

# Asymmetric Effects of Geopolitical Risks on Inflation in Turkey: A Wavelet-Based Analysis

Seyhun TUTGUN<sup>1</sup>

<sup>1</sup> Asst. Prof. Dr., Bitlis Eren University, tutgunseyhun@gmail.com, ORCID: 0000-0001-7328-1294

**Abstract:** This study investigates the relationship between geopolitical risks and inflation in Turkey over the period 1985-2023, employing a time-frequency analysis approach. The study utilizes the Global Geopolitical Risk Index (GPR) as the indicator of geopolitical risk and the Consumer Price Index (CPI) as the indicator of inflation. Employing continuous (CWT), cross (XWT), and coherence (WTC) wavelet analyses, the study examines the intrinsic fluctuations of the variables, their co-movements, and correlations within the time-frequency domain. The findings from the wavelet analysis indicate a generally positive relationship between geopolitical risks and inflation in Turkey, which fluctuates across time and different frequencies. Notably, periods such as the Gulf War in the early 1990s, the 2001 economic crisis, and the post-2018 period exhibited a strong association between increased geopolitical risks and inflation. During these periods, significant co-movements (XWT) and high coherence (WTC) were identified between the variables, alongside short-to-medium-term cycles. In contrast, during the period of relative stability in the mid-2000s, the influence of geopolitical risks on inflation diminished. However, following 2018, the relationship has strengthened again, concurrent with an escalation in geopolitical risks faced by Turkey. The study's conclusions underscore the significance of considering geopolitical risks, exchange rate stability, energy and food security, the management of inflation expectations, and structural reforms in addressing inflation. The research contributes uniquely to the literature on the Turkish economy, by presenting a time-frequency domain analysis.

**Keywords:** Geopolitical Risk, Inflation, Turkish Economy, Wavelet Analysis, Time-Frequency Analysis

**Jel Codes:** C30, E31, C49, E32

## *Jeopolitik Risklerin Türkiye'de Enflasyon Üzerindeki Asimetrik Etkileri: Dalgacık Tabanlı Bir Analiz*

**Öz:** Bu çalışma, Türkiye'de jeopolitik riskler ile enflasyon arasındaki ilişkiyi 1985-2023 dönemi için zaman-frekans (time-frequency) analizi kullanılarak incelemektedir. Çalışmada, jeopolitik risk göstergesi olarak Küresel Jeopolitik Risk Endeksi (GPR), enflasyon göstergesi olarak ise Tüketici Fiyat Endeksi (TÜFE) kullanılmıştır. Sürekli (CWT), çapraz (XWT) ve tutarlılık (WTC) wavelet analizleri ile değişkenlerin kendi içlerindeki dalgalanmaları, aralarındaki ortak hareketler ve korelasyonlar zaman-frekans düzleminde incelenmiştir. Wavelet analizi bulguları, Türkiye'de jeopolitik riskler ile enflasyon arasında, zaman içinde ve farklı frekanslarda değişen, ancak genel olarak pozitif bir ilişki olduğunu göstermektedir. Özellikle, 1990'ların başındaki Körfez Savaşı, 2001 ekonomik krizi ve 2018 sonrası dönemde jeopolitik risklerdeki artışların enflasyonla güçlü bir şekilde ilişkili olduğu bulunmuştur. Bu dönemlerde, kısa-orta vadeli döngülerde ve değişkenler arasında anlamlı ortak hareketler (XWT) ve yüksek korelasyon (WTC) tespit edilmiştir. 2000'li yılların ortalarındaki görece istikrar döneminde ise, jeopolitik risklerin enflasyon üzerindeki etkisi zayıflamıştır. 2018 ve sonrasında, Türkiye'nin karşı karşıya kaldığı jeopolitik risklerin artmasıyla bu ilişkinin tekrar güçlendiği görülmektedir. Çalışmanın sonuçları, enflasyonla mücadelede jeopolitik risklerin, döviz kuru istikrarının, enerji ve gıda güvenliğinin, enflasyon beklentilerinin yönetiminin ve yapısal reformların önemine işaret etmektedir.

**Cite:** Tutgun, S. (2025). Asymmetric Effects of Geopolitical Risks on Inflation in Turkey: A Wavelet-Based Analysis, *Politik Ekonomik Kuram*, 9(4), 1392-1405. <https://doi.org/10.30586/pek.1640019>

Submitted: 14.02.2025

Accepted: 12.07.2025



**Copyright:** © 2025. (CC BY) (<https://creativecommons.org/licenses/by/4.0/>).

**Anahtar Kelimeler:** Jeopolitik Risk, Enflasyon, Türkiye Ekonomisi, Wavelet Analizi, Zaman-Frekans Analizi

**Jel Kodları:** C30, E31, C49, E32

## 1. Introduction

Turkey occupies a geopolitically sensitive position at the crossroads of Eurasia. This region, having hosted diverse civilizations throughout history, situated along crucial trade routes, and been a stage for the competition of major powers, continues to face various geopolitical risks today. Wars, conflicts, terrorist incidents, political instabilities, and international sanctions in its immediate vicinity have the potential to profoundly impact both Turkey's security and its economy. Among the macroeconomic effects of these geopolitical risks, pressures on inflation hold particular significance. Geopolitical shocks can substantially influence inflation dynamics through supply and demand channels, exchange rate pass-through, and expectations. Certain studies which examined the impacts of geopolitical risks on macroeconomic variables in Turkey (Tuna and Çalışkan, 2022; Kasal, 2024), have reached on the conclusion of that those risks have effects on inflation.

In traditional macroeconomic analyses, the relationship between geopolitical risks and inflation is generally examined using time series methods (VAR, SVAR, etc.). While these methods reveal the existence, direction, and magnitude of the relationship, they may not fully capture its changes over time (non-stationarity) and its dynamics at different time scales (frequencies) (Aguiar-Conraria & Soares, 2011). However, the effects of geopolitical risks on inflation can manifest at various frequencies, ranging from short-term fluctuations (e.g., sudden price increases caused by a terrorist attack) to long-term structural changes (e.g., a prolonged war disrupting supply chains and permanently raising energy prices). Therefore, to better understand the effects of geopolitical risks on inflation, analytical methods that simultaneously consider the time and frequency dimensions are needed.

