

Research Article / Araştırma Makalesi

**UNCOVERING THE ASYMMETRIC EFFECTS OF INVESTOR
SENTIMENT, SOVEREIGN CREDIT RISK, AND COMMODITY RETURNS
ON BORSA ISTANBUL: A NOVEL MULTIVARIATE WAVELET-
QUANTILE APPROACH***

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ABSTRACT

This study examines the effects of investor sentiment (VIX), sovereign credit risk (CDS), the exchange rate (USD/TRY), and Brent crude oil returns on BIST 100 returns across different investment horizons and quantile levels, while controlling for the remaining macro-financial factors. Using daily data from January 2, 2015, to January 29, 2026, the analysis employs the Multivariate Wavelet Quantile Regression (MWQR), Wavelet Quantile Regression (WQR), and Wavelet Quantile Granger Causality (WQGC) approaches developed by Adebayo (2025). The findings reveal substantial heterogeneity in the effects of macrofinancial variables on BIST 100 returns across market regimes and investment horizons. Increases in USD/TRY, VIX, and CDS are associated with strong negative effects on BIST 100 returns, particularly over short-term horizons and in lower market quantiles. By contrast, Brent crude oil returns exert a positive and statistically significant effect on BIST 100 returns, especially over medium- and long-term horizons after controlling for the other macrofinancial variables. The WQGC results further indicate strong short-term causal linkages from USD/TRY, VIX, and CDS to BIST 100 returns. In contrast, the causal influence of Brent crude oil is relatively limited in the short term but becomes more pronounced over medium- and long-term horizons. Overall, the findings suggest that maintaining macrofinancial stability, containing sovereign risk, and strengthening investor confidence are particularly important for supporting the resilience of the Turkish equity market across different market regimes and investment horizons.

Keywords: *Different Investment Horizons, Investor Sentiment, MWQR, Borsa Istanbul, Exchange Rate*

JEL Classification: *G11, G15, C22*

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YATIRIMCI DUYARLILIĞI, KREDİ RİSK PRİMİ VE EMTİA GETİRİLERİNİN BORSA İSTANBUL GETİRİLERİ ÜZERİNDEKİ ASİMETRİK ETKİLERİNİN ORTAYA ÇIKARILMASI: YENİ ÇOK DEĞİŞKENLİ WAVELET-KANTİL YAKLAŞIMI

ÖZET

Bu çalışma, Borsa İstanbul (BIST 100) getirileri üzerinde yatırımcı duyarlılığı (VIX), ülke kredi risk primi (CDS), döviz kuru (USD/TRY) ve Brent petrol getirilerinin etkilerini, diğer ortak değişkenleri kontrol ederek farklı yatırım ufukları ve kantil düzeylerinde incelemektedir. Bu amaçla, 02.01.2015-29.01.2026 dönemine ait günlük veriler kullanılarak Adebayo (2025) tarafından geliştirilen Çok Değişkenli Wavelet Kantil Regresyonu (MWQR), Wavelet Kantil Regresyonu (WQR) ve Wavelet Kantil Granger Nedensellik (WQGC) yöntemleri uygulanmıştır. Bulgular, makro-finansal değişkenlerin BIST 100 getirileri üzerindeki etkilerinin homojen olmadığını, piyasa rejimi ve yatırım ufukuna bağlı olarak farklılaştığını göstermektedir. USD/TRY, VIX ve CDS primlerindeki artışlar, özellikle kısa vadede ve düşük piyasa kantillerinde BIST 100 getirileri üzerinde güçlü ve negatif etkilere sahiptir. Buna karşılık, Brent petrol getirilerinin diğer makro-finansal faktörler kontrol edildiğinde özellikle orta ve uzun vadede BIST 100 getirileri üzerinde pozitif ve istatistiksel olarak anlamlı etkiler belirlenmiştir. WQGC sonuçları, USD/TRY, VIX ve CDS ile BIST 100 getirileri arasındaki nedenselliğin kısa vadede güçlü olduğunu; Brent petrolün etkisinin ise kısa vadede sınırlı kalırken orta ve uzun vadede anlamlı hâle geldiğini göstermektedir. Genel olarak bulgular; makro-finansal istikrarın korunmasının, ülke riskinin kontrol altında tutulmasının ve yatırımcı güveninin pekiştirilmesinin, farklı piyasa rejimleri ve yatırım ufuklarında Türk hisse senedi piyasasının dayanıklılığını desteklemek açısından özellikle önemli olduğunu göstermektedir.

