



VALIDITY OF THE UNEMPLOYMENT HYSTERESIS HYPOTHESIS IN TÜRKİYE: ADF AND FRACTIONAL FREQUENCY FOURIER ADF UNIT ROOT TEST

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Abstract

The unemployment hysteresis hypothesis implies that shocks in the economy have permanent effects on unemployment rates, in other words, unemployment rates that increase due to economic stagnation will not automatically return to their equilibrium level despite economic growth. The aim of this study is to test the validity of the unemployment hysteresis hypothesis in the Turkish economy separately with monthly data with 234 observations and quarterly data with 78 observations covering the period January 2005-June 2024. For this purpose, both the Augmented Dickey-Fuller (ADF) test, one of the traditional unit root tests, and the Fractional Frequency Fourier ADF (FFFADF) test, one of the most recent unit root tests, are used in the analysis part of the study. In the study, Türkiye's general, male and female unemployment rates are analyzed separately. According to the results of the analysis, it is determined that there is unemployment hysteresis in general, male and female unemployment rates in Türkiye.

Keywords: *Unemployment Hysteresis Hypothesis, Türkiye, Unit Root Analysis*

JEL Classification: C01, C12, C32, E24

TÜRKİYE'DE İŞSİZLİK HİSTERİSİ HİPOTEZİNİN GEÇERLİLİĞİ: ADF VE KESİRLİ FREKANSLI FOURIER ADF BİRİM KÖK TESTİ

Öz

İşsizlik histerisi hipotezi, ekonomideki şokların işsizlik oranları üzerinde kalıcı etkilerin olduğu, başka bir ifadeyle ekonomik durgunluk sebebiyle artış gösteren işsizlik oranlarının ekonomik büyümeye rağmen otomatik olarak denge seviyesine dönmeyeceği anlamına gelmektedir. Bu çalışmanın amacı, Ocak 2005-Haziran 2024 dönemini kapsayan 234 gözlemlilik aylık ve 78 gözlemlilik çeyreklik veriler ile Türkiye ekonomisinde işsizlik histerisi hipotezinin geçerliliğini ayrı ayrı test etmektir. Bu amaçla çalışmanın analiz kısmında yöntem olarak hem geleneksel birim kök testlerinden Augmented Dickey-Fuller (ADF) testi hem de en güncel birim kök testlerinden Kesirli Frekanslı Fourier ADF (FFFADF) testi kullanılmıştır. Çalışmada Türkiye'nin; genel, erkek ve kadın işsizlik oranları ayrı ayrı analiz edilmiştir. Analiz sonuçlarına göre Türkiye'de genel, erkek ve kadın işsizlik oranlarında işsizlik histerisinin bulunduğu tespit edilmiştir.

Anahtar Kelimeler: *İşsizlik Histerisi Hipotezi, Türkiye, Birim Kök Analizi*

JEL Sınıflandırması: C01, C12, C32, E24

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1. Introduction

Unemployment is an economic problem that can occur in every country, regardless of the economic or development level of the countries. The problem of unemployment is, first of all, an important issue that must be eliminated in order for people to continue their lives (Baktemur, 2024: 181-182). Because unemployment has political, cultural and psychological effects as well as socio-economic consequences (Öztürk, 2020: 4884). Due to unemployment, countries are unable to use their resources effectively and therefore produce below their capacity. From this point of view, the problem of unemployment constitutes an obstacle to economic growth and development for developing countries (Takım, 2010: 315). Although unemployment is a factor that directly affects the welfare level of countries, it is in a close relationship with other economic variables. This situation, on the one hand, contributes to the increase in policy options that can be implemented to solve the unemployment problem, on the other hand, it may cause the problem to become more complex (Aydın, 2023: 2).

Due to the complexity of the unemployment problem, it is very important to analyze the structure of unemployment in a country and to determine economic policies to solve the problem. In the literature on the structure of unemployment, the natural rate hypothesis and the unemployment hysteresis hypothesis are mainly used (Ulucak, 2021: 300-301).

According to the natural rate hypothesis proposed by Phelps (1967, 1968) and Friedman (1968), shocks in the economy have a temporary effect on the unemployment rate, in other words, unemployment rates tend to return to their natural level after the shocks. For the natural rate hypothesis to be valid, the unemployment rate series should exhibit a stationary structure (Smyth and Easaw, 2001: 359-360).

In 1973, OPEC (Organization of Petroleum Exporting Countries) decided to reduce the amount of oil exports and production, leading to a worldwide shortage of raw materials, an increase in production costs and thus a decrease in production. Due to the decrease in the amount of production, employers had to lay off their employees (Üçler, 2022: 217). As oil became scarce worldwide, oil prices increased and this led to inflation, while the amount of production decreased and unemployment rates increased due to scarce oil. Due to this decision taken by OPEC, the world entered a period in which inflation and unemployment increased together, that is, stagflation (Barsky and Kilian, 2002: 137-140).

Blanchard and Summers (1986), who contributed to the literature by criticizing the natural rate hypothesis, observed that unemployment rates around the world did not decline to their previous natural level after the oil crisis, and expressed this result as “unemployment hysteresis” as a result of their analysis.