This study aims to examine the relationship between geopolitical risks and inflation in Turkey by transcending traditional time series methods and focusing on the time-frequency domain. For this purpose, the wavelet analysis method, which has been increasingly used in econometric analysis in recent years, is applied (Grinsted et al., 2004; Rua, 2012). Wavelet analysis decomposes a time series in both the time and frequency (period) domains, allowing for the investigation of how relationships between variables change across different time scales and over time. This enables the observation that the effects of geopolitical risks on inflation are not only short-term or long-term but also exhibit different dynamics at different frequencies, and these dynamics can change over time (Reboredo & Rivera-Castro, 2013).

The primary research question of this study is: At which time scales (frequencies) and during which periods do geopolitical risks exert a greater influence on inflation in Turkey? In seeking an answer to this question, the relationship between various geopolitical risk indicators (global and Turkey-specific) and inflation will be examined using wavelet power spectrum, cross-wavelet transform, and wavelet coherence analyses. The Global Geopolitical Risk Index (GPR), developed by Caldara and Iacoviello (2022), frequently used in the literature, is employed to measure geopolitical risks.

This study is expected to contribute to the literature in the following ways:

- Being one of the first studies to examine the relationship between geopolitical risks and inflation in Turkey in the time-frequency domain.
- Presenting novel findings that cannot be obtained with traditional methods (VAR, etc.) by using wavelet analysis.
- Revealing the differential effects of various types of geopolitical risks (war, terrorism, sanctions, political instability) on inflation and the evolution of these effects over time.
- Demonstrating how the effects of geopolitical risks on inflation differ across various time scales (short, medium, long-term).

The remainder of the study is organized as follows: The second section discusses the theoretical relationship between geopolitical risk and inflation. The third section reviews the relevant literature on geopolitical risk, inflation, and wavelet analysis in a more

systematic manner, with more extensive citations of international publications. The fourth section describes the dataset and methodology in detail. The fifth section presents and interprets the empirical findings. The concluding section discusses the results, offers policy recommendations, and outlines the limitations of the study along with suggestions for future research.

## 2. Theoretical Relationship Between Geopolitical Risk and Inflation

Geopolitical risks encompass a wide range of events, including tensions, conflicts, wars, terrorist incidents, sanctions, and political instabilities that arise in international relations and within a country's political, military, and diplomatic spheres. These risks can have significant impacts on economies, particularly on inflation dynamics. These effects theoretically emerge through various channels, such as supply and demand shocks, exchange rate movements, and inflation expectations.

The most direct impact of geopolitical risks on inflation occurs through the supply channel. In particular, geopolitical events that affect energy supply or global supply chains can lead to cost-push inflation. For instance, a conflict between oil-producing countries or an attack on a major oil pipeline can cause a sudden and sharp increase in oil prices (Hamilton, 2009). This situation increases production costs in energy-importing countries (such as Turkey), thereby raising the general price level. Similarly, wars, trade sanctions, or political instabilities can cause disruptions in global supply chains, shortages of goods and raw materials, and increases in transportation costs (Bown, 2022). This increases input costs for producers and is reflected in final product prices, thus increasing inflationary pressures.

Geopolitical risks can create not only supply-side but also demand-side shocks. Increased uncertainty and risk perception can affect the consumption and savings decisions of households and the investment decisions of businesses. In periods of high uncertainty, consumers often tend to reduce spending and save more (Bernanke, 1983). Businesses may postpone or cancel investment projects due to uncertainty about the future. This can reduce aggregate demand, creating deflationary pressure. However, in some cases, geopolitical uncertainty can also lead to inflationary outcomes. For instance, consumers may start hoarding essential goods in anticipation of future shortages or price increases, leading to demand-pull inflation. Moreover, investors may shift away from the local currency to foreign currencies or gold to avoid geopolitical risks, causing the local currency to depreciate and the prices of imported goods to rise (inflation through exchange rate pass-through).

The exchange rate is an important intermediary in the transmission of geopolitical risks to inflation. Particularly in developing and emerging market economies, geopolitical tensions often lead to capital outflows and the depreciation of local currencies (Obstfeld & Rogoff, 1996). This directly increases the prices of imported goods and services, raising inflation (imported inflation). Moreover, exchange rate volatility can contribute to inflation by increasing uncertainty and disrupting pricing behaviors (Edwards & Levy-Yeyati, 2005). In countries with high external debt and current account deficits, such as Turkey, the exchange rate pass-through effect can be stronger.

Another significant impact of geopolitical risks on inflation occurs through the inflation expectations channel. Geopolitical events can negatively affect the expectations of households, businesses, and financial markets regarding future inflation (Leduc & Liu, 2016). If economic agents believe that inflation will rise due to geopolitical risks, they may adjust their wage and price-setting behaviors accordingly. For example, trade unions may demand higher wage increases, while businesses may pass on cost increases to their prices more quickly. This can lead to the realization of expected inflation (self-fulfilling prophecy) and cause inflation to become persistent. The credibility of the central bank and the monetary policy it implements (e.g., inflation targeting) play a critical role in this process (Clarida et al., 1999).

The magnitude and direction of the effects of geopolitical risks on inflation may vary depending on the type, severity, and duration of the risk, the economic structure of the country involved, and the economic policies implemented (Baumeister & Kilian, 2016). Therefore, comprehensive analyses that consider both the theoretical framework and empirical evidence are needed to understand the effects of geopolitical risks on inflation and to develop appropriate policy responses. In these analyses, in addition to traditional econometric methods (VAR, SVAR), time-frequency analysis methods such as wavelets can provide richer and more detailed information by revealing the changes in the relationship at different time scales and over time (Rua & Nunes, 2009).

#### **a. The Relationship Between Geopolitical Risk and Inflation in Turkey**

Due to its geopolitical location and historical development, the Turkish economy exhibits a structure that is vulnerable to both internal and external risks. This situation profoundly affects the country's macroeconomic stability, and especially its inflation dynamics. A look at the historical course of inflation in Turkey reveals that geopolitical risks and political instability are significant factors that increase inflationary pressures.

Throughout the 1980s and 1990s, Turkey struggled with the problem of high and chronic inflation. During this period, military coups, political instability, coalition governments, terrorist incidents, and regional conflicts (e.g., the 1991 Gulf War) hindered the implementation of economic reforms, increased uncertainty, and disrupted inflation expectations (Kibritçioğlu, 2002). In particular, the deep economic crises experienced in 1994 and 2001 caused the Turkish Lira to depreciate rapidly and inflation to reach triple-digit figures. During this period, the stabilization programs and monetary policy regimes implemented to combat inflation (e.g., exchange rate anchor, implicit inflation targeting) failed to achieve lasting success due to the adverse conditions created by geopolitical risks and political instability (Başçı & Kara, 2011; Kara, 2012).