Anahtar Kelimeler: Farklı Yatırım Ufukları, Yatırımcı Duyarlılığı, MWQR, Borsa İstanbul, Döviz Kuru
JEL Sınıflandırması: G11, G15, C22

1. Introduction

The process of financial liberalization and globalization, which gained momentum from the 1980s onward, largely eliminated the boundaries between national markets by removing restrictions on capital movements and deepening financial integration. However, this increased integration has strengthened interdependence across markets, rendering developing economies more vulnerable to global shocks and external risks (Akgüneş, 2023; Aydın, 2025; Sarıtaş & Nazlıoğlu, 2019; Sever, 2025). The global risk environment—initially triggered by the COVID-19 pandemic in 2020, further intensified by the 2022 Russia-Ukraine War and the 2023 Israel-Palestine conflict, and subsequently compounded by escalating US-China trade tensions and geopolitical frictions between Israel and Iran by 2025—have transformed uncertainty from a temporary cyclical fluctuation into a structural phenomenon (Altemur & Kurt Cihangir, 2025; Aydoğdu, 2025; Aydın, 2025; Bekereci et al., 2025; Gülcemal, 2025; Tuncay, 2025). This “multiple-crisis” environment has reinforced the interaction between the real economy and financial markets through supply chain disruptions and energy price shocks, significantly increasing the sensitivity of asset pricing mechanisms to uncertainty. The elevated level of uncertainty has also altered investor behavior. As risk perception intensifies, portfolio strategies are rebalanced; investors tend to shift away from risky assets toward perceived safe instruments during periods of heightened uncertainty. In this context, the impact of macro-financial shocks on emerging

stock markets, such as the Istanbul Stock Exchange, particularly during episodes of heightened capital volatility, often does not follow a linear pattern. Rather, these effects vary asymmetrically over time depending on the prevailing market regime, volatility conditions, and shifts in risk perception. Therefore, understanding the multifaceted effects of macro-financial shocks on financial markets is crucial for maintaining financial stability, accurately identifying market vulnerabilities, and designing effective risk management strategies (Akgüneş, 2023; Kök & Nazlıoğlu, 2020; Tufaner, 2021; Tuncay, 2025).

In developing economies such as Türkiye, which are highly sensitive to global capital movements, stock market performance cannot be explained solely by domestic factors such as firm profitability and balance sheet indicators; it is also strongly influenced by external financing conditions, the global liquidity cycle, and international risk appetite (Sever, 2025). High external financing needs, a structural savings gap, and a production structure dependent on energy imports render the Turkish economy relatively more vulnerable to global liquidity contractions and sudden capital outflows, as illustrated by its inclusion in the “Fragile Five” group (Bekereci et al., 2025; Sarı, 2024). For Türkiye, as a net energy importer, sudden and persistent increases in Brent oil prices—a key input in production costs—deteriorate the current account balance and exert downward pressure on macroeconomic stability through cost-driven inflation. These developments are transmitted to stock prices through adjustments in discount rates and revisions in profit expectations, particularly during periods of heightened uncertainty, thereby triggering asymmetric market responses (Aydın, 2025; Korkmaz & Başçı, 2023; Yavuz & Sağlam, 2020). In this context, volatility in sovereign CDS premiums, which reflect country credit risk and external borrowing costs, together with abrupt exchange rate fluctuations, emerges as a key stress indicator for both domestic and foreign investors (Topaloğlu et al., 2024; Tufaner, 2021). Increases in CDS premiums signal a deterioration in perceived country risk. They may lead to reversals in capital flows, while currency depreciation adds additional pressures on the financial system through balance-sheet and expectations channels. Moreover, increases in the VIX—widely regarded as a global uncertainty indicator and a proxy for investor sentiment—reshape portfolio allocation decisions by accelerating exits from risky assets, thereby intensifying selling pressure and volatility in the stock market (Aydın, 2025; Gürbüz, 2024). Therefore, examining the role of these risk factors in shaping the dynamics of the BIST 100 is critical for policymakers and investors seeking to preserve macroeconomic stability and financial market depth (Sever, 2025; Şahinler, 2025).

