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Validity of the Phillips Curve in Türkiye: Wavelet Transform Coherence (WTC) Analysis

Türkiye'de Phillips Eğrisinin Geçerliliği: Dalgacık Dönüşümü Tutarlılığı (WTC) Analizi

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ABSTRACT

Inflation and unemployment, which play a crucial role in ensuring economic stability, have a complex relationship with each other. In this context, the aim of this study is to examine the validity of the Phillips curve in Türkiye by using the variables of general unemployment rate, male unemployment rate, female unemployment rate, Consumer Price Index (CPI), CPI measured by prices of goods and CPI measured by prices of services sector covering the period 2005:1-2024:8. In the analysis part of the study, the stationarity of the variables is tested with the Fractional Frequency Fourier ADF (FFFADF) unit root test. The validity of the Phillips curve between CPI variables and unemployment variables is analyzed separately by Wavelet Transform Coherence (WTC) analysis. When the results of the analysis are analyzed in general, it is concluded that the Phillips curve is not valid in the Turkish economy. Based on the findings, policymakers in the Turkish economy should focus on supply-side policies such as tax cuts and incentives for technological innovations and structural reforms such as increasing the flexibility of the labor market and organizing vocational training programs.

MAKALE BİLGİSİ

Makale Türü
Araştırma Makalesi

Anahtar Kelimeler
İşsizlik
Enflasyon
Phillips Eğrisi
Dalgacık Dönüşümü Tutarlılığı
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ÖZ

Ekonomik istikrarın sağlanmasında kilit rol oynayan enflasyon ve işsizlik, birbirleriyle karmaşık bir ilişki içindedir. Bu bağlamda çalışmanın amacı, Türkiye'de Phillips eğrisinin geçerliliğini 2005:1-2024:8 dönemini kapsayan genel işsizlik oranı, erkek işsizlik oranı, kadın işsizlik oranı, Tüketici Fiyat Endeksi (TÜFE), mal fiyatlarıyla hesaplanmış TÜFE ve hizmet sektörünün fiyatlarıyla hesaplanmış TÜFE değişkenlerini kullanarak incelemektir. Çalışmanın analiz kısmında değişkenlerin durağanlık sınaması Kesirli Frekanslı Fourier ADF (FFFADF) birim kök testi ile test edilmiştir. TÜFE değişkenleri ile işsizlik değişkenleri arasındaki Phillips eğrisinin geçerliliği ise, Dalgacık Dönüşümü Tutarlılığı (WTC) analizi ile ayrı ayrı analiz edilmiştir. Analiz sonuçları genel olarak değerlendirildiğinde, Türkiye ekonomisinde Phillips eğrisinin geçerli olmadığı sonucuna ulaşılmıştır. Bulgulardan hareketle Türkiye ekonomisinde politika yapıcıların ekonomi politikaları belirlerken, vergi indirimi ve teknolojik yenilikleri teşvik etmek gibi arz yönlü politikalara ve işgücü piyasasının esnekliğini artırmak ve mesleki eğitim programları düzenlemek gibi yapısal reformlara odaklanması gerekmektedir.

1. Introduction

Inflation and unemployment are among the most important issues in the world economy. Because these two phenomena are among the most important concepts that show the course of the economy. While inflation refers to the continuous increase in the prices of goods and services, unemployment is defined as the economic problem caused by individuals who accept the wage level prevailing in the market and cannot find a job despite looking for a job (Yayar and Tekgün, 2022: 335-336). The relationship between inflation and unemployment is estimated by the "*Phillips Curve*" method.

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The original Phillips curve was introduced to the literature with the study published by A. W. Phillips (1958). Phillips argued that there is a negative and non-linear relationship between the rate of change in monetary wages and the unemployment rate. This relationship refers to the relationship between demand and supply of goods and services. If demand is higher than supply, prices rise, whereas if demand is lower than supply, prices fall. At the same time, when the unemployment rate is high and the demand for labor is low, wages will decrease, and therefore, working individuals will not be willing to work at that wage level over time. Therefore, a linear relationship between unemployment and wages is unlikely. Phillips (1958) argued that the rate of change in monetary wage rates is affected by the rate of change in labor demand and hence unemployment. Thus, in a year of rising business activity, when the demand for labor is rising and the unemployment rate is falling, employers will bid more strongly for labor services than in a period when the mean unemployment rate is the same but the demand for labor is not rising. Conversely, in a period of falling business activity, falling labor demand and rising unemployment, employers will be less inclined to raise wages and workers will be in a weaker position to raise wages than in a period when the mean unemployment rate is the same but labor demand is not falling (Phillips, 1958: 283).

The Phillips curve has been criticized by many economic schools. Monetarist economic thinkers argued that a negative relationship between inflation and unemployment is valid only in the short run and that such a trade-off relationship does not exist in the long run. New Keynesian thinkers approved the functioning of the trade-off relationship between unemployment and inflation rate in the short run within the framework of rational expectations, but argued that this trade-off relationship is unacceptable in the long run (Akiş, 2020: 407-408).

Samuelson and Solow (1960) transformed the Phillips curve into a curve showing the relationship between the rate of change in prices and the unemployment rate (Akkuş, 2013: 100-101). In their study, they argued that the mean price level will increase when the unemployment rate is low and decrease when it is high, and as a result, high levels of employment and production will lead to much higher price increases (Bayrak and Kanca, 2013: 100).

The original Phillips curve was established in 1958, but it has evolved continuously and continues to be one of the main arguments of policy makers. Therefore, this relationship is still valid today. Therefore, governments try to determine the optimal combination of unemployment and inflation problems. Since the Turkish economy has been experiencing high inflation for many years, combating inflation and unemployment has become one of the main objectives of government programs (Köktaş et al., 2023: 1018).