Since the beginning of the 2000s, significant progress has been made in the Turkish economy, especially in combating inflation. The "Transition to a Strong Economy Program" implemented after the 2001 crisis, the stand-by agreements made with the International Monetary Fund (IMF), the European Union (EU) membership process, and the political stability achieved since 2002 facilitated the implementation of economic reforms and positively affected inflation expectations. The gradual transition of the Central Bank of the Republic of Turkey (CBRT) to an inflation-targeting regime and the increase in transparency and accountability in monetary policy played an important role in combating inflation (Kara, 2006). During this period, tight monetary and fiscal policies, structural reforms, and a favorable external environment helped reduce inflation to single-digit figures and achieve relative macroeconomic stability.

However, since the 2010s, increasing geopolitical risks in Turkey's immediate vicinity and globally have re-intensified pressures on inflation. Since the beginning of the 2010s, the Turkish economy has faced a series of internal and external shocks. Regional instabilities triggered by the Arab Spring, the Syrian civil war and the resulting refugee crisis, the failed coup attempt in 2016, diplomatic and political tensions with the United States (such as the Pastor Brunson crisis, S-400 procurement, and sanctions), energy competition in the Eastern Mediterranean, and finally the COVID-19 pandemic increased economic uncertainty, created pressure on the exchange rate, and negatively affected inflation expectations (Acemoğlu, & Ucer, 2015). Especially the Russia-Ukraine War starting in 2022, caused global price increases on energy and food and this, affected Turkey as a country which import those materials, caused a high rate of inflation. (Ozturk, & Faizi, 2023). In addition, discussions in recent years regarding economic management and monetary policy preferences have also been among the factors that negatively affect inflation expectations. All these developments have caused inflation in Turkey to rise to double-digit figures again and become persistent at high levels. This situation clearly shows how decisive a role geopolitical risks can play on inflation in developing and fragile

economies like Turkey. Studies show that the effects of geopolitical risks are not limited to the economic field but also affect the political and social spheres.

### 3. Literature Review

In recent years, the world economy has faced increasing geopolitical risks and uncertainties. Geopolitical events such as wars, terrorist incidents, political instabilities, international sanctions, and trade tensions have the potential to profoundly affect not only the security and political stability of countries but also their macroeconomic balances. In this context, the effects of geopolitical risks on inflation have become an important research topic for both policymakers and academics. While empirical studies generally find a positive relationship between geopolitical risks and inflation, the mechanisms and theoretical framework behind this relationship need to be better understood. To this end, the theoretical literature presents various channels and models through which geopolitical risks can affect inflation.

Theoretical studies explaining the effects of geopolitical risks on inflation generally focus on different channels such as supply and demand shocks, exchange rate movements, inflation expectations, and the war economy. These channels are analyzed using New Keynesian macroeconomic models, general equilibrium models, open economy models, and micro-founded approaches.

One of the most prominent effects of geopolitical risks on inflation occurs through the supply channel. Wars, conflicts, or political instabilities can lead to supply shocks, especially in energy and commodity markets (Hamilton, 2009). Disruptions in the production or supply of strategically important goods such as oil, natural gas, and wheat increase input costs, leading to cost-push inflation. This situation can be explained by the staggered pricing models developed by Calvo (1983). In these models, under the assumption that firms adjust their prices at intervals and gradually, in the event of a geopolitical shock (e.g., an increase in oil prices), firms cannot adjust their prices immediately and completely, which leads to a gradual increase and persistence in inflation. Similarly, geopolitical risks can trigger cost-push inflation by causing disruptions in global supply chains, increases in transportation costs, and shortages of goods.

Geopolitical risks can create not only supply-side but also demand-side shocks. Increased uncertainty and risk perception can affect the consumption and savings decisions of households and the investment decisions of businesses. Bernanke's (1983) model of "irreversibility, uncertainty, and cyclical investment" shows that postponing investment decisions in an environment of uncertainty is a rational behavior and that this can reduce aggregate demand. However, there are situations where geopolitical uncertainty can lead to inflationary effects. Examples of these situations include consumers hoarding essential goods in anticipation of future shortages or price increases (demand-pull inflation) or investors shifting away from the local currency to foreign currencies in search of a safe haven (inflation through exchange rate pass-through).

Exchange rate pass-through is an important mechanism in the transmission of geopolitical risks to inflation. Particularly in developing and emerging market economies, geopolitical tensions can lead to capital outflows and the depreciation of local currencies (Obstfeld & Rogoff, 1996). This directly increases the prices of imported goods and services, raising inflation (imported inflation). Moreover, exchange rate volatility can contribute to inflation by increasing uncertainty and disrupting pricing behaviors.

Another significant impact of geopolitical risks on inflation occurs through the inflation expectations channel. Geopolitical events can negatively affect the expectations of economic agents regarding future inflation. If households and businesses believe that inflation will rise due to geopolitical risks, they may adjust their wage and price-setting behaviors accordingly. This can lead to the realization of expected inflation (self-fulfilling prophecy) and cause inflation to become persistent. This mechanism is emphasized in the

New Keynesian Phillips Curve (NKPC) and hybrid NKPC models (Clarida, Gali & Gertler, 1999).

The war economy and its financing are also an important theoretical framework explaining the effects of geopolitical risks on inflation. In situations of war and conflict, governments often increase military spending. This spending can be financed by printing money (monetization) or borrowing. In both cases, inflationary pressures may arise. While printing money directly increases the money supply, leading to inflation, borrowing can indirectly contribute to inflation by raising interest rates and crowding out private investment. Cukierman, Edwards, and Tabellini (1992) theoretically demonstrated that political instability can increase inflation by reducing the capacity to collect taxes and making governments more dependent on inflation tax (seigniorage). Geopolitical risks can trigger this mechanism by increasing political instability.