Studies examining the dynamics of financial markets indicate that the effects of global and domestic risk factors, as well as commodity prices, on the BIST vary depending on the nature of the variable and prevailing market conditions. The prevailing consensus in the literature suggests a strong and negative relationship between the VIX Index and the BIST 100 (Kaya, 2015; Kaya & Coşkun, 2015; Sarıtaş & Nazlıoğlu, 2019). This effect is reported to intensify and become more persistent during periods of global crises and heightened uncertainty, such as the COVID-19 pandemic (Aydın, 2025; Hatipoğlu & Tekin, 2017). In most studies, Türkiye’s sovereign CDS premiums emerge as a more dominant and negative determinant of stock market performance than global risk indicators. However, this relationship is shown to exhibit a heterogeneous structure depending on the prevailing risk regime, and evidence suggests the presence of bidirectional interactions between CDS premiums and the stock market (Altamur & Kurt Cihangir, 2025; Çetinkaya & Üçler, 2024; Sarpaca & Yenipazarlı, 2023; Şahinler, 2025;

Topaloğlu & Ege, 2020). Regarding the exchange rate-stock market nexus, the literature predominantly documents a negative relationship, largely attributed to the cost channel and heightened perceptions of financial instability. Nevertheless, several studies indicate that the impact of exchange rate shocks on the stock market is asymmetric, meaning that the magnitude of the response differs between positive and negative shocks (Kök & Nazlıoğlu, 2020; Özaydın, 2024; Tufaner, 2021). The effect of Brent oil prices represents one of the most complex and debated issues in the literature. Yavuz & Sağlam (2020) argue that oil price shocks have a strong, negative, asymmetric effect on the stock market. In contrast, some studies—such as Aktaş et al. (2018) and Güler & Nalın (2013)—report no statistically significant relationship between oil prices and the BIST 100 index or find that the effect remains limited (Korkmaz & Başçı, 2023). Conversely, Kakacak et al. (2020) identify a unidirectional causal relationship running from oil prices to the stock market. Moreover, recent evidence suggests that, particularly in the post-COVID-19 period, oil prices may move positively with the stock market due to the recovery in global demand, indicating that the relationship is time-varying and regime-dependent (Aydın, 2025; Bekereci et al., 2025). However, a substantial portion of the existing literature relies predominantly on linear econometric models (e.g., ARDL, VAR, VECM). While these approaches provide valuable insights, they may be insufficient to fully capture the nonlinear, regime-dependent, and time-varying dynamics of financial markets across different investment horizons and market conditions.

The heterogeneous findings reported in the existing literature, together with the limitations of traditional linear models in capturing the asymmetric and nonlinear dynamics of financial markets, necessitate a more comprehensive analytical framework. In this context, the primary objective of this study is to examine the effects of investor sentiment, sovereign credit risk premiums, exchange rates, and Brent oil prices on BIST 100 returns, while controlling for other common determinants, across different investment horizons and quantile levels of the return distribution. To this end, daily data spanning the period from January 2, 2015, to January 29, 2026, are employed. The analysis applies the Multivariate Wavelet Quantile Regression (MWQR) and Wavelet Quantile Regression (WQR) methods introduced by Adebayo et al. (2025), which enable the examination of relationships among variables within a multivariate framework across both time-frequency and quantile dimensions. Furthermore, to identify the direction and strength of causal linkages across different investment horizons and quantile levels, the Wavelet Quantile Granger Causality (WQGC) approach developed by Özkan et al. (2024) is incorporated into the empirical analysis. To the best of our knowledge, this study is the first to investigate the effects of these macro-financial risk indicators on BIST 100 returns using wavelet-filtered data within a joint time-frequency and quantile framework. By moving beyond conventional linear and single-dimensional approaches, the study contributes to the literature by providing a holistic assessment of the investment horizons and market conditions under which global and domestic risk factors, as well as commodity price movements, exert more pronounced effects on BIST 100 returns.