Although this relationship between inflation and unemployment has not received serious attention until the recent astronomical increase in the prices of goods and services in the Turkish economy, scientific studies in this field have been quite limited. For this purpose, the aim of this study is to analyze the validity of the Phillips curve for the Turkish economy using monthly data covering the period 2005:1-2024:8 by using the variables of general, male, female unemployment rates and CPI, CPI measured by goods prices and CPI measured by services prices. In this framework, in the analysis part of the study, the stationarity of the variables is tested with the FFFADF unit root test developed by Bozoklu et al. (2020), which is a recent method. The validity of the Phillips curve between CPI variables and unemployment variables is analyzed separately with WTC analysis.

This study makes important and original contributions to the literature. First of all, this issue has not been sufficiently focused on in the literature until recently. Second, a broader perspective is provided by including not only the overall unemployment rate but also its subcomponents, namely the male and unemployment rate variables. Third, for the first time, the WTC method, which is a powerful tool in time-frequency analysis, is used. Finally, in contrast to traditional testing techniques, modern and advanced analysis approaches are adopted. While traditional tests ignore

time-varying relationships, leading to misleading conclusions and erroneous policy recommendations, WTC analysis provides more reliable results thanks to its ability to analyze simultaneously in time and frequency domain.

This study consists of five main sections. After the introduction, there is a literature review section on national and international empirical studies on the Phillips curve, followed by a section explaining the data set and methodology, and then the findings from the econometric analysis. The study is concluded with a section that presents the conclusion and policy recommendations.

2. Literature Review

In this section of the study, recent national and international empirical studies on the validity of the Phillips curve, in other words, on the negative relationship between inflation and unemployment rates, are presented chronologically in Table 1.

Table 1: Summary of the Empirical Literature on the Phillips Curve

Author(s)	Year of Publication	Target Country(s)	Data Set	Analysis Method	Conclusion
Alper	2017	Türkiye	1987-2016	ARDL (Autoregressive Distributed Lag) test and Ordinary Least Squares (OLS)	Phillips curve is valid.
Petek and Aysu	2017	Türkiye	1980-2015	Vector Autoregression (VAR) Model and Granger causality test	A bidirectional causal relationship between the variables could not be found.
Eygü	2018	Türkiye	1990-2017	Least Squares (LS)	Phillips curve is valid.
Karacan	2018	Türkiye	2005-2018	Granger causality analysis, cointegration test and Error Correction Model (ECM)	There is no relationship between the variables.
Zayed et al.	2018	Philippines	1950-2017	OLS model and Johansen cointegration test	Phillips curve is not valid.
Abu	2019	Nigeria	1980-2016	ARDL bounds test method, FMOLS, DOLS, OLS, CCR estimation techniques, Granger and Toda-Yamamoto causality tests	Phillips curve is valid.
Duncan et al.	2019	Kenya	2006:M1-2016:M12	OLS	Phillips curve is valid.
Polat	2019	Türkiye's Level-2 regions	2008-2017	LS	Phillips curve is valid.
Salman and Uysal	2019	Türkiye	2006:Q1-2018:Q2, 2006:Q1-2011:Q4 and 2012:Q1-2018:Q2	VAR Granger causality test	In the long term, there is no causal relationship between the variables.
Sasongko and Huruta	2019	Indonesia	1984-2017	Granger causality test and VAR	There is a one-way causality from unemployment to inflation.
Wulandari et al.	2019	Indonesia	1987-2018	Vector Error Correction Model (VECM)	There is a one-way relationship from inflation to unemployment.
Atgür	2020	Türkiye	1988-2017	OLS and Johansen cointegration test	Phillips curve is valid.
Bozma et al.	2020	Türkiye's Level-1 regions	2006-2016	Panel ARDL test	Phillips curve is valid.
Lisani et al.	2020	ASEAN-10	1989-2018	VECM	In the long run, the Phillips curve is valid.
Özer	2020	Türkiye	2006:M1-2017:M12	Fourier ADL cointegration test and Dynamic Least Squares	Phillips curve is valid.
Qin	2020	United States (UN)	1962:Q2-2019:Q4	VAR	In the short and long term, the Phillips curve is valid.

Alıcı	2021	Türkiye	2005:01-2021:04	RALS (Residual Augmented Least Squares)	Phillips curve is not valid.
Nar	2021	Türkiye	1980-2019	Engle-Granger cointegration and Granger causality tests	Phillips curve is valid.
Ozan and Bakırtaş	2021	Türkiye	1995:Q1-2019:Q4	ARDL	New Keynesian Wage Phillips curve is valid.
Şengönül and Tekgün	2021	Türkiye's Level-2 regions	2005-2019	Panel ARDL	In 10 out of 26 regions, the short-term Phillips curve with a negative slope is valid.
Buyrukoğlu and Mercan	2022	Türkiye	2009:M5-2021:M11	Engle-Granger cointegration and Granger causality tests	Phillips curve is valid.
Karademir and Ceylan	2022	Norway	1995:Q1-2021:Q2	NARDL (Nonlineer Autoregressive Distributed Lag)	The backward-bending Phillips curve is valid.
Aydın	2023	Türkiye	1980-2021	ARDL	Phillips curve is valid.
Doğan	2023	Türkiye	1988-2021	Gregory Hansen cointegration test and FMOLS (Fully Modified Ordinary Least Square)	Phillips curve is valid.
Köktaş et al.	2023	Türkiye	2014:Q1-2021:Q3	ARDL and NARDL	Phillips curve is valid.
Madžar	2023	Serbia	2003-2022	Correlation analysis, Granger causality and Johansen cointegration tests	There is no long-term or causal relationship between inflation and unemployment.
Bükey and Kalkan	2024	Germany	1992:M1-2023:M4	Johansen cointegration and Toda-Yamamoto causality tests	Phillips curve is not valid.
Karagöl	2024	Türkiye	2005:M1-2023:M3	VAR	In the short and long term, the Phillips curve is valid.
Karataş	2024	Türkiye	2005:M1-2023:M9	Johansen cointegration test	Phillips curve is valid.
Kartal	2024	Türkiye	1960-2022	Maki (2012) cointegration test with multiple structural breaks and Newey-West HAC estimator	While the Phillips curve is valid in the short term, it is not valid in the long term.