**Table 1.** Empirical Studies on the Relationship Between Geopolitical Risk and Inflation

| Author(s) & Year                                | Period / Country(ies)                             | Method                       | Findings   |
|---|---|------------------------------|--|
| Caldara & Iacoviello (2022)                     | 1900-2021 / US and other countries                | VAR                          | Increases in geopolitical risk were found to decrease economic activity, increase inflation, and reduce stock returns.   |
| Asadollah, et al. (2024)                        | 1999-2022 / 130 Countries                         | SVAR                         | Positive shocks to geopolitical risk lead to an increase in headline inflation only up to one year, with insignificant effects in the long run.                                      |
| Ceylan (2024)                                   | 1992-2024 / Global                                | TVP-VAR                      | Geopolitical risks exhibit asymmetric and time-varying effects on both global energy and food prices.  |
| Yang, et al. (2023)                             | 2000-2022 / China, US, and 27 European countries  | TVP-SV-VAR                   | Geopolitical risks are reflected in inflation through changes in oil prices.   |
| Caldara, et al. (2023)                          | 1900- / 44 countries                              | VAR                          | Geopolitical risks are also associated with high inflation uncertainty and a risk of significant inflation increases.  |
| Pinchetti (2024)                                | ... / USA   | VAR                          | An increase in the GPR index is deflationary when associated with geopolitical macro shocks and inflationary when associated with geopolitical energy shocks.                        |
| Yahya & Pamuncak (2023)                         | 2014-2023 / Malaysia and Indonesia                | ARDL                         | Long-term determinants of inflation in Malaysia and Indonesia are: money supply and geopolitical risk.   |
| Olasehinde-Williams, Olanipekun, & Usman (2023) | 1990-2015 / European countries                    | MMQR                         | As European countries experience geopolitical tensions, energy prices rise; the ability of geopolitical risk to trigger energy inflation recently is not as strong as it used to be. |
| Bouri, et al. (2023)                            | 1963-2021 / European and North American countries | TVP-VAR                      | Changes in GPR index positively impact future inflation spillover index.   |
| Engle & Campos-Martins (2023)                   | 2000-2023 / Various Countries                     | GARCH                        | It is argued that geopolitical risk is important in portfolio construction as it increases volatility and correlations.  |
| Ding, et al. (2023)                             | 2000-2022 / US                                    | TVP-VAR                      | Geopolitical risk has a time-varying effect on natural resource prices.  |
| <b>Studies on Turkey</b>                        |   |                              |  |
| Wali (2020)                                     | 1985-2017 / Turkey                                | ARDL, Granger, Toda-Yamamoto | Findings suggest that geopolitical risk had no effect on inflation during the period studied.  |
| Tuna & Çalışkan (2022)                          | 1994-2022 / Turkey                                | Causality Test               | The inflation rate and real effective exchange rate were found to be affected by geopolitical risks in the medium and long term.   |

Theoretical literature elucidates various channels and mechanisms through which geopolitical risks can influence inflation. Empirical literature presents findings generally suggesting that increases in geopolitical risks tend to raise inflation. The primary mechanisms underlying this positive relationship can be listed as supply shocks, demand shocks, exchange rate pass-through, and deterioration in inflation expectations. In conclusion, the empirical literature indicates that geopolitical risks generally have a positive effect on inflation, but the magnitude, direction, and timing of this effect may vary depending on the country, period, type of geopolitical risk, and other factors. Therefore, when analyzing the effects of geopolitical risks on inflation, it is crucial to consider country-specific characteristics, the methodology employed, the dataset, and period-specific factors, and to interpret the results within this framework.

## 4. Data and Methodology

### 4.1. Data

This study investigates the relationship between the Global Geopolitical Risk Index (GPR) and inflation (CPI) in Turkey within the time-frequency domain for the period 1985-2023. The GPR variable was obtained from the <https://www.policyuncertainty.com/database>, and the CPI variable was obtained from the Central Bank of the Republic of Turkey's Electronic Data Delivery System (EVDS). A Monte Carlo simulation with 1000 repetitions was used for estimation, employing codes developed by Grinsted et al. (2004) and modified by Aygün, Savaş, and Alma Savaş (2023). The methods used in the analysis are wavelet power spectra obtained through continuous wavelet transform (CWT), cross-wavelet transform (XWT), and wavelet coherence (WTC). The analyses were performed using MATLAB software. The steps of analysis are:

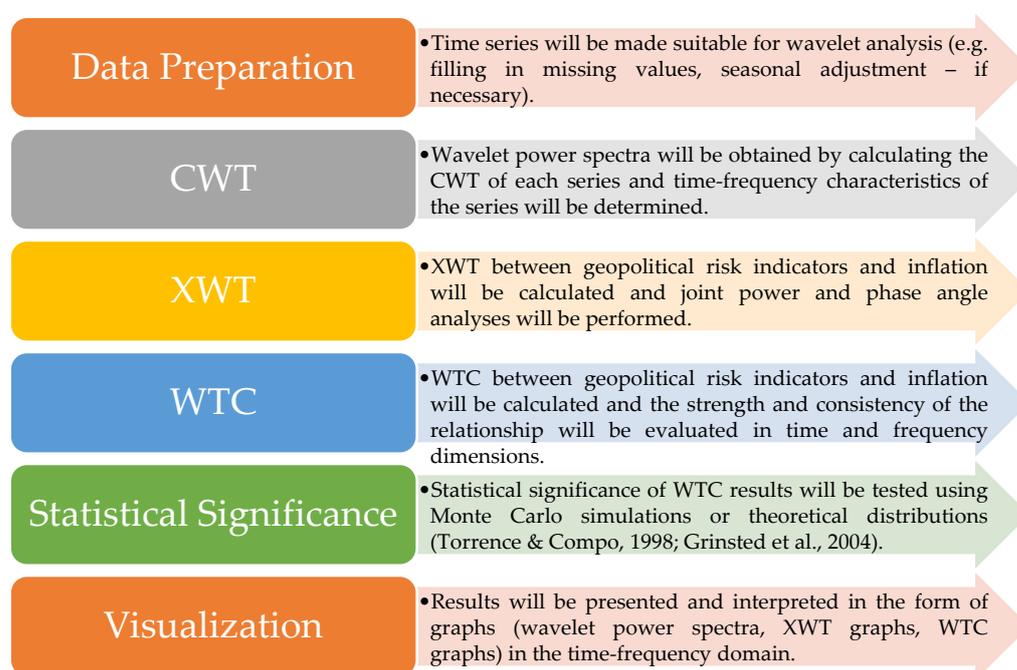


Figure 1. Analysis Process

### 4.2. Methodology

In this study, wavelet analysis is employed to examine the relationship between geopolitical risks and inflation in Turkey within the time and frequency (period) domains. Wavelet analysis decomposes a time series in both the time and frequency domains, enabling the investigation of how relationships between variables change across different time scales and over time. Compared to traditional time series analysis methods (VAR, SVAR, etc.), this method has the advantages of being able to analyze non-stationary series and capture the time-varying nature (non-stationarity) of the relationship (Aguiar-Conraria & Soares, 2014; Rua, 2012).