Furthermore, this study seeks to make three fundamental contributions to the literature by explicitly accounting for the complex, regime-sensitive nature of financial markets. First, it extends beyond conventional one-dimensional approaches by examining macro-financial effects not only through temporal dynamics but also simultaneously across different investment horizons and multiple quantiles of the return distribution. This integrated framework enables

the identification of whether risk factors generate short-term fluctuations or long-term structural effects, and how these effects vary across market regimes. Second, by evaluating investor sentiment, sovereign credit risk premiums, exchange rates, and oil prices within a unified multivariate framework, the study highlights the relative importance and interaction of external and domestic pressure channels affecting the BIST 100. Third, by testing whether the causal structure varies across different quantiles of the return distribution and across alternative investment horizons, the study challenges the implicit assumption that financial relationships are symmetric and time-invariant. This methodological framework facilitates more accurate modeling of the regime-dependent, fragile structure of the Istanbul Stock Exchange. The findings are expected to contribute to the development of dynamic risk management strategies for investors and to the conditional design of macroprudential policies for policymakers.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 introduces the dataset and outlines the econometric methodology. Section 4 presents the results of the preliminary diagnostic tests. Section 5 reports the empirical findings. Finally, Section 6 concludes and discusses policy implications.

2. Literature Review

The relationship between the BIST 100 and macro-financial and global risk indicators is a well-established and extensively researched topic in financial literature. Particular emphasis is placed on exchange rates, the VIX, sovereign credit default swap premiums and Brent oil prices. These variables influence equity markets via various channels, such as changes in the discount rate, shifts in risk perception, cost pressures and capital flow dynamics. Within this framework, numerous empirical studies have investigated the interactions between the BIST 100 and these macro-financial indicators. The present study systematically reviews the existing literature under four main categories. Specifically, contemporary empirical research examining the effects of exchange rates, the VIX, CDS premiums and Brent oil prices on the BIST 100 is presented below. The findings are assessed from a comparative perspective, taking into account differences in methodological approaches, sample periods and prevailing macroeconomic conditions.

2.1. Exchange Rate and BIST 100

The interaction between exchange rates and stock markets constitutes a fundamental research area in the macro-finance literature. It is generally acknowledged that exchange rate shocks—particularly in developing economies—affect stock prices through capital flow adjustments, changes in risk premiums, and firm-level profitability channels. However, empirical studies investigating the impact of the USD/TRY exchange rate on the BIST 100 index report heterogeneous findings regarding the direction, persistence, and dynamic structure of this relationship. The USD/TRY-BIST 100 nexus has largely been examined within the framework of linear econometric models. A substantial portion of the literature documents a negative impact of exchange rate depreciation on the BIST 100. For instance, Aktaş & Akdağ (2013), employing multiple linear regression and Granger causality analysis, find that increases in the USD/TRY exchange rate exert a statistically significant negative effect on the BIST 100 index. However, the absence of strong, unidirectional causality running from the exchange rate to the index suggests that the exchange rate effect is jointly determined with other macroeconomic variables. Similarly, Güngör & Polat (2020) show that exchange rate depreciation negatively