Since Türkiye is the country considered in this study, the literature review mainly includes empirical studies on the Turkish economy. When the empirical studies in Table 1 are evaluated, it is seen that the country groups, period intervals and analysis methods are different. This situation may lead to variability in the results obtained. When the results obtained from the literature studies on the Turkish economy are evaluated; Alper (2017), Eygü (2018), Polat (2019), Atgür (2020), Bozma et al. (2020), Özer (2020), Nar (2021), Şengönül and Tekgün (2021) in the short run in 10 out of 26 regions, Buyrukoğlu and Mercan (2022), Aydın (2023), Doğan (2023), Köktaş (2023), Karagöl (2024) in the short and long run, Karataş (2024) and Kartal (2024) in the short run. On the other hand, Alıcı (2021) and Kartal (2024) conclude that the Phillips curve is not valid in the long run. When the empirical studies outside the Turkish economy are analyzed, Zayed et al. (2018) in the Philippines and Bükey and Kalkan (2024) in Germany, Abu (2019) in Nigeria, Duncan et al. (2019) in Kenya, Lisani et al. (2020) in ASEAN-10 countries in the long run, Qin (2020) in the US in the short and long run, and Karademir and Ceylan (2022) in Norway, find that the backward-bending Phillips curve is valid.

When the literature studies are examined, it is seen that more traditional methods are used. In traditional methods, for example, correlation analysis analyzes in the time domain and Fourier transform analyzes in the frequency domain. Therefore, separate analyses are usually performed in time or frequency domain. The WTC analysis used in this study, on the other hand, analyzes simultaneously in the time and frequency domains, showing how the relationships between the series change over time and at which frequencies they are stronger. This is particularly advantageous in cases where the relationship between series changes over time. In recent studies on the validity of the Phillips curve, it is observed that only general unemployment and inflation rates are used, there are very few gender-based studies and CPI variables calculated by prices of goods and services are not used as inflation variables. This study contributes to the literature by using general and gender-based unemployment rates while analyzing the validity of the Phillips

curve and by testing CPI, CPI variables calculated with prices of goods and services with WTC analysis.

3. Data and Methodology

In order to test the validity of the Phillips curve in the Turkish economy, this study utilizes the general unemployment rate, male unemployment rate, female unemployment rate, CPI, CPI in goods prices and CPI in services prices. Seasonally adjusted unemployment and inflation data are obtained from the Turkish Statistical Institute (TurkStat) database. The variables to be analyzed are selected monthly with a total number of 235 observations. Since the common coverage of a large number of relevant data was forced to be chosen as 2005:1-2024:8, the period range was determined in this way. In order to test the validity of the Phillips curve, the FFFADF unit root test was first applied to the variables with econometric analysis programs, and then the long-term performance of the relationship between the variables used was investigated with WTC analysis.

In the model established to test the validity of the Phillips curve, CPI, CPI based on goods prices and CPI based on services sector prices are used as dependent variables and general, male and female unemployment rates are used as independent variables to represent unemployment. The model equations defining all variables included in the analysis are constructed as follows:

The model equations in which all variables included in the analysis are defined are as follows:

$$CPI = a_i + \beta_1 UN + \varepsilon_{it} \quad (1)$$

$$CPIP = a_i + \beta_1 UN + \varepsilon_{it} \quad (2)$$

$$CPIS = a_i + \beta_1 UN + \varepsilon_{it} \quad (3)$$

$$CPI = a_i + \beta_1 MUN + \varepsilon_{it} \quad (4)$$

$$CPIP = a_i + \beta_1 MUN + \varepsilon_{it} \quad (5)$$

$$CPIS = a_i + \beta_1 MUN + \varepsilon_{it} \quad (6)$$

$$CPI = a_i + \beta_1 FUN + \varepsilon_{it} \quad (7)$$

$$CPIP = a_i + \beta_1 FUN + \varepsilon_{it} \quad (8)$$

$$CPIS = a_i + \beta_1 FUN + \varepsilon_{it} \quad (9)$$

In the models, a_i denotes country-specific fixed effects, β denotes the slope coefficient, ε_{it} denotes the error term, t=2005:1,...,2024:8 denotes the time period, and i denotes the number of countries.

Table 2: Description of the Variables

Abbreviation	Name of the variables	Measurement Scale	Source
UN	Unemployment	Seasonally adjusted general unemployment rates	TurkStat
MUN	Male Unemployment	Seasonally adjusted male unemployment rates	TurkStat
FUN	Female Unemployment	Seasonally adjusted female unemployment rates	TurkStat
CPI	Consumer Price Index	Seasonal adjusted CPI rates	TurkStat
CPIP	Consumer Price Index Product	Seasonal adjusted CPIP rates	TurkStat
CPIS	Consumer Price Index Service	Seasonal adjusted CPIS rates	TurkStat

Table 2 shows the abbreviation, name, scope and sources of the variables.

3.1. FFFADF Unit Root Test

This test developed by Bozoklu et al. is based on the test developed by Enders and Lee (2012). Bozoklu et al. (2020) also included decimal values of frequencies in the model. Where the FFFADF test differs from the Enders and Lee (2012) test is that the frequency numbers are fractional rather than integer. The Phillips curve can be affected by structural breaks such as economic crises and policy changes. The FFFADF test is particularly preferred in this study since it more accurately determines the stationarity of the series by taking such breaks into account. The Fourier ADF test statistic is formulated as follows (Bozoklu et al., 2020: 5):

$$\Delta Y_t = \delta_0 + \delta_1 \, sin\left(\frac{2\pi kt}{T}\right) + \delta_2 \, cos\left(\frac{2\pi kt}{T}\right) + \delta_3 Y_{t-1} + \sum_{i=1}^{p} \alpha_i \, \Delta Y_{t-i} + \varepsilon_t \qquad (10)$$

Where π= 3.1416, t is the trend term, T is the number of observations, k is a given frequency and p is the optimal lag length. Omay (2015) developed the test that allows the frequency value to be fractional in the range k= [0,1,0,2, 0,3, ... ,2], while Bozoklu et al. (2020) extended the 0-2 frequency value range to k= [0,1, 0,2, ... ,5] and calculated the critical values for this frequency range using Monte Carlo simulations. Thanks to the test statistics obtained, it is determined whether the variables have a unit root or not, in other words, whether they are stationary or not.