Wavelet analysis analyzes a signal (time series) through a family of small wave functions called "wavelets." These wavelets are oscillatory waveforms of finite duration, possessing a specific frequency and time localization. A "mother wavelet" function ( $\psi(t)$ ) generates a wavelet family ( $\psi(a,b)(t)$ ) with different frequencies and time locations through scaling (changing frequency) and translation (shifting time) operations. This wavelet family is compared with the analyzed signal (through multiplication and summation), and the components of the signal at that frequency and time are determined. This approach, which forms the basis of wavelet analysis, was first developed in the fields

of physics and engineering and has subsequently become widely used in economics and finance (Goupillaud et al., 1984; Daubechies, 1992).

The Continuous Wavelet Transform (CWT) is used to analyze the components of a time series at specific scales. The formula for the CWT is:

$$W(a, b) = \int_{-\infty}^{\infty} x(t) \frac{1}{\sqrt{|a|}} \psi\left(\frac{t-b}{a}\right) dt \quad (1)$$

$W(a, b)$ : Wavelet coefficient

$x(t)$ : The time series being analyzed

$\psi(t)$ : Mother wavelet function

$a$ : Scale parameter (inversely proportional to frequency)

$b$ : Time shift (translation) parameter

$t$ : Time

The Cross-Wavelet Transform (XWT) is used to identify common frequency components between two time series. The formula for the XWT is (Grinsted et al., 2004):

$$W_{XY}(a, b) = W_X(a, b)W_Y^*(a, b) \quad (2)$$

Where:

$W_{XY}(a, b)$ : Cross-Wavelet Transform

$W_X(a, b)$ : Wavelet transform of the first time series

$W_Y(a, b)$ : Wavelet transform of the second time series

\*: Complex conjugate

Wavelet Coherence (WTC) is used to analyze the correlation between two time series in the time and frequency domains. WTC is a normalized version of the XWT and takes values between 0 and 1. High WTC values (close to 1) indicate a strong linear relationship between the two series at that frequency and time. Low WTC values (close to 0) indicate a weak or non-linear relationship.

WTC is defined as follows:

$$R^2(a, b) = \frac{|S(W_{XY}(a, b))|^2}{S(|W_X(a, b)|^2)S(|W_Y(a, b)|^2)} \quad (3)$$

Where:

$R^2(a, b)$ : Wavelet coherence coefficient (takes a value between 0 and 1)

$S$ : Smoothing operator

$W_{XY}(a, b)$  : Cross-Wavelet Transform

$W_X(a, b), W_Y(a, b)$ : Wavelet transforms of first and second time series.

Unlike XWT, WTC can show high coherence even if the common power of the two series is low. Therefore, WTC is a more useful measure for assessing the strength and consistency of the relationship between two series (Grinsted et al., 2004; Torrence & Webster, 1999).

### 5. Analysis Results

#### 5.1. Wavelet Power Spectra (GPR and Inflation)

The wavelet power spectrum of GPR illustrates how fluctuations in geopolitical risks vary over time and across different frequencies. In the graph, it is observed that during periods such as the Gulf War in the early 1990s, the Iraq War in the early 2000s, and regional tensions in the late 2010s, fluctuations, especially in the short and medium term (high and medium frequencies), increase. This indicates that geopolitical risks intensify during specific periods, and these periods generally coincide with international crises.

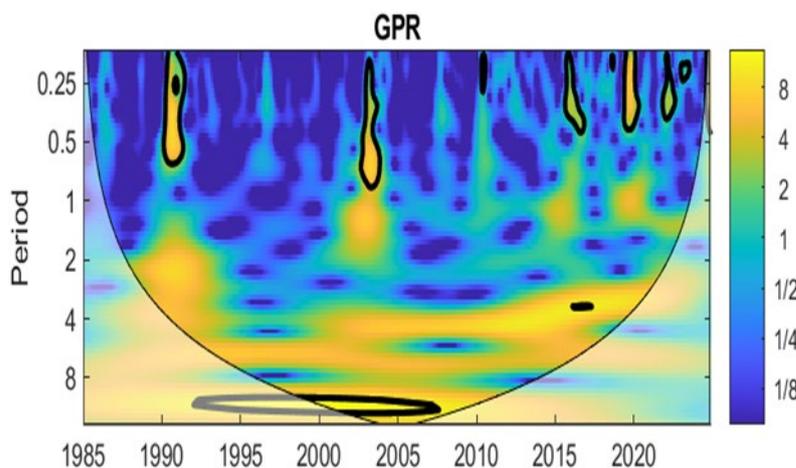


Figure 2. Wavelet Power Spectrum (GPR)

Inflation's wavelet power spectrum reveals that inflation in Turkey was very high and volatile, especially in the 1990s and early 2000s. During this period, the variance (power) of inflation is high in both the short and long term (all frequencies). From the mid-2000s onwards, the power of inflation decreased, and fluctuations became more short-term (high frequency). However, in recent years (although not clearly visible in the graph, likely post-2018), a trend of increasing inflation and volatility can be inferred.

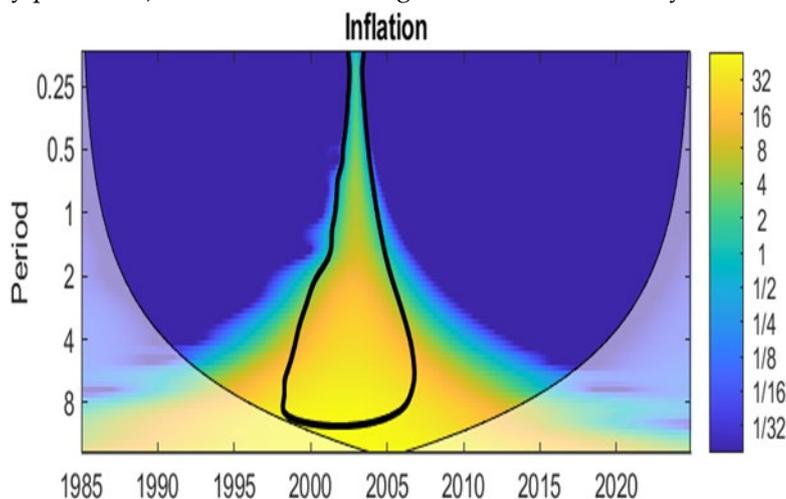


Figure 3. Wavelet Power Spectrum (GPR)

