3502	2.176718	2.043285
Lag_{opt}	12	12	10	9

In the FFFF-ADF test, in the $\sin\left(\frac{2\pi k^{fr}t}{T}\right)$ and $\cos\left(\frac{2\pi k^{fr}t}{T}\right)$ terms included in the model, firstly, the residual squares obtained from the OLS estimates made for each k value with the $k_{max}=2$, $0.1 \leq k^{fr} \leq k^{fr}_{max}$ and $\Delta k^{fr}=0.1$ restrictions suggested by the Omay (2015) study were taken to calculate the fractional frequency value, and the minimum k^{fr} value was selected. The results are shown in Table 4. As a result of the estimation, for Türkiye the frequency value is 1.8 and the optimal lag length is 12 in both the constant and the trended model. For the EU countries, the frequency value is 1.7 and the optimal lag is 10 in the constant model, while the frequency value is 1.8 and the optimal lag is 9 in the trended model.

Table 5. Test for the Validity of the FFFF-ADF Model

Countries	Test	Wald test	Critical Value			Stationary	
			1%	5%	10%	t stat.	Decision
Türkiye	Constant *F(k)*	2.08	-3.74	-3.06	-2.72	-	-
	Constant and trend *F(k)*	5.92***	-3.93	-3.26	-2.92	-3.61	**I(0)**
EU	Constant *F(k)*	1.23	-4.37	-3.78	-3.47		
	Constant and trend *F(k)*	7.75***	-4.62	-4.01	-3.69	-3.41	**I(0)**

Note: *Critical values are taken from Omay (2015) study.*

Table 5 shows that, according to the Wald test, the trend model for Türkiye and the EU countries has Fourier properties and is stationary at the I(0) level.

5. CONCLUSION

Structural breaks cause changes in the natural course of variables. For this reason, ignoring these changes can lead to erroneous results. The methods that test the stationarity of the variables have also increased their predictive power by including such structural changes in the model over time. Over time, the development of Fourier models and their inclusion in the models have improved the subject. Fourier models allow smoother transitions. For this reason, it predicts a soft and time-dispersed break rather than sudden changes in unit root analyzes with structural break. It is possible to test the significance of the added terms in the unit root tests created by expanding them with trigonometric terms, with the F constraint test. It is understood whether the variable related to this pathway is affected by structural changes.

In this study, the FF-ADF and FFFF-ADF tests are used to analyse the existence of the unemployment hypothesis in the EU countries and Türkiye. The purpose of presenting these two tests together is that they are DF (Dickey Fuller) based tests. First, the Fourier terms were found to be significant because of the FF-ADF test, which was applied using the methodology proposed by Enders and Lee (2012). As a result of the test, the unemployment series of Türkiye and the EU countries were found to be stationary. Therefore, the unemployment hysteresis is not valid.

The FF-ADF test takes frequency values as integers. Being an integer captures transient breaks. The FFFF-ADF test using fractional frequency values proposed by Omay (2015) was also applied. As a result of this test, trigonometric terms were found to be significant in both Türkiye and EU countries. As a result of this test, Fourier effects were found in the series and the series was found to have nonlinear properties. Furthermore, the series is stationary at I(0) according to the FFFF-ADF test. This result indicates that the unemployment hysteresis is not valid for Türkiye and EU countries.

Comparing the results of the empirical analysis with the literature, the validity of the natural rate hypothesis obtained for European countries is confirmed by Camarero et al. (2006); it is compatible with the studies by Christopoulos and León-Ledesma (2007) and Lee and Chang (2008). The results obtained for Türkiye are in direct agreement with the study by Belliler and Demiralp (2021). Given the recent period in which there have been economically important structural breaks for both Türkiye and European countries, the detection of non-linear features is the expected result.

The phenomenon of unemployment represents a significant challenge for countries worldwide. High unemployment levels can have a detrimental impact on aggregate demand and economic growth at the macroeconomic level (Karakuş and Atabey, 2021, p. 869). This situation can give rise to inequalities between individuals and social unrest due to an increase in poverty (Coşgun and Erdayı, 2023, p. 583). Ultimately, this situation represents a significant obstacle to economic growth and development. Consequently, governments implement active employment policies. Structural reforms, particularly in areas such as general education, vocational training and labour market flexibility, can assist in resolving the unemployment problem and supporting economic growth. Furthermore, it is essential to address imbalances in the labour market, implement employment-generating policies and encourage innovation.