3.2. Wavelet Transform Coherence (WTC) Analysis

The long-run performance of the relationship between the unemployment and inflation variables used in the model is analyzed by WTC analysis. WTC analysis provides valuable information for policymakers by analyzing the complex relationships between series in time and frequency domain in detail. In addition, WTC analysis is particularly preferred in this study because it overcomes the limitations of the Fourier approach and is a powerful tool in time-frequency analysis compared to traditional tests, in other words, the Wavelet approach provides more accurately localized temporal and frequency information (Kazak et al., 2024a). Torrence and Webster (1999) defined the adjusted wavelet fit coefficient as in equation 11:

$$R_n(s) = \frac{\left|S\left(s^{-1}\omega_n^{ab}(s)\right)\right|}{S(s^{-1}|\omega_n^a|)^{0,5} S\left(s^{-1}|\omega_n^b|\right)^{0,5}} \qquad (11)$$

S in the equation denotes a smoothing operator in time and scale. The range of the square wavelet coherence coefficient takes a value between zero and one. A value close to zero reflects a weak correlation, while a value close to one reflects a strong correlation (Kazak et al. 2024b: 5-6).

For the Morlet wavelet, S can be expressed as time and scale, respectively, as in Equation 12:

$$S_t(\omega) = \left(\omega_n(s)^* k_1^{-t^2/2s^2}\right); \; S_{sc}(\omega) = \left(\omega_n(s)^* k_2 \prod(0{,}6s)\right) \qquad (12)$$

Here, t and sc represent time and scale, respectively, k_1 and k_2 are normalization constants, Π is the rectangle function and the coefficient 0.6 represents the scale averaging factor empirically determined by Torrence and Compo (1998), (Yılancı and Pata, 2023: 4975-4976).

4. Empirical Findings

In this section of the study, firstly, descriptive statistics of the variables are presented. Then, the results of the FFFADF unit root test are interpreted to determine whether unemployment and inflation variables contain unit roots. Finally, the long-term performance of the relationship between the variables is evaluated by WTC analysis.

Table 3: Descriptive Statistics of Variables

	UN	MUN	FUN	CPI	CPIP	CPIS
Mean	10.406	9.594	12.135	1.330	1.326	1.331
Median	10.100	9.200	12.100	0.870	0.920	0.790
Maximum	15.100	15.000	18.000	13.750	16.430	9.470
Minimum	7.000	6.300	6.700	-1.310	-2.100	-0.300
Std. Dev.	1.838	1.898	2.335	1.748	1.947	1.566
Skewness	0.538	0.715	0.083	3.421	3.719	2.826
Kurtosis	2.553	2.827	2.378	19.051	23.459	11.857
Jarque-Bera	13.288	20.338	4.060	2980.798	4640.426	1081.077
Probability	0.001	0.000	0.131	0.000	0.000	0.000
Sum	2445.400	2254.700	2851.800	312.490	311.680	312.850
Sum Sq. Dev.	790.572	843.263	1276.217	714.938	887.348	573.766
Observations	235	235	235	235	235	235

Table 3 presents descriptive statistics on monthly unemployment and inflation data for the Turkish economy for the period between January 2005 and August 2024. According to the data in the table, the mean general, male and female unemployment rates are calculated as 10.4%, 9.5% and 12.1%, respectively. As a result, on mean, the highest unemployment rate is realized in the female unemployment rate, followed by the general and male unemployment rates. When the inflation data are analyzed, it is seen that all three variables are at the level of 1.3% on mean. When the maximum values were analyzed, it was found that the highest unemployment rate was 18% in the female unemployment rate and the highest inflation variable was 16.4% in the CPI variable calculated with goods prices. When the skewness values are analyzed, it is seen that the general, male and female unemployment variables are 0.5, 0.7 and 0.08, respectively. Therefore, while general and male unemployment rates show positive skewness, female unemployment rates exhibit a more symmetric distribution. According to the kurtosis values, all unemployment rates are close to a normal distribution but slightly kurtotic. Male unemployment rates (2.8) exhibit a more pronounced tail towards higher values and a flatter distribution than the general unemployment rates (2.5). The CPI variable measured in goods prices has the highest values for both skewness (3.7) and kurtosis (23.4). This indicates that increases in goods prices are more asymmetric and more prone to sudden, large increases. The services CPI variable, on the other hand, has lower skewness (2.8) and kurtosis (11.8) values than the others. This implies that increases in services prices are more symmetric and have less sudden and large increases than goods prices. The study continued with the FFFADF unit root test.

Table 4: FFFADF Unit Root Test Model Results with Constant

	Frequency	Min SSR	F Test Statistics	Optimal Lag	FFFADF Test Statistics	%1 Critical Value	%5 Critical Value	%10 Critical Value
UN	2	126.207	2.445	14	-3.720**	-3.93232	-3.2634	-2.91708
MUN	1.9	161.574	6.016	14	-4.708***	-3.92961	-3.28551	-2.9459
FUN	0.8	158.871	3.200	12	-2.962	-4.39964	-3.85091	-3.56637
DFUN	3.5	166.306	2.265	11	-4.303***	-3.64256	-3.01236	-2.68748
CPI	0.1	321.875	11.806	2	-6.638***	-4.38991	-3.84603	-3.56127
CPIP	0.1	491.495	13.676	1	-8.984***	-4.38991	-3.84603	-3.56127
CPIS	0.1	139.182	4.571	11	-2.717	-4.38991	-3.84603	-3.56127
DCPIS	3.9	154.830	1.821	10	-5.775***	-3.58699	-2.96783	-2.64678

Note: ** and *** Critical values indicate 5% and 1% significance level, respectively.