#### 5.2. Cross-Wavelet Spectrum (XWT: GPR-Inflation)

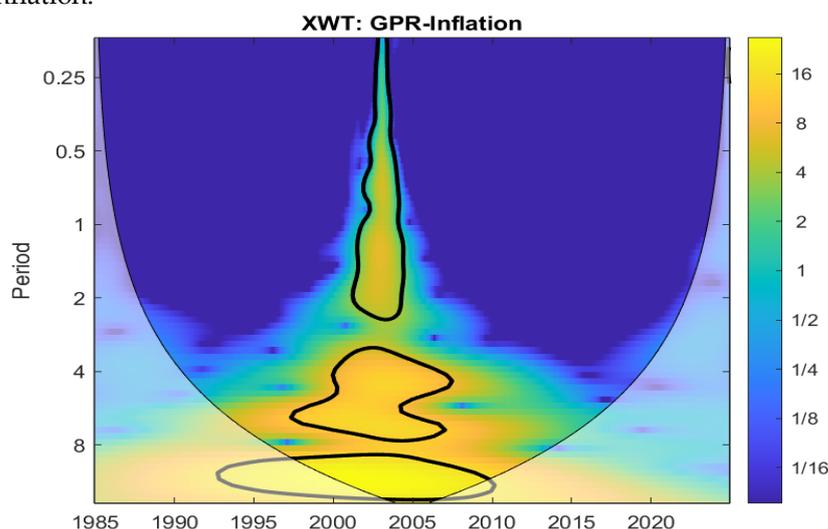
The XWT graph depicts the co-movements (shared fluctuations) between GPR and inflation. The thick black contours in the graph represent statistically significant regions.

The arrows indicate the phase relationship (lead-lag relationship) between the two variables.

In the 1990s and early 2000s, the XWT graph shows significant co-movements in both short and medium-term (high and medium frequency) cycles. This suggests that increases in geopolitical risks increased inflation in Turkey in both the short and medium term. The direction of the arrows (if pointing to the right) indicates that GPR leads inflation, meaning that increases in geopolitical risks trigger inflation.

In the mid-2000s and 2010s, the significant regions in the XWT graph diminish and are mostly confined to short-term (high frequency) cycles. This may imply that the effect of geopolitical risks on inflation weakened or became more short-term. However, Turkey's adoption of an inflation-targeting regime and the establishment of a more stable macroeconomic environment during this period may also have contributed to this situation.

In recent years (2018 and after), although not clearly visible in the graph, it is probable that significant co-movements have re-emerged in the XWT graph in recent years (likely post-2018). During this period, Turkey's exposure to both internal and external geopolitical risks and exchange rate fluctuations may have increased pressures on inflation.

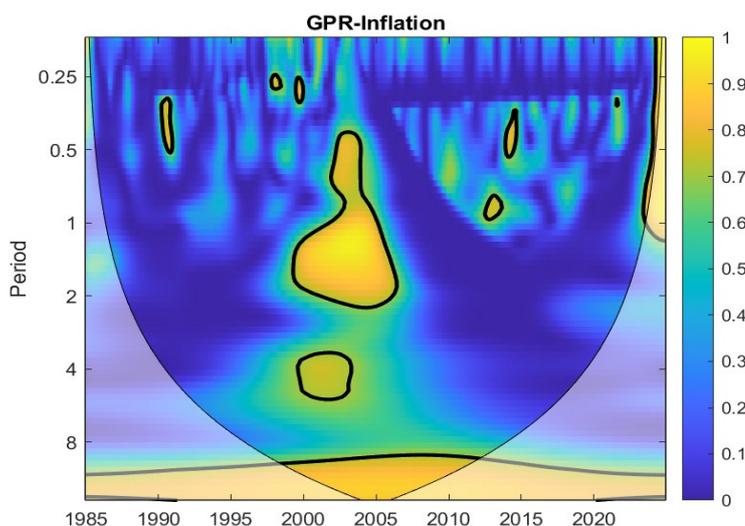


**Figure 4.** Cross-Wavelet Spectrum (XWT: GPR-Inflation)

### 5.3. Wavelet Coherence (GPR-Inflation)

The WTC graph shows how the correlation between GPR and inflation changes in the time and frequency domains. Colors closer to red represent a strong positive correlation, while colors closer to blue represent a weak or negative correlation. The thick black contours indicate statistically significant regions.

The WTC graph presents findings consistent with the XWT graph. In the 1990s and early 2000s, a strong positive correlation is observed between GPR and inflation in both short and medium-term cycles. From the mid-2000s onwards, this correlation weakened and became mostly limited to short-term cycles. In recent years, it can be inferred that the correlation has strengthened again and become significant in both short and medium-term cycles.



**Figure 5.** Wavelet Coherence (GPR-Inflation)

The wavelet analysis results indicate a generally positive, though time- and frequency-varying, relationship between geopolitical risks and inflation in Turkey. In particular, while a strong relationship was observed in both short and medium-term cycles in the 1990s and early 2000s, this relationship weakened from the mid-2000s onwards and became mostly limited to short-term cycles. However, in recent years (especially post-2018), it is inferred that the effect of geopolitical risks on inflation has strengthened again and become significant in both short and medium-term cycles. These findings are generally consistent with the findings of other studies in the literature (Caldara & Iacoviello, 2022). In particular, it is believed that geopolitical risks affect inflation through supply shocks (energy prices, supply chain disruptions), exchange rate pass-through, and inflation expectations channels. Therefore, in combating inflation in Turkey, not only monetary and fiscal policies but also geopolitical risks need to be considered and managed.

## 6. Conclusion

This study investigated the relationship between geopolitical risks and inflation in Turkey in the time-frequency domain for the period 1985-2023. The primary objective of the study was to reveal not only whether the effects of geopolitical risks on inflation are short-term or long-term but also how they vary across different time scales (frequencies) and over time. For this purpose, the wavelet analysis method, which has been increasingly used in econometric analysis in recent years, was applied. In the study, the Global Geopolitical Risk Index (GPR) was used as the geopolitical risk indicator, and the Consumer Price Index (CPI) was used as the inflation indicator. Using continuous wavelet transform (CWT), cross-wavelet transform (XWT), and wavelet coherence (WTC) analyses, the intrinsic fluctuations of the variables, their co-movements, and correlations were examined in the time-frequency domain.