The unemployment rate is high in both European countries and Türkiye. One of the reasons for this is the level of unemployment benefits and social assistance paid to the unemployed. Such payments are high in EU countries. The high level of benefits and allowances reduces the motivation of the unemployed to look for a job. In particular, the increase in these payments reduces the likelihood of the unemployed accepting jobs with lower wages. Unemployment benefits and social assistance are available in Türkiye. However, unemployment benefits in particular are far from sufficient for individuals to live on. Individuals in Türkiye are unable to view unemployment benefits as an insurance. Another significant issue related to unemployment is trade union activity. The strength of trade unions in Europe prevents workers from accepting lower real wages and prevents the implementation of policies that stabilise the market (Caporale et al., 2022: 6). In Türkiye, on the other hand, there is no strong trade union activity. Nevertheless, high inflation reduces real wages and purchasing power. Consequently, it is already impossible to develop policies that will bring in outsiders with strong trade union activity. As we can see, the labour market dynamics in Türkiye and the EU countries are quite different.

The findings of this study indicate that the commonly held belief that unemployment is a result of economic policies is not supported by empirical evidence. This suggests that economic policies may have a limited impact on unemployment in the long term. Consequently, in light of the lack of evidence supporting the notion of unemployment hysteria, it is imperative that economic policies focus on more effective and long-term solutions. In this context, investments in areas such as education, innovation and competitiveness, as well as policies to increase employment, may be more effective in solving the unemployment problem. Additionally, having a more flexible and diversified economic structure in the face of economic crises or external shocks can reduce the negative effects on unemployment. Therefore, it should not be forgotten that structural reforms are important as well as economy-wide analyses when addressing the unemployment problem.

REFERENCES

Arestis, P., & Mariscal, I. B. F. (1999). Unit roots and structural breaks in OECD unemployment. *Economics Letters*, *65*(2), 149-156. https://doi.org/10.1016/s0165-1765(99)00131-7

Bayat, T., Temiz, M., & Konat, G. (2020). Türkiye'de işsizlik histerisi hipotezinin geçerliliği üzerine amprik bir çalışma (1923-2019). *Pearson Journal*, *5*(7), 1-8.

Belliler, İ. S., & Demiralp, A. (2021). Türkiye'de işsizlik histerisi: doğrusal olmayan birim kök testinden kanıtlar. *Pearson Journal*, *7*(22), 167-178. https://doi.org/10.46872/pearson.402

Blanchard, O. J., & Summers, L. H. (1986a). Hysteresis in unemployment. *Nber Workıng Paper Serıes.* Working Paper No. 2035. https://doi.org/10.3386/w2035

Blanchard, O. J., & Summers, L. H. (1986b). Hysteresis and the European unemployment problem. *NBER Macroeconomics Annual*, *1*, 15-78. https://doi.org/10.3386/w1950

Brunello, G. (1990). Hysteresis and "the Japanese unemployment problem": a preliminary investigation. *Oxford Economic Papers*, *42*(3), 483-500. https://doi.org/10.1093/oxfordjournals.oep.a041959

Cai, Y., & Omay, T. (2021). Using double frequency in Fourier Dickey–Fuller unit root test. *Computational Economics*, 1-26. https://doi.org/10.1007/s10614-020-10075-5

Camarero, M., Carrion-i-Silvestre, J. L., & Tamarit, C. (2006). Testing for hysteresis in unemployment in OECD countries: New evidence using stationarity panel tests with breaks. *Oxford Bulletin of Economics and Statistics*, *68*(2), 167-182. https://doi.org/10.1111/j.1468-0084.2006.00157.x

Caporale, G. M., Gil-Alana, L. A., & Trejo, P. V. (2022). Unemployment persistence in Europe: Evidence from the 27 EU countries. *Heliyon*, *8*(2), 1-7. https://doi.org/10.1016/j.heliyon.2022.e08898

Chang, T. (2011). Hysteresis in unemployment for 17 OECD countries: Stationary test with a Fourier function. *Economic Modelling*, *28*(5), 2208-2214. https://doi.org/10.1016/j.econmod.2011.06.002