Table 4 presents the results of the FFFADF unit root test for the model with constant term. The FFFADF test statistic value of the female unemployment variable is -2.9 and the CPI variable calculated with service prices is -2.7. Since these two variables were not stationary at the level, they were made stationary by taking the first difference. Thus, the FFFADF test statistic value of the female unemployment variable was calculated as -4.3 and the FFFADF test statistic value of the CPI variable calculated with service prices was calculated as -5.7. The FFFADF test statistic values of general and male unemployment variables are calculated as -3.7 and -4.7. Since these values are

significant at the 5% and 1% levels, respectively, it is determined that the general and male unemployment variables do not contain unit root and are therefore stationary. The calculated FFFADF test statistic values of CPI and CPI calculated with goods prices are -6.6 and -8.9, respectively. These values are significant at the 1% level. Therefore, it is concluded that these series are stationary.

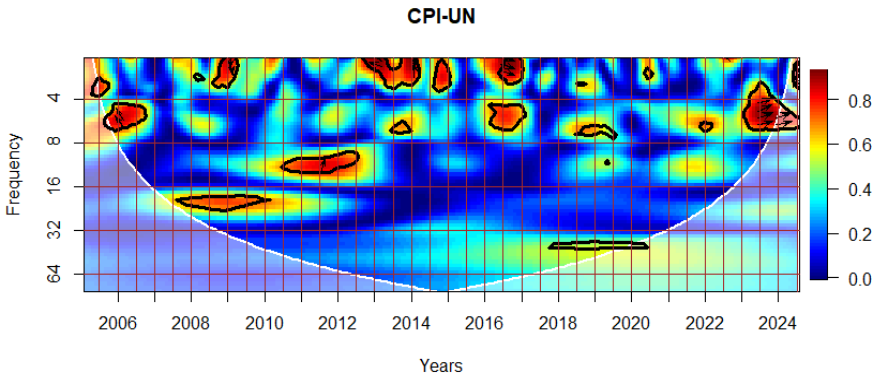
Table 5: FFFADF Unit Root Test Model Results with Constant and Trend

	Frequency	Min SSR	F Test Statistics	Optimal Lag	FFFADF Test Statistics	%1 Critical Value	%5 Critical Value	%10 Critical Value
UN	2	123.726	6.977	14	-4.899***	-4.58848	-3.99084	-3.67822
MUN	1.9	161.245	6.738	14	-4.863***	-4.62627	-4.03641	-3.72891
FUN	2	155.583	3.866	12	-3.237	-4.58848	-3.99084	-3.67822
DFUN	3.6	166.182	2.217	11	-4.365***	-4.28882	-3.66774	-3.34332
CPI	0.8	318.785	10.251	1	-8.875***	-4.80277	-4.26329	-3.98427
CPIP	1	488.066	6.539	1	-9.121***	-4.82426	-4.29002	-4.00625
CPIS	0.1	130.156	3.959	11	-3.013	-4.76837	-4.21683	-3.93332
DCPIS	3.9	154.628	2.428	10	-6.042***	-4.2438	-3.62900	-3.31264

Note: *** Critical value indicates 1% significance level.

Table 5 presents the results of the FFFADF unit root test for the model with constant and trend. It is observed that the FFFADF test statistic value of the female unemployment variable is -3.2, while the CPI variable calculated with service prices is -3.01. Since these two variables were not stationary at the level, they were made stationary by taking the first difference. Thus, the FFFADF test statistic value of the female unemployment variable was calculated as -4.3 and the FFFADF test statistic value of the CPI variable calculated with service prices was calculated as -6.04. The FFFADF test statistic values of general and male unemployment variables are calculated as -4.8. Since these values are significant at the 1% level, it is concluded that general and male unemployment variables do not contain unit root and therefore are stationary. The calculated FFFADF test statistic values of CPI and CPI calculated with goods prices are -8.8 and -9.1, respectively. This result means that both variables are greater in absolute value than the critical table values at all significance levels, in other words, they are significant and stationary at 1% level. In non-stationary series, spurious correlations and misleading results can be obtained. In order to obtain reliable results in WTC analysis, the series should be stationary. After the non-stationary series were made stationary, the study continued with the WTC analysis.

Figure 1: WTC Analysis of CPI and UN Series



Source: Author's own study.

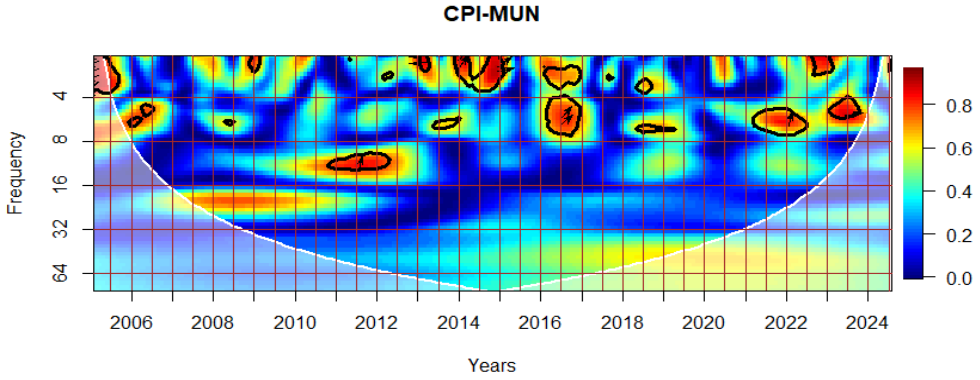
The figure 1 shows the relationship between the CPI and the general unemployment rate between January 2005 and August 2024. The downward or leftward direction of the arrows means that there is a negative relationship between the variables, while the upward or rightward direction

of the arrows means that there is a positive relationship between the variables. All figures in the analysis were evaluated within this framework.