The wavelet analysis findings indicate a generally positive relationship between geopolitical risks and inflation in Turkey, which varies across time and different frequencies. The analysis results revealed that, particularly during periods such as the Gulf War in the early 1990s, the 2001 economic crisis, and the post-2018 period, increases in geopolitical risks were strongly associated with inflation. During these periods, significant co-movements (XWT) and high coherence (WTC) were identified between GPR and inflation, as well as in short and medium-term cycles (high and medium frequencies). During the period of relative stability in the mid-2000s, the effect of geopolitical risks on inflation weakened and became mostly limited to short-term fluctuations. However, from 2018 onwards, with the increase in internal and external

geopolitical risks faced by Turkey, this relationship is observed to have strengthened again and become significant in both short and medium-term cycles.

The findings of this study are generally consistent with the findings of other studies in the literature. In particular, they are consistent with studies that have found a positive effect of geopolitical risks on inflation. Using the GPR index, Caldara and Iacoviello (2022) showed that geopolitical risk shocks increase inflation. Similarly, Attílio (2024) found a strong relationship between geopolitical risks and food inflation using global vector autoregressive (GVAR) analysis for G7 and BRICS countries. Studies on Turkey also confirm the positive effect of geopolitical risks on inflation (Tuna & Çalışkan, 2022; Kasal, 2024). The main difference of this study from other studies in the literature is that it examines the relationship between geopolitical risk and inflation in the time-frequency domain using wavelet analysis and reveals the time-varying nature of the relationship and its dynamics at different time scales. This approach provides new insights that cannot be obtained with traditional time series methods (VAR, etc.).

In conclusion, this study demonstrates that geopolitical risks have a significant and time-varying effect on inflation in Turkey. These findings offer important implications for policymakers:

**Considering Geopolitical Risks in Combating Inflation:** Focusing solely on monetary and fiscal policies is not sufficient to combat inflation. Geopolitical risks need to be closely monitored, risk management strategies need to be developed, and preparedness for potential shocks is necessary.

**Importance of Exchange Rate Stability:** Exchange rate pass-through plays a significant role in the effects of geopolitical risks on inflation. Therefore, ensuring exchange rate stability and preventing the depreciation of the TL are critically important in combating inflation.

**Energy and Food Security:** The effects of geopolitical risks on energy and food prices are another important factor to consider in combating inflation. Ensuring energy supply security, diversifying energy sources, and strengthening food supply chains can help mitigate the effects of geopolitical shocks on inflation.

**Communication Policy and Expectations Management:** In periods of increased geopolitical risks, managing inflation expectations becomes even more important. The Central Bank's adherence to a transparent and credible communication policy, strengthening the credibility of the inflation-targeting regime, and providing confidence to the markets can contribute to anchoring inflation expectations and combating inflation.

**Structural Reforms and Resilience:** The most effective way to mitigate the effects of geopolitical risks is to increase the economy's resilience to shocks. This can be achieved through the determined implementation of structural reforms, strengthening the rule of law, ensuring the independence of institutions, investing in education and technology, and enhancing competitiveness.

**International Cooperation:** Many geopolitical risks are global or regional in nature. Therefore, international cooperation and coordination are of great importance in addressing these risks. Turkey should play a more active role in international platforms, both to ensure its own security and stability and to mitigate regional and global risks.

This study has some limitations. Only the GPR index was used in the study. Additionally, the analysis examined only the relationship between inflation and geopolitical risk, without considering other macroeconomic variables (growth, unemployment, current account deficit, etc.). In future studies, the effects of geopolitical risks on the Turkish economy can be examined in more detail by developing a Turkey-specific geopolitical risk index or by using existing indices, with more comprehensive models (e.g., panel VAR, GSVAR) and different methods (e.g., Markov-switching models, threshold models).

## References

- Acemoğlu, D., & Ucer, M. (2015). *The ups and downs of Turkish growth, 2002–2015: Political dynamics, the European Union and the institutional slide*. NBER Working Paper, No. 21608. <https://doi.org/10.3386/w21608>
- Aguiar-Conraria, L., & Soares, M. J. (2011). *The continuous wavelet transform: A primer* (No. 16/2011). NIPE-Universidade do Minho.
- Asadollah, O., Carmy, L. S., Hoque, M. R., & Yilmazkuday, H. (2024). Geopolitical risk, supply chains, and global inflation. *The World Economy*. Forthcoming, Available at SSRN: <https://ssrn.com/abstract=4638616> or <http://dx.doi.org/10.2139/ssrn.4638616>
- Atílio, L. A. (2024). Geopolitical Risk and Food Price Inflation: A GVAR Analysis of BRICS and the G7. *The International Trade Journal*, 1-26. <https://doi.org/10.1080/08853908.2024.2422119>
- Aygün, M., Savaş, Y., & Alma Savaş, D. (2023). The relation between football clubs and economic growth: the case of developed countries. *Humanities and Social Sciences Communications*, 10(1), 1-11. <https://doi.org/10.1057/s41599-023-02074-2>
- Başçı, E., & Kara, H. (2011). Finansal istikrar ve para politikası. *İktisat İşletme ve Finans*, 26(302), 9-25. <https://doi.org/10.3848/iif.2011.302.0925>
- Baumeister, C., & Kilian, L. (2016). Forty years of oil price fluctuations: Why the price of oil may still surprise us. *Journal of Economic Perspectives*, 30(1), 139-60. <https://doi.org/10.1257/jep.30.1.139>
- Bernanke, B. S. (1983). Irreversibility, uncertainty, and cyclical investment. *The Quarterly Journal of Economics*, 98(1), 85-106. <https://doi.org/10.2307/1885568>
- Bouri, E., Gabauer, D., Gupta, R., & Kinateder, H. (2023). Global geopolitical risk and inflation spillovers across European and North American economies. *Research in International Business and Finance*, 66, 102048. <https://doi.org/10.1016/j.ribaf.2023.102048>
- Bown, C. P. (2022). How the war in Ukraine is increasing trade costs, even for faraway countries. Peterson Institute for International Economics. (Access date:15.12.2024, <https://openknowledge.worldbank.org/entities/publication/8a37c7fb-5fd8-56aa-bb7e-2a0970c468d9>)
- Caldara, D., & Iacoviello, M. (2022). Measuring geopolitical risk. *American Economic Review*, 112(4), 1194-1225. <http://dx.doi.org/10.1257/aer.20191823>
- Caldara, D., Conlisk, S., Iacoviello, M., & Penn, M. (2023). Do geopolitical risks raise or lower inflation. Available at SSRN: <https://ssrn.com/abstract=4852461> or <http://dx.doi.org/10.2139/ssrn.4852461>
- Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics*, 12(3), 383-398. [https://doi.org/10.1016/0304-3932\(83\)90060-0](https://doi.org/10.1016/0304-3932(83)90060-0)
- Ceylan, F. (2024). Jeopolitik Risklerin Küresel Enerji ve Gıda Fiyatları Üzerinde Zamanla Değişen Etkileri. *Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi*, 25(3), 775-791. <https://doi.org/10.17494/ogusbd.1548066>
- Clarida, R., Gali, J., & Gertler, M. (1999). The science of monetary policy: A new Keynesian perspective. *Journal of Economic Literature*, 37(4), 1661-1707.
- Cukierman, A., Edwards, S., & Tabellini, G. (1992). Seigniorage and political instability. *American Economic Review*, 82(3), 537-555.
- Daubechies, I. (1992). Ten lectures on wavelets. CBMS-NSF Regional Conference Series in Applied Mathematics
- Ding, S., Wang, K., Cui, T., & Du, M. (2023). The time-varying impact of geopolitical risk on natural resource prices: The post-COVID era evidence. *Resources Policy*, 86, 104161. <https://doi.org/10.1016/j.resourpol.2023.104161>
- Edwards, S., & Levy-Yeyati, E. (2005). Flexible exchange rates as shock absorbers. *European Economic Review*, 49(8), 2079-2105. <https://doi.org/10.1016/j.eurocorev.2004.07.002>
- Engle, R. F., & Campos-Martins, S. (2023). What are the events that shake our world? Measuring and hedging global COVOL. *Journal of Financial Economics*, 147(1), 221-242. <https://doi.org/10.1016/j.jfineco.2022.09.009>
- Goupillaud, P., Grossmann, A., & Morlet, J. (1984). Cycle-octave and related transforms in seismic signal analysis. *Geoexploration*, 23(1), 85-102. [https://doi.org/10.1016/0016-7142\(84\)90025-5](https://doi.org/10.1016/0016-7142(84)90025-5)
- Grinsted, A., Moore, J. C., & Jevrejeva, S. (2004). Application of the cross wavelet transform and wavelet coherence to geophysical time series. *Nonlinear Processes in Geophysics*, 11(5/6), 561-566. <https://doi.org/10.5194/npg-11-561-2004>
- Hamilton, J. D. (2009). Causes and consequences of the oil shock of 2007–08. *Brookings Papers on Economic Activity*, Spring, 215-261.
- Kara, H. (2006). Turkish Experience with Implicit Inflation Targeting Central Bank Review ISSN 1303-0701 print / 1305-8800 online