Cheng, S. C., Wu, T. P., Lee, K. C., & Chang, T. (2014). Flexible Fourier unit root test of unemployment for PIIGS countries. *Economic Modelling*, *36*, 142-148. https://doi.org/10.1016/j.econmod.2013.09.021

Christopoulos, D. K., & León-Ledesma, M. A. (2007). Unemployment hysteresis in EU countries: What do we really know about it? *Journal of Economic Studies*. https://doi.org/10.1108/01443580710745353

Coşgun, Ş. N., & Erdayı, A. U. (2023). Türkiye'de işsizlik ve sosyal dışlanma ilişkisi: Yozgat ilinde bir alan araştırması. *Alanya Akademik Bakış*, *7*(1), 581-598. https://doi.org/10.29023/alanyaakademik.1224625

Çınar, M., & Sevüktekin, M. (2017). *Ekonometrik zaman serileri analizi (Eviews Uygulamalı*), 5. Baskı, İstanbul: Dora Yayınları.

Çiçen, Y. B. (2021). 2008 global krizinde cinsiyet ve yaş gruplarına göre işsizlik histerisi: Türkiye için Fourier durağanlık analizi. *Uluslararası Yönetim İktisat ve İşletme Dergisi*, *17*(1), 79-101. https://doi.org/10.17130/ijmeb.783454

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, *74*(366a), 427-431. https://doi.org/10.1080/01621459.1979.10482531

Dursun, G. (2017). *Unemployment hysteresis in central and eastern European countries: Further evidence from Fourier unit root test*. Rome Proceedings, Econ-World2017, Rome. https://rome2017.econworld.org/papers/Dursun_Unemployment.pdf

Enders, W., & Lee, J. (2012). A unit root test using a Fourier series to approximate smooth breaks. *Oxford Bulletin of Economics and Statistics*, *74*(4), 574-599. https://doi.org/10.1111/j.1468-0084.2011.00662.x

Friedman, M. (1995). *The role of monetary policy* (pp. 215-231). Macmillan Education UK. https://doi.org/10.1007/978-1-349-24002-9_11

García-Cintado, A., Romero-Ávila, D., & Usabiaga, C. (2015). Can the hysteresis hypothesis in Spanish regional unemployment be beaten? New evidence from unit root tests with breaks. *Economic Modelling*, *47*, 244-252. https://doi.org/10.1016/j.econmod.2015.02.035

Ghoshray, A., & Stamatogiannis, M. P. (2015). Centurial evidence of breaks in the persistence of unemployment. *Economics Letters*, *129*, 74-76. https://doi.org/10.1016/j.econlet.2015.02.012

Jaeger, A., & Parkinson, M. (1994). Some evidence on hysteresis in unemployment rates. *European Economic Review*, *38*(2), 329-342. https://doi.org/10.1016/0014-2921(94)90061-2

Kahyaoğlu, H., Tuzun, O., Ceylan, F., & Ekinci, R. (2016). İşsizlik histerisinin geçerliliği: Türkiye ve seçilmiş AB ülkeleri üzerine bir uygulama. *Manisa Celal Bayar Üniversitesi Sosyal Bilimler Dergisi, 14*(4), 103-128. https://doi.org/10.18026/cbayarsos.280055

Karakuş, M., & Atabey, A. Ö. (2021). Genç işsizlik, ihracat ve büyüme arasındaki ilişki: Türkiye için ampirik bir analiz. *Alanya Akademik Bakış*, *5*(2), 865-882. https://doi.org/10.29023/alanyaakademik.889070

Lee, C. C., & Chang, C. P. (2008). Unemployment hysteresis in OECD countries: Centurial time series evidence with structural breaks. *Economic Modelling*, *25*(2), 312-325. https://doi.org/10.1016/j.econmod.2007.06.002

Lee, J., & Strazicich, M. C. (2003). Minimum Lagrange multiplier unit root test with two structural breaks. *Review of Economics and Statistics*, *85*(4), 1082-1089. https://doi.org/10.1162/003465303772815961

Omay, T. (2015). Fractional frequency flexible Fourier form to approximate smooth breaks in unit root testing. *Economics letters*, *134*, 123-126. https://doi.org/10.1016/j.econlet.2015.07.010