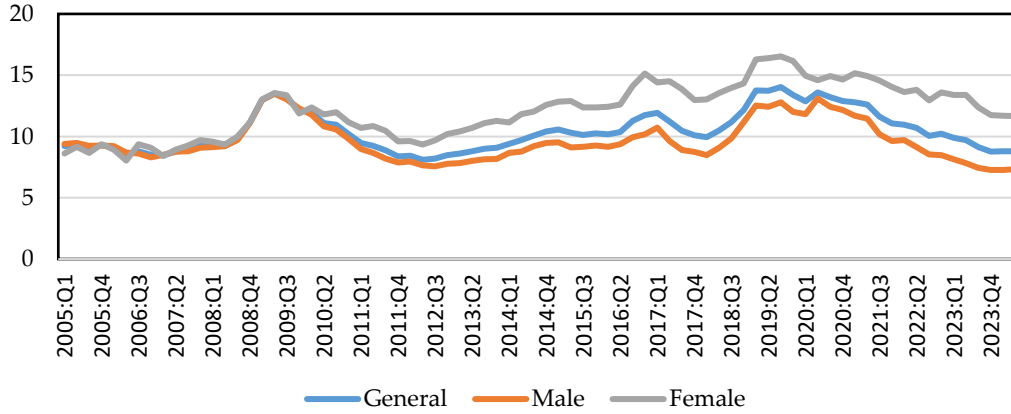
In the unemployment hysteresis hypothesis, it is argued that shocks in the economy have permanent effects on unemployment rates, in other words, unemployment rates that increase due to economic stagnation will not automatically return to their equilibrium level despite economic growth (Cho and Rho, 2019: 19-20). The validity of the unemployment hysteresis hypothesis depends on the unemployment rate series containing a unit root. Therefore, if the series is found to have a unit root as a result of unit root tests, the hysteresis hypothesis is valid and policymakers should intervene to reduce unemployment to its previous natural level (Romero-Ávila and Usabiaga, 2007: 698).

Quarterly unemployment data for Türkiye for the period January 2005-June 2024 are obtained from the Turkish Statistical Institute (TurkStat) database and Figure 1 is derived from these data.

When the unemployment data in Figure 1 are analyzed, it is seen that the general, male and female unemployment rates in the Turkish economy followed a fluctuating course between 2005 and 2024. The general unemployment rate, which was 9.2% in 2005, experienced a break with the global financial crisis in 2008 and rose to 13.5% in 2009 (Atgür, 2021: 1468). It is noteworthy that

female unemployment rates in Türkiye are higher than male and general unemployment rates and were calculated as 16.5% in 2019. After 2019, general, male and female unemployment rates have been on a downward trend.

Figure 1. **General and Gender Based Unemployment Rates in Türkiye (January 2005-June 2024)**



The main objective of this study is to go beyond merely determining the validity of the unemployment hysteresis hypothesis for Türkiye using monthly and quarterly data covering the period January 2005-June 2024, and to comprehensively analyze the potential effects of this hypothesis on labor market dynamics and policy implications. Given Türkiye's unique economic conditions and frequent shocks, accurately identifying the persistence of unemployment rates is of great importance for macroeconomic stability and the effectiveness of employment policies. In this context, the analysis section of the study employs both the ADF test, a traditional unit root test, and the FFFADF test, one of the most up-to-date unit root tests capable of more accurately capturing potential structural breaks and non-linear characteristics in unemployment series. To the best of our knowledge, no comprehensive study has been conducted that simultaneously analyzes monthly and quarterly data at different frequencies and applies this current method for the Turkish economy. In this regard, the study fills the existing gap in the literature by providing empirical evidence, and the findings are expected to add depth to policy discussions regarding unemployment issues in Türkiye.

This study consists of five main sections. After the introduction, there is a literature review on the validity of the unemployment hysteresis hypothesis, followed by a section explaining the dataset and methodology, then the findings from the econometric analysis, and finally a section that presents the conclusion of the study and policy recommendations.

2. Literature Review

An analysis of empirical studies explaining the course of unemployment reveals that unit root tests are generally utilized to test the unemployment hysteresis hypothesis. In this framework, in this section of the study, recent, national and international empirical studies on the validity of the unemployment hysteresis hypothesis are presented chronologically.

When the empirical studies for the Turkish economy are analyzed, Aydın (2020) examined the validity of the unemployment hysteresis hypothesis for Türkiye with wavelet-based unit root tests using data covering the period 2005:01-2018:10. ADF, Fan and Gençay (2010) wavelet-based variance ratio test and Eroğlu and Soybilgen (2018) wavelet-based ADF unit root tests were used in the study. According to the findings, the unemployment hysteresis hypothesis is not valid in Türkiye in the analyzed period. Bayat et al. (2020) tested the existence of unemployment hysteresis in Türkiye with the FFFADF unit root test using the data on unemployment rates between 1923 and 2019. The findings show that the hysteresis hypothesis is valid for unemployment rates in the