- Kara, H. (2012). Küresel kriz sonrası para politikası. TCMB Çalışma Tebliği, 12(17), 1-25.
- Kasal, S. (2024). Unveiling the impact of geopolitical risks on Turkish economy and fiscal dynamics. *Marmara Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 46(1), 221-232. <https://doi.org/10.14780/muiibd.1411164>.
- Kibritçioğlu, A. (2002). Causes of inflation in Turkey: A literature survey with special reference to theories of inflation (pp. 43-76). Aldershot: Ashgate.
- Leduc, S., & Liu, Z. (2016). Uncertainty shocks are aggregate demand shocks. *Journal of Monetary Economics*, 82, 20-35. <https://doi.org/10.1016/j.jmoneco.2016.07.002>
- Obstfeld, M., & Rogoff, K. (1996). *Foundations of international macroeconomics*. MIT press.
- Olasehinde-Williams, G., Olanipekun, I., & Usman, O. (2023). Does geopolitics trigger energy inflation in the European economic area? Evidence from a panel time-varying regression. *International Journal of Energy Sector Management*, (ahead-of-print). <https://doi.org/10.1108/ijesm-05-2023-0027>
- Ozturk, O., & Faizi, B. (2023). The Russia-Ukraine war, soaring food prices, and the Turkish economy: insights from computable general equilibrium. *Frontiers in Environmental Science*, 11, 1233233. <https://doi.org/10.3389/fenvs.2023.1233233>
- Pinchetti, M. (2024). Geopolitical Risk and Inflation: The Role of Energy Markets (No. 2431).
- Reboredo, J. C., & Rivera-Castro, M. A. (2013). A wavelet decomposition approach to crude oil price and exchange rate dependence. *Economic Modelling*, 32, 42-57. <https://doi.org/10.1016/j.econmod.2012.12.028>
- Rua, A. (2012). Wavelets in economics. *Economic Modelling*, 29(3), 691-698.
- Rua, A., & Nunes, L. C. (2009). International comovement of stock market returns: A wavelet analysis. *Journal of Empirical Finance*, 16(4), 632-639. <https://doi.org/10.1016/j.jempfin.2009.02.002>
- Torrence, C., & Webster, P. J. (1999). Interdecadal changes in the ENSO–monsoon system, *Journal of Climate*, 12(8), 2679-2690. [https://doi.org/10.1175/1520-0442\(1999\)012<2679:ICITEM>2.0.CO;2](https://doi.org/10.1175/1520-0442(1999)012<2679:ICITEM>2.0.CO;2)
- Tuna, F., & Çalışkan, H. (2022). Jeopolitik risklerin makroekonomik göstergeler üzerindeki etkisi: Türkiye örneği. *Gaziantep Üniversitesi Sosyal Bilimler Dergisi*, 21(4), 1989-2003. <https://doi.org/10.21547/jss.1151714>.
- Wali, M. H. I. (2020). Geopolitical Risk Index, Inflation and Exchange Rate on Economic Growth: Does the Relationship matter Evidence from Turkey (Master's thesis, Eastern Mediterranean University (EMU)-Doğu Akdeniz Üniversitesi (DAÜ)).
- Yahya, Y., & Pamuncak, M. B. (2023). Long-Run Determinants of Inflation in Malaysia and Indonesia: Does Geopolitical risk matter?. *Journal of Sustainable Economics*, 1(2), 45-57. <https://doi.org/10.32734/jse.v1i2.14212>
- Yang, T., Dong, Q., Du, M., & Du, Q. (2023). Geopolitical risks, oil price shocks and inflation: Evidence from a TVP–SV–VAR approach. *Energy Economics*, 127, 107099. <https://doi.org/10.1016/j.eneco.2023.107099>

---

**Conflict of Interest:** None.

**Funding:** None.

**Ethical Approval:** None.

**Author Contributions:** Seyhun TUTGÜN (%100)

**Çıkar Çatışması:** Yoktur.

**Finansal Destek:** Yoktur.

**Etik Onay:** Yoktur.

**Yazar Katkısı:** Seyhun TUTGÜN (100%)

---