Omay, T., & Baleanu, D. (2021). Fractional unit-root tests allowing for a fractional frequency flexible Fourier form trend: predictability of Covid-19. *Advances in Difference Equations*, *2021*(1), 167. https://doi.org/10.1186/s13662-021-03317-9

Omay, T., Shahbaz, M., & Stewart, C. (2021). Is there really hysteresis in the OECD unemployment rates? New evidence using a Fourier panel unit root test. *Empirica*, *48*(4), 875-901. https://doi.org/10.1007/s10663-021-09510-z

Mitchell, W. F. (1993). Testing for unit roots and persistence in OECD unemployment rates. *Applied Economics*, *25*(12), 1489-1501. https://doi.org/10.1080/00036849300000153

Perron, P. (1989). The great crash, the oil price shock, and the unit root hypothesis. *Econometrica: Journal of the Econometric Society*, 1361-1401. https://doi.org/10.2307/1913712

Phelps, E. S. (1994). *Structural slumps: The modern equilibrium theory of unemployment, interest, and assets*. Harvard University Press. https://doi.org/10.2307/1060754

Pissarides, C. A. (1992). Loss of skill during unemployment and the persistence of employment shocks. *The Quarterly Journal of Economics*, *107*(4), 1371-1391. https://doi.org/10.2307/2118392

Røed, K. (1996). Unemployment hysteresis-macro evidence from 16 OECD countries. *Empirical Economics*, *21*, 589-600. https://doi.org/10.1007/bf01180703

Sigeze, Ç., Coşkun, N., & Ballı, E. (2019). AB ülkelerinde ve Türkiye'de işsizlik histerisinin Fourier-KPSS birim kök testi ile incelenmesi. *İzmir İktisat Dergisi*, *34*(1), 15-24. https://doi.org/10.24988/ije.2019341761

Song, F. M., & Wu, Y. (1998). Hysteresis in unemployment: Evidence from OECD countries. *The Quarterly Review of Economics and Finance*, *38*(2), 181-192. https://doi.org/10.1016/s1062-9769(99)80111-2

Srinivasan, N., & Mitra, P. (2012). Hysteresis in unemployment: Fact or fiction? *Economics Letters*, *115*(3), 419-422. https://doi.org/10.1016/j.econlet.2011.12.070

Tarı, R. (2015). *Ekonometri*. Umuttepe Yayınları. Kocaeli

Tekin, İ. (2018). Türkiye'de işsizlik histerisi: Fourier fonksiyonlu durağanlık sınamaları. *Dokuz Eylül Üniversitesi İktisadi İdari Bilimler Fakültesi Dergisi*, *33*(1), 97-127. https://doi.org/10.24988/deuiibf.2018331685

Yaya, O. S., Ogbonna, E., Gil-Alana, L. A., Furuoka, F., & Vo, X. V. (2022). *Testing Unemployment Hysteresis in European Countries*: Argument based on Three-Generation unit root tests. SSRN 4158893. https://doi.org/10.2139/ssrn.4158893

Yazgan, Ş., Yalçınkaya, Ö., & Kadanalı, E. (2019, June). *Analysing natural unemployment rate or unemployment hysteresis in Turkish economy: An Application on agricultural and non-agricultural unemployment rate series*. In 4th Internatıonal Conference on Advances in Natural & Applıed Scıences (p. 732).

Yilanci, V., & Eris, Z. A. (2013). Purchasing power parity in African countries: Further evidence from fourier unit root tests based on linear and nonlinear models. *South African Journal of Economics*, *81*(1), 20-34. https://doi.org/10.1111/j.1813-6982.2012.01326.x

Yilanci, V., Ozkan, Y., & Altinsoy, A. (2020). Testing the unemployment hysteresis in G7 countries: Fresh evidence from fourier threshold unit root test. *Romanian Journal of Economic Forecasting*, *23*(3), 49-59.

Yılmaz, M. (2023). An Econometric study on the validity of the unemployment hysteresis hypothesis in EU-15 and EU-28. *OPUS Journal of Society Research*, *20* (Special Issue-Human Behavior and Social Institutions), 842-851. https://doi.org/10.26466/opusjsr.1329033

Zivot, E., & Andrews, K. (1992), Further evidence on the great crash, the oil price shock, and the unit root hypothesis. *Journal of Business and Economic Statistics*, *10*(10), 25–70. https://doi.org/10.2307/1391541