It is clear from the figure above that there is rarely a significant relationship between both variables. At the beginning of 2006, there was a low-frequency significant and negative relationship between both variables, while the same relationship manifests itself as a low-frequency negative significant relationship in 2009.

In 2016, there is a low-frequency positive relationship and finally, after 2023, there is a low-frequency positive relationship. Therefore, since the Phillips curve claims a negative relationship between inflation and unemployment, there is a low frequency of negative relationship in Türkiye in early 2006 and early 2009. In 2006 and 2009, the Phillips curve was valid when the Turkish economy was experiencing relatively stable growth and inflation was kept under control. However, it is clear from the graph that this relationship has weakened in the periods after 2017 and 2023 due to increased uncertainties and fluctuations. In conclusion, while the Phillips curve was valid in Türkiye in 2006 and 2009, it was invalid in 2017 and after 2023.

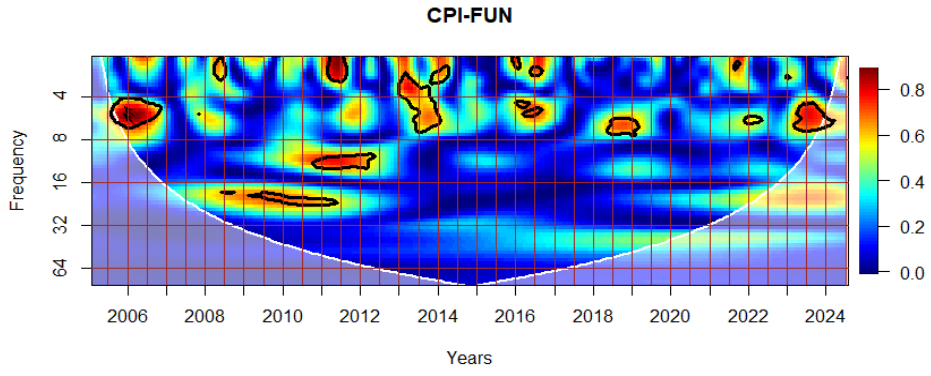
Figure 2: WTC Analysis of CPI and MUN Series



Source: Author's own study.

Figure 2 shows the relationship between CPI and male unemployment rate. When the relationship between both variables is analyzed, it is observed that there is a significant relationship in some years, but generally there is no significant relationship. In 2011, there was a significant relationship at the medium frequency, and since the direction of the arrows point upwards, it is seen that there is a positive relationship between the variables in question. At low frequencies, a similar situation is observed in 2013, 2014, 2016 and 2022. Therefore, the relationship between CPI and male unemployment rate shows that the Phillips curve is not valid.

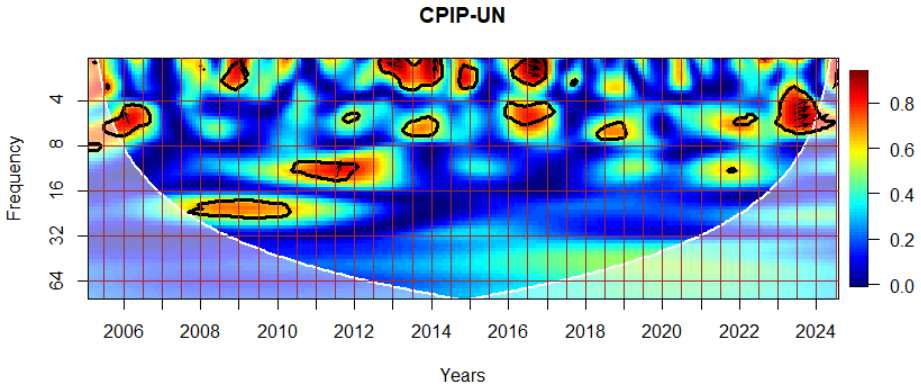
Figure 3: WTC Analysis of CPI and FUN Series



Source: Author's own study.

The figure above shows the relationship between CPI and female unemployment rate. Except for 2006 and 2007, there is no significant relationship between these two variables to indicate the direction of the relationship. The only relationship that indicates whether the relationship is positive or negative is encountered with low frequency in 2006 and 2007, but since the arrows of this relationship point both upwards and to the left, there is no clear indication that the Phillips series is valid or the Phillips curve is invalid.

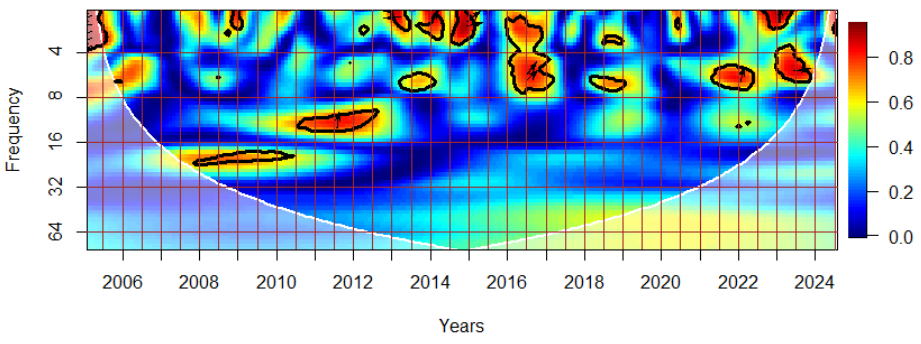
Figure 4: WTC Analysis of CPIP and UN Series



Source: Author's own study.