analyzed period. Çemrek and Şeker (2020) analyzed the existence of the hysteresis effect in female unemployment in Türkiye by using monthly unemployment rates over the age of 15 for the period between January 2005 and June 2019 using the Zivot-Andrews (ZA) unit root test and the single-break unit root test developed by Lee and Strazicich (LS). As a result of the study, it is found that the hysteresis effect is valid in female unemployment in Türkiye. Öztürk (2020) examined the validity of the unemployment hysteresis in Türkiye with monthly data covering the period between January 2005 and August 2019 by using ADF, Phillips-Perron (PP) and Lee-Strazicich (LS) unit root test with structural breaks in two stages. According to their findings, unemployment hysteresis is valid for labor force participation, employment and youth unemployment series, while the structuralist approach is valid for general and non-agricultural unemployment data. Kılıç et al. (2021) tested the validity of the youth unemployment hysteresis in Türkiye between 1988 and 2019 using the ZA test and one- and two-break LM unit root tests. According to the results, it is found that there are unit roots with structural breaks in the youth unemployment series in Türkiye and the existence of hysteresis effects in youth unemployment is accepted. Orhan and Solmaz (2021) tested the existence of unemployment hysteresis both at the unit level and for the panel as a whole for TR Level-2 regions using unemployment data for the period 2004-2020 in Türkiye with the Cross-Sectionally Augmented Dickey-Fuller (CADF) panel unit root test. In the study, first and second generation panel unit root tests are used as a result of cross-section dependence and the results show that the unemployment hysteresis hypothesis is valid in regions other than TR-62, TR-63, TR-82, TR-83 and TR-A2 regions. Şak (2021) investigated the unemployment hysteresis in Türkiye using annual data for the period 1988-2018, both in aggregate and in the context of female and male unemployment separately with the Fourier Kruse unit root test. In the study, it is found that there is a hysteresis effect in female unemployment, but there is no hysteresis effect in male unemployment and total unemployment in the aggregate model. Ulucak (2021) tested which of the natural rate, structuralist and hysteresis hypotheses the unemployment rate in Türkiye conforms to for the period 1923-2020 using conventional unit root tests (ADF, PP, DF-GLS, KPSS and NP), unit root tests with structural breaks (ZA, LP, LS and RALS-LM) and unit root tests with Fourier extension (Fourier ADF, Fourier LM and Fourier GLS). The study concludes that unemployment in Türkiye follows a course that supports the hysteresis hypothesis. Yurtkuran (2021) tested the validity of the unemployment hysteresis hypothesis in Türkiye with the Narayan-Popp (NP), Fourier ADF and Fourier KSS unit root tests using data for the period 2006:Q1-2019:Q2. According to the results of the study, the unemployment hysteresis hypothesis is valid in Türkiye. Azazi and Ateş (2022) examined the hysteresis effect of general seasonally adjusted total unemployment and seasonally adjusted total youth unemployment in Türkiye with the PP unit root test using monthly data for the period January 2014-February 2022. The variables used in the study are tested in all three equations of the unit root test and it is found that there is no hysteresis effect in all equations. Belliler and Demiralp (2022) examined the validity of unemployment hysteresis in Türkiye with unemployment data covering the years 1923-2021 using the linearity tests of Harvey and Leybourne (2007) and Harvey et al. (2008). In the study, Hepsağ (2021) unit root test was used as the unemployment series was found to be nonlinear. The findings show that the unemployment hysteresis hypothesis is not valid for Türkiye, whereas the natural rate hypothesis is valid. Atamer et al. (2023) analyzed the unemployment data for Türkiye between 1988 and 2020 separately for female, male and total unemployment using ADF, PP, ZA unit root tests, Lumsdaine-Papell and LS structural break unit root tests. The findings show that the unemployment hysteresis hypothesis is valid for female, male and total unemployment in Türkiye. Aydın (2023) tested the validity of the hysteresis hypothesis for the Turkish economy separately for the sub-periods 1923-1979 and 1980-2021 with ZA, LS and NP unit root tests using the unemployment rates of 15 years and above between 1923-2021. The findings show that the unemployment hysteresis in Türkiye is valid for the period 1923-1979, but invalid for the period after 1980. Kutlu (2023) conducted a Fourier ADF unit root test for the existence of unemployment hysteresis in Türkiye by using quarterly data for the period 2005:Q1-2020:Q2 in the context of youth female unemployment. The empirical findings show that the hysteresis effect is valid in youth female unemployment in Türkiye. Üçler et al. (2023)

examined the hysteresis effect in the labor market with PP unit root test using monthly unemployment data for youth male and youth female between January 2014 and January 2022 in Türkiye. In the study, it is observed that youth female unemployment data have more hysteresis than youth male unemployment data. Yardımcı (2023) tested the stationarity properties of unemployment data using data from January 2014 to January 2023 in Türkiye with ADF, structural break (ZA and LS) and non-linear (KSS and KS) unit root tests. The study concluded that the unemployment hysteresis is valid according to the results of the traditional, one-break and non-linear unit root tests, and the natural rate of unemployment is valid according to the results of the unit root test that allows two breaks and the non-linear Wavelet type unit root test that also allows breaks. Atabey (2024) analyzed the validity of the unemployment hysteresis hypothesis in Türkiye with data for the period 1988-2021. In the study, the stationarity of general, youth, female and male unemployment rates as well as general, youth, female and male labor force participation rates were tested by Carrion-i-Silvestre et al. (2009) unit root test with multiple structural breaks, Fourier ADF and Fourier KPSS unit root tests. Although different findings were obtained as a result of the tests applied in the study, the existence of unemployment hysteresis effect is among the common results. Baktemur (2024) tested the hysteresis hypothesis with linear (ADF) and non-linear (CSR) unit root tests using general unemployment and youth unemployment data of the Turkish economy covering the period 2014:1-2023:7. The results show that the series are non-stationary, in other words, the hysteresis hypothesis is valid in Türkiye. Using monthly data between January 2005 and October 2023, Daştan (2024) tested the possible hysteresis effect in age and gender disaggregated unemployment rates in Türkiye with ADF, PP unit root tests, unit root tests that allow one or two structural breaks in the series such as ZA, LS and NP tests and the new generation ADF type Autoregressive Neural Networks unit root tests developed by Yaya et al. (2021). The results of the study reveal that the hysteresis effect in unemployment rates specific to the Turkish economy is valid regardless of age or gender differences.