affects stock prices and that this effect is more pronounced than that of interest rates. Within an ARDL framework, Gürbüz (2024) reports that increases in the U.S. dollar exchange rate have a long-run negative effect on the BIST 100. Tufaner (2021) identifies unidirectional causality running from the exchange rate to the BIST 100 and argues that exchange rate increases heighten perceptions of financial fragility, thereby exerting downward pressure on the stock market. Conversely, several studies suggest that exchange rate depreciation may have a positive effect on the BIST 100, particularly in the long run. Gazel (2017), using the ARDL bounds testing approach, finds a negative short-run but positive long-run impact of the exchange rate on the BIST 100. Ünal et al. (2022) report a positive long-term relationship between the exchange rate and the BIST 100, while İlkan et al. (2022), employing the Maki cointegration test that accounts for structural breaks, document long-run co-movement between the USD/TRY rate and the BIST 100. Based on the Fourier Bootstrap ARDL results, Karaca (2024) concludes that exchange rate increases are associated with higher levels of the BIST 100. Similarly, Aydın (2025), using a time-varying parameter VAR (TVP-VAR) framework, demonstrates that the positive impact of exchange rate shocks strengthens, particularly in the post-2023 period. Yıldız (2025) further identifies a positive long-run effect of USD/TRY increases on the BIST 100 and reports bidirectional causality between the two variables. Studies emphasizing the asymmetric and conditional structure of the relationship provide additional insights. Boyacıoğlu et al. (2023), applying the Hatemi-J asymmetric causality test, show that negative shocks in the BIST 100 generate positive shocks in the exchange rate, while exchange rate shocks significantly affect positive movements in the stock market. Karaca (2024) also demonstrates that causality from the exchange rate to the BIST 100 emerges only in specific quantiles, highlighting distributional heterogeneity. Impulse-response analyses conducted by Güney & Saka Ilgın (2019) indicate that exchange rate shocks have a negative impact during the first five months, followed by a positive effect thereafter. Özmerdivanlı (2021), based on Johansen cointegration and VECM results, identifies bidirectional causality between the BIST 100 and the USD/TRY exchange rate. Şeker (2021) finds that the BIST 100 reacts negatively to short-term shocks in dollar-denominated yields, pointing to a substitution effect between the two markets. Finally, Çakar & Şahin (2025), using wavelet analysis, report a strong positive correlation between USD/TRY and the BIST 100, with exchange rate effects being more pronounced in short-term fluctuations and gradually weakening over medium and long-term horizons.

2.2. VIX and BIST 100

The VIX index, widely regarded as one of the primary indicators of global financial uncertainty, has generated extensive literature, particularly on its effects on emerging equity markets. By reflecting fluctuations in global risk appetite, the VIX plays a decisive role in externally financed markets such as the Istanbul Stock Exchange (BIST) through channels including capital flows, portfolio reallocation, and shifts in investor sentiment. Empirical studies examining the VIX-BIST 100 relationship yield rich and heterogeneous findings on the direction, persistence, asymmetry, causal structure, and time-varying nature of the relationship. Sarıtaş & Nazlıoğlu (2019), employing a VAR framework with impulse-response functions and variance decomposition analysis, demonstrate that VIX shocks exert a short-term negative effect on the BIST 100. Their variance decomposition results indicated that although the VIX helps explain fluctuations in the BIST 100, its explanatory power remains relatively limited. Similarly, İltaş & Güzel (2021), using both Toda-Yamamoto and Fourier Toda-Yamamoto causality tests that

account for structural breaks, identified unidirectional causality running from the VIX to the BIST 100, suggesting that the VIX serves as a leading indicator for the Turkish stock market. Kök & Nazlıoğlu (2020), applying the Hatemi-J asymmetric causality test, find significant asymmetric causality from positive VIX shocks to negative BIST 100 shocks, indicating that increases in global volatility exert stronger effects during bearish market conditions. In contrast, Han (2025) reports no significant relationship under symmetric testing procedures but identifies bidirectional causality under both positive and negative shocks within the asymmetric Hatemi-J framework. These findings imply the presence of feedback effects, whereby movements in the BIST 100 may also influence global risk perception. Using the ARDL bounds testing approach, Akgüneş (2021) documents a long-run relationship between the two variables, reporting that VIX exerts a negative short-term effect on the BIST 100 that gradually diminishes over the long term. Münyas (2022), employing the Bayer-Hanke cointegration test and a VECM specification, identifies cointegration between the VIX and emerging market equity indices and concludes that the BIST 100 is among the markets most sensitive to VIX shocks. This evidence underscores the high exposure of Turkish capital markets to shifts in global risk sentiment. Nevertheless, not all studies reach consistent conclusions. Özhan et al. (2023), based on VAR and Granger causality analyses, fail to detect statistically significant causality running from the VIX to the BIST 100. Although impulse-response functions reveal short-term negative reactions, the model's overall explanatory power remains weak, suggesting that the VIX effect may be sensitive to sample selection, seasonal factors, and model specification. More recent studies emphasize distributional and regime-dependent dynamics. Altınkeski et al. (2024), employing quantile-based correlation analysis, show that the VIX functions as a net risk transmitter in the global system, whereas many emerging markets—including the BIST 100—act as net risk absorbers. This effect intensifies during crisis episodes and bear market conditions. Similarly, Gülcemal (2025) finds, within a QVAR framework, that the BIST 100 behaves as a net shock absorber and exhibits heightened sensitivity to VIX-related shocks. The results indicate that while the VIX effect is dominant under normal market conditions, the joint impact of VIX and geopolitical risk shocks becomes more pronounced during bullish market phases. Finally, Karaçayır (2025), using wavelet coherence analysis, documents a strong and persistent negative relationship between the VIX and the BIST 100 across both short- and long-term horizons, confirming that increases in global volatility are associated with declines in the Turkish stock market.