Figure 4 shows the relationship between the CPI in goods prices and the general unemployment rate. In general, the relationship between the two variables is rarely significant enough to indicate the direction of the relationship. In 2006, there was a positive relationship between unemployment and CPI measured in goods prices at a low frequency. The same relationship is observed at medium frequency in 2011, at low frequency between 2014 and 2016, and finally at low frequency between 2023 and 2024. Therefore, it is understood that the Phillips curve is invalid since the direction of the arrows point upwards and to the right in the periods when a significant relationship between the CPI calculated in goods prices and the general unemployment rate is detected. Economic fluctuations during these periods, especially events such as the 2008 global financial crisis and the 2018 currency crisis, caused significant fluctuations in the Turkish economy. These fluctuations led to the deterioration of the Phillips curve relationship by distorting inflation expectations and negatively affecting the labor market. In 2013, the arrow pointing to the left indicates that there is a low-frequency negative relationship. Therefore, it is concluded that the Phillips curve is valid only in 2013 and at low frequency between the CPI calculated with goods prices and the unemployment rate.

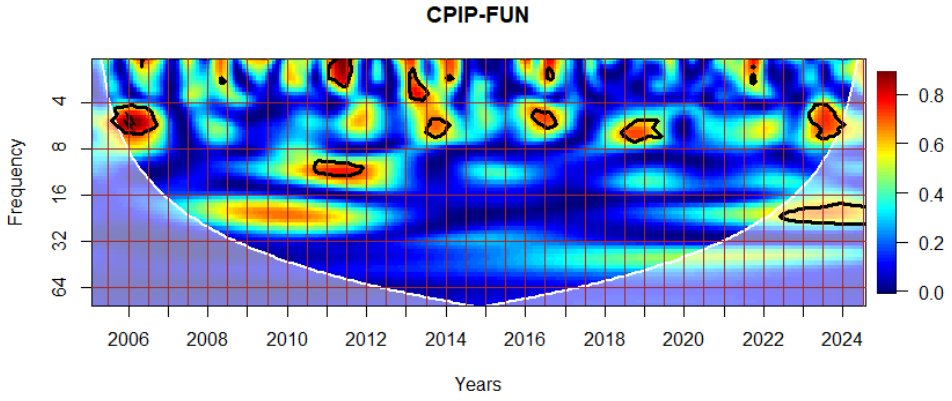
Figure 5: WTC Analysis of CPIP and MUN Series



Source: Author's own study.

Figure 5 shows the relationship between the CPI and the male unemployment rate. There is a negative relationship between these two variables at low frequency in 2013. Therefore, there is evidence that the Phillips curve is valid at low frequency in 2013, but when the other significant relationships are analyzed, it is understood that there is a positive relationship between these variables in 2012 at medium frequency and in 2017, 2022 and 2023 at low frequency, as the direction of the arrows point upwards and to the right. Therefore, there is evidence that the Phillips curve is invalid in these years and at these frequencies. In particular, events such as the global economic recovery in 2012, political uncertainties in 2017 and the earthquake disaster in 2023 caused significant fluctuations in the Turkish economy. These fluctuations led to a deterioration in the Phillips curve relationship by distorting inflation expectations and adversely affecting the labor market.

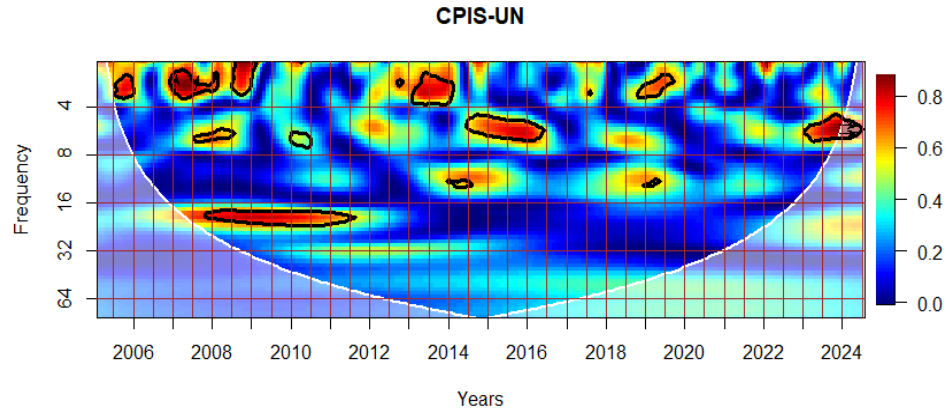
Figure 6: WTC Analysis of CPIP and FUN Series



Source: Author's own study.

The figure above shows the relationship between CPI in goods prices and female unemployment rate. There is a significant relationship between the CPI and the female unemployment rate in 2006 only, but it is not clear from the direction of the arrows whether this significant relationship is positive or negative. Therefore, it is difficult to draw a clear conclusion about the validity or invalidity of the Phillips curve from the relationship between goods CPI and the female unemployment rate.

Figure 7: WTC Analysis of CPIS and UN Series

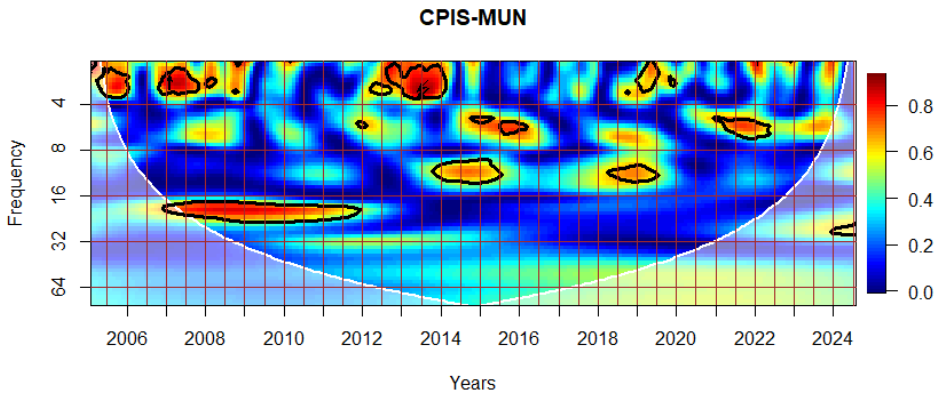


Source: Author's own study.