As for national and international empirical studies, Chang et al. (2005) tested the validity of the unemployment hysteresis hypothesis for 10 European Union countries using data from 1961 to 1999 with the Panel SURADF unit root test and found evidence supporting the hysteresis effect in all countries except Belgium and the Netherlands. Dritsaki and Dritsaki (2013) tested the validity of the unemployment hysteresis hypothesis for three European countries using data from 1984 to 2010, employing both univariate and panel unit root tests. The study yielded strong findings supporting the hysteresis effect. Akkuş and Topuz (2019) tested the validity of the unemployment hysteresis hypothesis for the five most vulnerable developing countries (Brazil, Indonesia, India, South Africa, and Türkiye) using unemployment data from 1980 to 2016, employing ADF, single-break LM, and Fourier unit root tests. According to the results, the unemployment hysteresis hypothesis is valid for the countries under consideration. Yaya et al. (2019) examined the validity of the unemployment hysteresis hypothesis for 42 African countries using annual unemployment data between 1991 and 2017 with the Fourier ADF unit root test. The results show that the unemployment hysteresis hypothesis is valid in only 7 countries out of 42 African countries (Algeria, Botswana, Cabo Verde, Democratic Republic of Congo, Guinea-Bissau, Liberia and Tanzania). Girardi et al. (2020) examined the effects of 126 different demand expansions on the economy and unemployment rates using data for 34 OECD (Organization for Economic Cooperation and Development) countries between 1960 and 2015 with the “adjusted” local projection estimator proposed by Teulings and Zubanov (2014). The unemployment hysteresis hypothesis holds for OECD countries as the results show that demand changes have a persistent and strong impact on the unemployment rate. Khraief et al. (2020) tested the existence of the unemployment hysteresis hypothesis for 29 selected OECD countries for the period 1980-2013 using “Harvey et al. (2008) linear and Kruse (2011) nonlinear unit root tests”, “LLC, IPS, MW and Choi (2001) first generation panel unit root tests” and “MP, Pesaran (2007) and Choi (2006) second generation panel unit root tests”. According to the results, the unemployment hysteresis hypothesis is valid in Hungary, Japan, Spain and Sweden. Raifu and Abodunde (2020) used data covering the period 1970-2017 for the Nigerian economy to investigate the validity of the

unemployment hysteresis hypothesis using linear and nonlinear unit root tests. Except for the quantile unit root test, the findings from the other unit root tests indicate that the hysteresis effect is valid for the Nigerian economy. Yılcı et al. (2020) tested the validity of the unemployment hysteresis in G7 countries for the period 1991-2019 using monthly data with the Fourier Threshold Unit Root (FTUR) test that takes into account both structural breaks and nonlinearity. According to the findings, unemployment hysteresis is valid in Canada, France and the United Kingdom. Omay et al. (2021) tested the validity of the unemployment hysteresis hypothesis in 23 countries (14 European Union countries and 9 OECD countries) with annual unemployment data for the period 1960-2016 using the sequential panel selection method proposed by Chortareas and Kapetanios (2009) and IPS and Fourier IPS unit root tests. According to the results, the unemployment hysteresis hypothesis is not valid in all countries considered. Özdemir (2021) investigated the empirical significance of whether the unemployment problem is structural or transitory on the basis of region-based, income-based and aggregate analyses of different countries for annual data between 1991-2018 by using ADF, PP, KPSS and Hadri-LM unit root tests. According to the results, the unemployment hysteresis hypothesis is valid. Bostancı and Koç (2022) examined the validity of the unemployment hysteresis hypothesis in 10 Balkan countries with Fourier unit root tests using monthly unemployment rate data (Albania, Montenegro and Serbia quarterly) covering the largest period for each country. According to the results, the unemployment hysteresis hypothesis is valid in all countries except Albania and Montenegro. Cheng (2022), using seasonally adjusted monthly unemployment rate data of 34 selected Asian and OECD countries for the period April 1998 to December 2018, tested the hysteresis hypothesis with the non-linear unit root test developed by Park and Shintani (2016) and ADF, DF-GLS, PP and KPSS unit root tests. According to the results, the hysteresis hypothesis is valid for most of the countries. Çorakçı et al. (2022), using monthly unemployment rate data covering the period 2000:2-2020:6 for 19 Eurozone countries, examined the hysteresis effect with the nonlinear unit root tests proposed by IPS, Pesaran (2007), Uçar and Omay (2009) and Cerrato et al. (2007) and the stepwise break tests proposed by Omay et al. (2018). The results indicate the existence of the hysteresis effect in most of the Euro Area. Kılıç et al. (2022) tested the validity of the unemployment hysteresis hypothesis in 36 OECD countries with ADF, RALS-ADF, KSS, ZA, Fourier-ADF and Fourier-KSS tests using monthly unemployment rate data covering the largest period for each country. The findings show that in all unit root tests except the Fourier-ADF test, the hysteresis effect predominantly prevails in OECD countries. Minyuku and Sheefeni (2024) tested the validity of the unemployment hysteresis hypothesis in South Africa using data from 2000 to 2023 with traditional unit root tests, Fourier ADF tests, and Discrete Wavelet Transform and Maximum Overlap Wavelet Transform unit root tests. According to the results, while all linear tests reveal some reversion to the mean, the Fourier ADF test confirms the partial hysteresis effect.