2.3. CDS and BIST100

Five-year CDS premiums, widely regarded as key indicators of sovereign risk, are among the most important measures of financial fragility and external financing conditions, particularly in developing economies. An increase in CDS premiums signals a deterioration in country risk perception, potentially accelerating capital outflows, raising external financing costs, and exerting downward pressure on equity markets through these transmission channels. Accordingly, the relationship between CDS premiums and the BIST 100 index is particularly important in economies such as Türkiye, which are highly sensitive to external financing conditions and global capital flows. Empirical studies examining the CDS-BIST 100 nexus in the Turkish literature report heterogeneous—and at times contradictory—findings regarding the direction, persistence, volatility transmission mechanism, and causality structure of the relationship. Eren & Başar (2016), employing an ARDL bounds testing approach, document a negative short-run and positive long-run effect of CDS premiums on the BIST 100. Their findings suggest that while

rising CDS premiums exert downward pressure on equity prices in the short term by reflecting heightened risk perception, long-term financial adjustment mechanisms may partially offset this effect. Similarly, Topaloğlu & Ege (2020) identify, based on cointegration and causality analyses, a negative long-run relationship between CDS premiums and BIST 100 returns, along with unidirectional causality running from CDS to the stock market. In contrast, Demir & Dinç (2021) fail to detect a statistically significant causal link between CDS and the BIST 100, although they report that both variables significantly influence the exchange rate. Several studies support the mutual interaction hypothesis. Sarpaca & Yenipazarlı (2023), Gül et al. (2024), Sarı (2024), Tekin (2024), and Topaloğlu et al. (2024) report bidirectional causality between CDS premiums and the BIST 100. Notably, Tekin (2024) and Sarı (2024) emphasize that increases in the BIST 100 contribute to reductions in CDS premiums in the long run, suggesting that stock market performance may serve as a leading indicator shaping sovereign risk perception. Nonlinear and regime-sensitive approaches provide further insights. Özaydın (2024), using both linear and artificial neural network (ANN)-based Granger causality tests, identifies causality running from CDS premiums to the BIST 100 and argues that nonlinear models yield more comprehensive results. Similarly, Altemur & Kurt Cihangir (2025) employ the Quantile-on-Quantile Regression (QQR) framework and demonstrate that the impact of CDS premiums on BIST indices is heterogeneous and asymmetric across quantiles. While negative pricing pressure dominates at lower CDS levels, positive pricing dynamics emerge in certain sectors when CDS premiums are high, suggesting a nonlinear, regime-dependent relationship. Additional evidence highlights the importance of volatility transmission channels. Sever (2025), using both traditional and frequency-domain causality tests, identifies unidirectional causality from the BIST 100 to CDS premiums, implying that stock market dynamics can influence sovereign risk perceptions. Şahinler (2025) detected bidirectional causality in both mean and variance, whereas Sönmez et al. (2023) report unidirectional causality from CDS to the BIST 100 during periods of rising risk and document reciprocal volatility spillovers between the two markets. Their findings indicate that shocks in CDS premiums significantly increase stock market volatility. In contrast, Camgöz (2023) finds no significant volatility spillover from CDS premiums to the stock market but identifies volatility transmission in the opposite direction—from the stock market to CDS premiums. Önem (2022) reports unidirectional volatility spillovers from CDS to certain BIST sub-indices but does not find a significant contemporaneous correlation. Finally, Şeyranlioğlu & Çilek (2023) show that increases in CDS premiums are associated with declines in the BIST 100, underscoring the dominant role of the sovereign risk premium channel.