The figure above shows the relationship between the CPI and the general unemployment rate calculated with the prices of the service sector. The correlation findings, which can be characterized as significant and from which we can get an idea about the direction of the relationship, were found with low frequency in 2007 and 2024. When the direction of the arrows is analyzed in both of these

years, it is observed that the direction of the arrows is upward and to the right. In 2008, the global financial crisis and in 2024, factors such as high inflation, political uncertainties and earthquakes disrupted the Phillips curve relationship. This emphasizes that the Turkish economy is vulnerable to external shocks and internal structural problems. Therefore, since the relationship between the CPI, which is calculated with the prices of the service sector, and the general unemployment rate is positive, there is evidence that the Phillips curve is invalid in both periods.

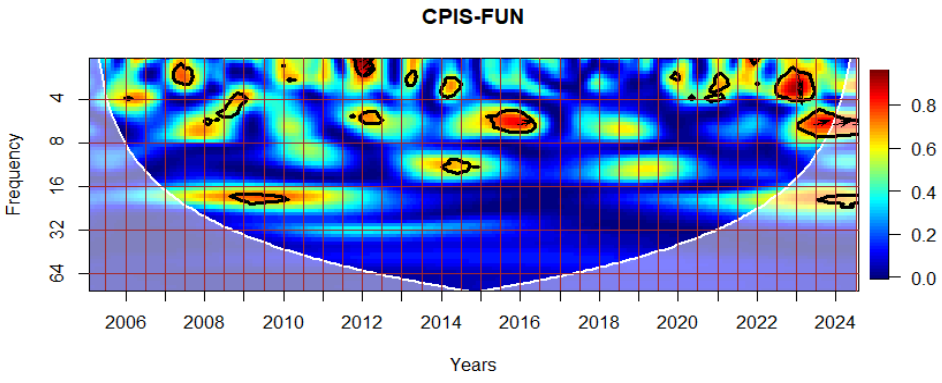
Figure 8: WTC Analysis of CPIS and MUN Series



Source: Author's own study.

Figure 8 shows the relationship between the CPI calculated with service sector prices and the male unemployment rate. When the figure is analyzed, there are two significant relationships with the direction of the arrows. In 2007, when the direction of the arrow points upwards in the low-frequency relationship, there is evidence that the Phillips curve is not valid for 2007, but in 2013, when the direction of the arrows points downwards and to the left in the low-frequency relationship, there is a negative relationship between the CPI calculated with prices of services and the male unemployment rate. Therefore, it is understood that the Phillips curve is valid between these two variables in 2013.

Figure 9: WTC Analysis of CPIS and FUN Series



Source: Author's own study.

Figure 9 shows the relationship between CPI inflation in services prices and the female unemployment rate. Significant relationships that provide information about the direction of the relationship emerge in 2012, 2016, 2023 and 2024. When the relationship in these years is analyzed, the fact that the direction of the arrows point upwards and to the right in the low-frequency significant relationships in 2012, 2016 and 2024 means a positive relationship between the variables, and there is evidence that the Phillips curve is invalid. However, in the low frequency significant relationship in 2023, the arrows point downwards. Therefore, since there is a negative

relationship between the variables at low frequency only in 2023, there is evidence that the Phillips curve is valid.

5. Conclusion and Policy Recommendations

In this study, the validity of the Phillips curve is investigated by using the general, male and female unemployment rates, CPI, CPI in goods prices and CPI in services prices for the Turkish economy covering the period 2005:1-2024:8. When the results of the analysis are evaluated in general, it is found that the Phillips curve is not valid for the Turkish economy. Significant relationships were found between CPI and CPI with goods prices and female unemployment rates, but since the direction of the arrows could not be determined exactly, no conclusions could be drawn about the validity of the Phillips curve. In this study, the Phillips curve is found to be valid between CPI and general unemployment rates in 2006 and 2009, between CPI with goods prices and general and male unemployment rates in 2013, and finally between CPI with services prices and male unemployment rates in 2013 and female unemployment rates in 2023. These results show how economic fluctuations and structural changes affect the Phillips curve relationship in Türkiye in 2006, 2009, 2013 and 2023. Therefore, it is concluded that the Phillips curve in the Turkish economy is valid only in some years and invalid when analyzed in general. These analysis results support the studies of Zayed et al. (2018), Alıcı (2021) and Bükey and Kalkan (2024).

When the significant relationships obtained as a result of the analysis are evaluated, it is found that there is a more intense positive relationship between male unemployment rate and CPI and between general and male unemployment rates and CPI calculated with prices of goods variables in the Turkish economy. Therefore, the overall study provides evidence that the Phillips curve is not valid for male unemployment rates and the Phillips curve is not valid between the CPI based on prices of services and female unemployment rates in the Turkish economy, and it is concluded that policies aimed at consumers' demands do not affect male and female unemployment rates. Therefore, when determining inflation policies, attention should be paid to policies that may overlap with employment policies.

Policymakers should also focus on supply-side policies, such as tax cuts and incentives for technological innovation, and structural reforms, such as increasing labor market flexibility and introducing vocational training programs. These policies can help lower inflation and reduce unemployment by boosting output. The Central Bank's ability to keep inflation expectations under control by implementing transparent and credible monetary policies can also help stabilize the Phillips curve in the long run. In the case of the Phillips curve in the Turkish economy, when unemployment rates are high and inflation rates are low, policymakers can reduce unemployment rates by increasing the amount of demand through expansionary policies, but this may cause inflation rates to rise. Conversely, when inflation rates are high and unemployment rates are low, contractionary policies can reduce inflation rates by reducing the amount of demand, but this may increase unemployment. Moreover, wage policies can prevent inflation from rising by keeping wage increases under control, or reduce unemployment by encouraging wage increases. Therefore, employment and inflation policies should be evaluated independently of each other. Finally, this study examines the validity of the Phillips curve using general, male and female unemployment rates and CPI, CPI measured by goods prices and CPI measured by services prices. In future studies, in order to contribute to the literature, the validity of the Phillips curve in other sectors such as agriculture and industry can be examined by including male and young female unemployment rates in the analysis.

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