When empirical studies are analyzed, the differences in the period intervals, countries/country groups and the methods used in the analysis may lead to different results regarding the validity of the unemployment hysteresis hypothesis. In the reviewed literature, it is observed that there are studies that reach different conclusions in terms of the validity of the unemployment hysteresis hypothesis.

3. Data and Methodology

In order to examine the validity of the unemployment hysteresis hypothesis, it is necessary to determine whether the series are stationary or not. For this purpose, in this study, both the ADF test, one of the traditional unit root tests, and the FFFADF test, one of the most recent unit root tests, were used as methods to test the unemployment hysteresis hypothesis in the Turkish economy. General, male and female unemployment rate variables are used as the data set for the Turkish economy. The study covers the period January 2005-June 2024. Data were obtained from TurkStat database. The general, male and female unemployment rate variables to be analyzed consist of 234 monthly and 78 quarterly observations.

3.1. ADF Unit Root Test

Unit root tests are used to examine the stationarity properties of variables. Dickey and Fuller introduced the Dickey-Fuller (DF) unit root test in 1979 and developed the ADF unit root test in 1981. The ADF test statistic is obtained with the help of the following equations (İltaş and Demirgüneş, 2020: 977);

$$\Delta Y_t = \delta Y_{t-1} + \sum_{j=2}^p \beta_j \Delta Y_{t-j+1} + \varepsilon_t \quad (1)$$

$$\Delta Y_t = \alpha_0 + \delta Y_{t-1} + \sum_{j=2}^p \beta_j \Delta Y_{t-j+1} + \varepsilon_t \quad (2)$$

$$\Delta Y_t = \alpha_0 + \delta Y_{t-1} + \alpha_2 t + \sum_{j=2}^p \beta_j \Delta Y_{t-j+1} + \varepsilon_t \quad (3)$$

The model numbered (1) created for the ADF process is used in the stationarity tests with the coefficient shown in the equation and no trend effect, the model numbered (2) is used in the stationarity tests with the fixed coefficient effect but no trend effect, and the model numbered (3) is used in the stationarity tests with the fixed coefficient and trend effect (Yılmaz, 2023: 846). The unit root data obtained through these models are determined according to the MacKinnon critical values of 1%, 5% and 10% significance levels. According to the results obtained in the research, the following hypotheses are established (Özcan and Arı, 2013: 110);

$H_0: \delta = 0$ is non-stationary, the series contains unit root.

$H_1: \delta < 0$ is stationary, the series does not contain unit root.

In terms of hypotheses, if the calculated test statistic is larger, the series is non-stationary, and if the calculated test statistic is smaller, the null hypothesis is rejected and the series is stationary (Önal, 2021: 33-34).

3.2. FFFADF Unit Root Test

Traditional unit root tests do not take structural breaks into account. However, it has recently been argued that since macroeconomic variables have a non-linear and structurally broken structure, unit root tests that take into account non-linear and structural breaks produce more accurate results (Ergün-Tatar, 2021: 379).

Pierre Perron first drew attention to structural breaks in 1989 and argued that ignoring structural breaks would lead to failure to reject the unit root in unit root tests. The omission of structural breaks has been tried to be overcome by different unit root tests developed by Perron (1989), Zivot and Andrews (1992), Lee and Strazicich (2003). However, since structural breaks are taken into account by dummy variable method in these tests, only sudden change dynamics can be captured (Lee and Strazicich, 2003: 1082). Therefore, Fourier-based unit root tests have been developed in the literature to capture smooth transitions and changes instead of abrupt changes. The Fourier ADF unit root test detects not only sudden changes but also slow changes. The location, number and form of structural breaks do not affect the power of the test (Yılancı, 2017: 55).

The FFFADF unit root test was proposed by Bozoklu et al. (2020). This test is based on the test proposed by Enders and Lee (2012). Since Bozoklu et al. (2020) include the decimal values of frequencies in the model, they introduced the FFFADF unit root test as a contribution to the literature. The FFFADF test differs from the test proposed by Enders and Lee (2012) because the frequency numbers are fractional rather than integer. The Fourier ADF test statistic is obtained using the following equations (Bozoklu et al., 2020: 5);

$$\Delta Y_t = \delta_0 + \delta_1 \sin\left(\frac{2\pi kt}{T}\right) + \delta_2 \cos\left(\frac{2\pi kt}{T}\right) + \delta_3 Y_{t-1} + \sum_{i=1}^p \alpha_i \Delta Y_{t-i} + \varepsilon_t \quad (4)$$

In Equation 4, (t) denotes the trend term, (T) denotes the number of observations, $\pi= 3.1416$, (k) denotes a certain frequency, and (p) denotes the optimal lag length. Bozoklu et al. (2020) used the Akaike information criterion to determine the appropriate lag length and based on Omay's (2015) study, they chose the appropriate value $(\tilde{k})$ that gives the least sum of squares in the range $[0.1, 0.2, \dots, 5]$. Testing for nonlinearities, the null hypothesis $\delta_1 = \delta_2 = 0$ is tested with the F-test. To test the null hypothesis of a unit root, the statistical significance of the coefficient ρ is tested. Omay (2015) contributed to the literature by developing the test that allows the frequency to be fractional in the range $k= [0,1,0,2, 0,3, \dots, 2]$. Bozoklu et al. (2020) extended the 0-2 frequency value range to $k= [0,1, 0,2, \dots, 5]$ and calculated the critical values for this frequency range using Monte Carlo simulations (Yılmaz, 2023: 846). By comparing the obtained test statistics with the critical values, it is checked whether the series used in the analysis has a unit root (Hacımamoğlu, 2023: 210).

The fact that the appropriate frequency value is fractional implies that structural breaks are permanent, whereas an integer value implies that structural breaks are temporary. In other words, whether structural changes are temporary or permanent is related to whether the frequency value is integer or fractional (Özer, 2022: 276).

4. Empirical Findings

In this study, in which the validity of the unemployment hysteresis hypothesis for Türkiye is tested with monthly and quarterly data covering the period January 2005-June 2024, the variables of general, male and female unemployment rates are analyzed separately with ADF and FFFADF unit root tests. In this section of the study, after presenting the descriptive statistics of the variables, the results of the ADF and FFFADF unit root tests for monthly and quarterly data with constant and with constant and trend are presented.

Table 1: Descriptive Statistics for Monthly Data

	General	Male	Female
Mean	10.40769	9.611111	12.11496
Median	10.1	9.2	12.25
Maximum	14.1	13.6	16.7
Minimum	8	6.9	7.8
Std. Dev.	1.646802	1.642999	2.205025
Skewness	0.680186	0.81137	0.052409
Kurtosis	2.362825	2.699408	2.08893
Jarque-Bera	22.00189	26.55552	8.20009
Probability	0.000017	0.000002	0.016572
Sum	2435.4	2249	2834.9
Sum Sq. Dev.	631.8862	628.9711	1132.878
Observation	234	234	234

Descriptive statistics for monthly data for Türkiye for the period January 2005-June 2024 are presented in Table 1. When the values in the table are analyzed; while the 234-month mean general unemployment rate for Türkiye is 10.4%, the unemployment rate for male and female is 9.6% and 12.1%, respectively. Therefore, based on monthly data, it is seen that the unemployment rate of male in Türkiye is lower than the unemployment rate of female.

Table 2 presents the descriptive statistics of unemployment rates in the Turkish labor market for a total of 78 quarters between January 2005 and June 2024. When the values in the table are analyzed; according to the quarterly data, the general unemployment rate is calculated as 10.4%, the unemployment rate for male is 9.6% and the unemployment rate for female is 12.1%. When the maximum values are analyzed, it is seen that the highest unemployment rate in Türkiye was

14.03%. In the quarter in which male had the highest unemployment rate, it rose to 13.5%, while female's unemployment rate was 16.53%. Therefore, in the light of quarterly data, it was determined that the unemployment rate of female was higher than the unemployment rate of male.

Table 2: Descriptive Statistics for Quarterly Data

	General	Male	Female
Mean	10.40769	9.611111	12.11496
Median	10.11667	9.2	12.36667
Maximum	14.03333	13.5	16.53333
Minimum	8.1	7.266667	8.033333
Std. Dev.	1.635332	1.62492	2.195855
Skewness	0.653619	0.779223	0.025825
Kurtosis	2.312194	2.632397	2.052037
Jarque-Bera	7.091327	8.332637	2.929232
Probability	0.028849	0.015509	0.231167
Sum	811.8	749.6667	944.9667
Sum Sq. Dev.	205.9221	203.3081	371.277
Observation	78	78	78

Table 3: ADF Unit Root Test for Monthly Data Model Results with Constant

	ADF Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value	Probability Value
General	-1.58944	-3.45835	-2.87376	-2.57336	0.4864
Male	-1.69793	-3.45835	-2.87376	-2.57336	0.4310
Female	-1.94739	-3.45835	-2.87376	-2.57336	0.3102

The results of the constant model in Table 3, where monthly data are analyzed with the ADF unit root test, show that unemployment hysteresis is present in the general, male and female unemployment rate. When the probability values are analyzed, since the probability value of the general unemployment rate is the highest probability value, it is understood that the unemployment hysteresis effect is higher in the general unemployment rate. Looking at the unemployment hysteresis series by gender in the Turkish economy, it is concluded that the unemployment hysteresis series in the male labor market is higher than the unemployment hysteresis series in the female labor market since the probability value of male is higher than the probability value of female.

Table 4: FFFADF Unit Root Test for Monthly Data Model Results with Constant

	Frequency	Min SSR	F Test Statistics	Optimal Lag	FFFADF Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value
General	3.6	25.19612	7.940482	1	-2.12877	-3,6379	-2,99511	-2,67325
Male	3.6	35.52037	6.414888	3	-2.28497	-3,6379	-2,99511	-2,67325
Female	0.9	45.23303	2.712336	1	-2.94706	-4,36749	-3,81304	-3,52169

Table 4 presents the results of the FFFADF unit root test for general, male and female unemployment rate variables for monthly data. According to the FFFADF test results, the appropriate frequency length of the general unemployment rate and male unemployment rate is calculated as 3.6, while the appropriate frequency length of the female unemployment rate is 0.9. In addition, when the appropriate lag length is evaluated, it is understood from Table 4 that the appropriate lag length of the general unemployment rate and the female unemployment rate is calculated as 1, while the appropriate lag length of the male unemployment rate is calculated as 3. In order to analyze the hysteresis of general unemployment rate, male unemployment rate and female unemployment rate, it is necessary to look at the FFFADF statistic values in Table 4.

The FFFADF statistic result of the general unemployment rate is calculated as -2.12. Since this value is greater than the calculated critical values, it is understood that the general unemployment rate contains a hysteresis effect. Similarly, the FFFADF test statistic result for male unemployment rate is calculated as -2.28. Since this value is larger than the critical values calculated for the male unemployment rate, it is understood that the unemployment hysteresis hypothesis is valid for male unemployment rates as well.

Finally, the FFFADF test statistic value of female unemployment rates in Table 4 is calculated as -2.94. Since this statistical value calculated for the female unemployment rate is also larger than the calculated critical values, it is seen that the unemployment rates of female also contain unemployment hysteresis. The results of the FFFADF unit root test are consistent with the results of the ADF unit root test. In the results of both tests applied for econometric analysis, it is determined that the general, male and female unemployment rate in the Turkish economy have unemployment hysteresis.

Table 5: ADF Unit Root Test for Monthly Data Model Results with Constant and Trend

	ADF Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value	Probability Value
General	-1.38783	-3.99793	-3.42923	-3.13809	0.8623
Male	-1.6706	-3.99793	-3.42923	-3.13809	0.7613
Female	-2.05589	-3.99793	-3.42923	-3.13809	0.5672

Table 5 presents the results of the ADF unit root test for monthly data for the model with constant and trend. When these results are analyzed, it is seen that general unemployment series and gender-based unemployment series contain unit roots. When probability values are analyzed, the probability value of the general unemployment rate is calculated as 0.86. This value is higher than the probability value of female and male unemployment rates. Therefore, according to the results of the ADF unit root test with constant and trend model based on monthly data, it is concluded that general, female and male unemployment rates have a hysteresis effect in the Turkish economy.

Table 6: FFFADF Unit Root Test for Monthly Data Model Results with Constant and Trend

	Frequency	Min SSR	F Test Statistics	Optimal Lag	FFFADF Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value
General	3.6	25.1961	7.889293	1	-1.81726	-4,28882	-3,66774	-3,34332
Male	3.6	35.44922	6.489994	3	-2.20711	-4,28882	-3,66774	-3,34332
Female	2	44.6825	3.447106	1	-3.02017	-4,58848	-3,99084	-3,67822

Table 6 presents the results of the FFFADF unit root test for monthly data for the model with constant and trend. According to the FFFADF test results, the appropriate frequency length of the general unemployment rate and male unemployment rate is 3.6, while the appropriate frequency length of the female unemployment rate is 2. When the appropriate lag length is evaluated, it is determined that the appropriate lag length of the general unemployment rate and the female unemployment rate is 1, while the appropriate lag length of the male unemployment rate is calculated as 3. The FFFADF test statistic values of the general unemployment rate, male unemployment rate and female unemployment rate analyzed for the presence of hysteresis are calculated as -1.81, -2.20 and -3.02, respectively. These values mean that the calculated FFFADF test statistic values are smaller in absolute value than the critical table values at all significance levels, in other words, the series are non-stationary. As a result, it is determined that general, female and male unemployment rates in the Turkish economy have a hysteresis effect.

When the data in Table 7, which includes the results of the ADF unit root test with constant model for quarterly data, are analyzed, it is observed that unemployment hysteresis exists in the general unemployment rate, male unemployment rate and female unemployment rate. When

probability values are analyzed, the probability value of the female unemployment rate is calculated as 0.36. Since this probability value is higher than the probability values of the general unemployment rate and the male unemployment rate, it is concluded that the unemployment hysteresis effect is higher in the female unemployment rate according to the results of the ADF unit root test with constant model for quarterly data in the Turkish economy.

Table 7: ADF Unit Root Test for Quarterly Data Model Results with Constant

	ADF Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value	Probability Value
General	-2.48455	-3.51905	-2.90014	-2.58741	0.1232
Male	-2.50407	-3.51905	-2.90014	-2.58741	0.1185
Female	-1.82449	-3.51905	-2.90014	-2.58741	0.3661

Table 8: FFFADF Unit Root Test for Quarterly Data Model Results with Constant

	Frequency	Min SSR	F Test Statistics	Optimal Lag	FFFADF Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value
General	3.6	16.68594	3.809893	1	-2.40091	-3,68838	-3,00928	-2,66532
Male	3.6	18.15928	4.784223	1	-2.36808	-3,68838	-3,00928	-2,66532
Female	3.5	28.61529	3.010992	6	-1.31027	-3,68907	-3,00928	-2,6644

When the results of the FFFADF unit root test for quarterly data are analyzed in Table 8, it is observed that general, male and female unemployment rate variables contain unit roots. When the appropriate lag length is evaluated, the appropriate lag length of general unemployment rate and male unemployment rate is 1, while the appropriate lag length of female unemployment rate is 6. When the FFFADF test statistic values analyzing the hysteresis of general unemployment rate, male unemployment rate and female unemployment rate are analyzed, the results are calculated as -2.40, -2.36 and -1.31, respectively. Since these values are larger than the table critical values, it is understood that all series contain hysteresis effect. The results of the FFFADF unit root test fixed model for quarterly data in the Turkish economy show that the general, male and female unemployment rate contain unemployment hysteresis.

Table 9: ADF Unit Root Test for Quarterly Data Model Results with Constant and Trend

	ADF Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value	Probability Value
General	-2.47201	-4.08336	-3.47003	-3.16198	0.3409
Male	-2.45416	-4.08336	-3.47003	-3.16198	0.3496
Female	-1.80895	-4.08336	-3.47003	-3.16198	0.6908

Table 9 presents the results of the ADF unit root test for quarterly data for the model with constant and trend. When the probability values for quarterly data are analyzed, it is observed that unemployment hysteresis is present in the general unemployment rate, male unemployment rate and female unemployment rate. According to the probability values, the highest probability value is calculated as 0.69 for the female unemployment rate.

In this framework, when we look at the unemployment hysteresis series in general and by gender in the Turkish economy, it is determined that the unemployment hysteresis series in the female labor market is higher than the unemployment hysteresis series in the general and male labor market since the probability value of female is higher than the probability value of male.

Table 10 presents the results of the FFFADF unit root test for quarterly data for the model with constant and trend. When the data in the table are analyzed, it is seen that general unemployment rate, male unemployment rate and female unemployment rate variables contain unit root, in other words, the series are non-stationary.

Table 10: FFFADF Unit Root Test for Quarterly Data Model Results with Constant and Trend

	Frequency	Min SSR	F Test Statistics	Optimal Lag	FFFADF Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value
General	3.6	16.62479	3.779503	1	-2.32093	-4,33992	-3,67568	-3,33067
Male	3.6	17.8804	4.800294	1	-2.26958	-4,33992	-3,67568	-3,33067
Female	3.5	28.33508	2.853865	1	-2.12192	-4,33841	-3,68688	-3,33067

According to the results of the FFFADF unit root test with constant and trend model, the appropriate frequency length of the general unemployment rate and male unemployment rate is calculated as 3.6, while the appropriate frequency length of the female unemployment rate is 3.5. At the same time, when the appropriate lag length is evaluated, the appropriate lag length of general unemployment rate, male unemployment rate and female unemployment rate is calculated as 1. When the FFFADF test statistic values of the general unemployment rate, male unemployment rate and female unemployment rate are analyzed for the presence of hysteresis, the results are -2.32, -2.26 and -2.12, respectively. Since these values are smaller in absolute value than the table critical values, it means that all series contain unit root, in other words, the hysteresis effect is valid in the Turkish economy.

5. Conclusion

In this study, the validity of the unemployment hysteresis hypothesis for general, male, and female unemployment rates in the Türkiye economy is comprehensively examined using monthly and quarterly data for the period January 2005-June 2024 with traditional ADF and current FFFADF unit root tests. The findings consistently reveal the existence of unemployment hysteresis in the general, male, and female unemployment rates in Türkiye in both the ADF and FFFADF unit root test methodologies applied with monthly and quarterly data. In particular, the hysteresis effect is observed to be more pronounced in the monthly data.

The results of this study occupy an important place among the complex and divergent findings in the national and international literature on the validity of the unemployment hysteresis hypothesis. The findings are consistent with numerous national studies that point to the exposure of unemployment rates in Türkiye to persistent shocks and support the existence of the hysteresis effect. In this context, Bayat et al. (2020), Çemrek and Şeker (2020), Kılıç et al. (2021), Ulucak (2021), Yurtkuran (2021), Atamer et al. (2023), Kutlu (2023), Üçler et al. (2023), Yardımcı (2023), Atabey (2024), Baktemur (2024), and Daştan (2024) on the Turkish economy and finding a hysteresis effect in unemployment. This similarity suggests that there is a tendency toward permanence in the structure of the Türkiye labor market in response to shocks.

However, the results of the analysis contradict the findings of some studies, such as Aydın (2020), Omay et al. (2021), Azazi and Ateş (2022) and Belliler and Demiralp (2022). Such differences may stem from differences in the time periods included in the analysis, the data frequencies used, the structural breaks or non-linear relationships ignored by traditional tests in the preferred econometric methodologies, and the unique socio-economic conditions of each country. The use of the FFFADF unit root test in this study offers the potential to more effectively capture potential non-linear structures and structural breaks in unemployment series, thereby providing the literature with more robust and detailed empirical evidence. The simultaneous analysis of monthly and quarterly data also fills a gap in the literature by providing valuable information on unemployment dynamics from different time perspectives.

The findings of the study, which show that the unemployment hysteresis hypothesis is valid in Türkiye, offer powerful implications that are critical for policymakers. Even temporary shocks in unemployment rates leave lasting effects, indicating that the labor market's self-balancing mechanisms are insufficient. This situation emphasizes the need for the government to take preventive and continuous measures to combat unemployment. From this point of view,

vocational training courses and re-employment programs that will bring the skills of unemployed individuals or new entrants to the labor force in line with market demands should be expanded and made more effective. In particular, combating female unemployment, which has a higher probability value in the analysis, should be a priority area in national employment policies. Supportive policies that encourage female's participation in the labor force, such as childcare and flexible working arrangements, should be developed, and incentives such as tax breaks or credit facilities for female-friendly workplaces should be provided. Legal sanctions to prevent informal employment, which could be a significant factor in the persistence of unemployment, should be strengthened, and inspections should be increased. This will improve the health of the labor market and make it more resilient to shocks. Early warning systems and rapid response mechanisms should be established to absorb the negative effects of economic shocks on unemployment before they become permanent.

In conclusion, this study not only presents empirical evidence of persistent unemployment in the Türkiye labor market, but also highlights the importance of more proactive and targeted strategies in combating unemployment for policymakers.

Future studies may focus on examining unemployment hysteresis at the sectoral level or conducting quantitative analyses of the effects of specific policy implementations on hysteresis.

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