2.4. Oil and BIST 100

The interaction between oil prices and stock markets constitutes a key determinant of macro-financial stability, particularly in energy-importing economies. In countries with high energy dependence, such as Türkiye, fluctuations in oil prices may directly and indirectly influence the BIST 100 index through multiple channels, including production costs, inflation expectations, current account dynamics, sovereign risk premiums, and shifts in investor behavior. This multi-channel transmission mechanism indicates that the oil-stock market nexus exhibits a dynamic and conditional structure that extends beyond a simple price effect. Empirical studies investigating the oil-BIST 100 relationship in the Turkish literature report heterogeneous findings regarding the direction, persistence, asymmetry, causality structure, and time-frequency characteristics of the relationship. Yıldırım and Çekiç (2019) identified unidirectional causality from crude oil prices to the BIST 100 within a linear Granger causality framework; however,

their nonlinear causality tests revealed bidirectional interactions. Moreover, they document an asymmetric effect from the BIST 100 to oil prices during periods of negative stock returns. Similarly, Kakacak et al. (2020) and Korkmaz & Başcı (2023) report unidirectional causality from Brent oil prices to the BIST 100, although they emphasize that the presence and strength of long-run cointegration relationships vary across different sample periods. Yılmaz & Yüce Akıncı (2024), employing the Johansen cointegration test and VECM analysis, detect a long-run relationship and unidirectional causality running from oil prices to the BIST 100. In contrast, Tuna (2022) finds no significant causal relationship between oil prices and the BIST 100 during the COVID-19 period, arguing that the impact of oil shocks dissipated rapidly. These findings suggest that the oil-stock market relationship is highly sensitive to sample selection, structural breaks, and prevailing economic conditions. Nonlinear and regime-dependent approaches provide further insights into the asymmetric structure of the relationship. Yavuz & Sağlam (2020) report that increases in oil prices exert a strong, negative, asymmetric effect on the BIST 100, whereas decreases in oil prices do not generate effects of comparable magnitude. Bildirici et al. (2022), using an MS-GARCH copula-based causality approach, identify strong unidirectional causality from oil prices to the BIST 100 in both low- and high-volatility regimes and document a predominantly negative relationship. Hatipoğlu & Tekin (2017), using quantile regression, find that the impact of oil prices on the BIST 100 is generally limited and statistically significant only in the middle quantiles. Tuncay (2025), employing an NARDL framework, fails to detect long-run asymmetric cointegration between oil-related uncertainty and the BIST 100, concluding that the overall effects remain statistically weak. Taken together, these studies indicate that the oil-BIST 100 relationship is predominantly asymmetric and regime-dependent; however, evidence of a stable long-run structural linkage is not consistently supported across different periods. Wavelet-based studies incorporating the time-frequency dimension further reveal that the relationship varies across investment horizons. Özkan et al. (2025) document a strong, significant long-term relationship between crude oil volatility and the BIST 100, and note that the inclusion of geopolitical uncertainty strengthens this linkage. Bekereci et al. (2025), using wavelet coherence analysis, detect positive co-movement between oil prices and the BIST 100 in the short and medium term during the 2019-2021 period, while identifying a more complex dynamic structure as of 2023, with oil leading in the short term and equities leading in the medium term. Aydoğdu (2025), within a TVP-VAR extended connectedness framework combined with wavelet coherence analysis, shows that inter-market spillovers intensify during periods of heightened volatility. In particular, the BIST 100 emerges as a net shock transmitter, whereas Brent oil acts as a net shock absorber in the post-pandemic period. These findings suggest that the frequently cited unidirectional causality from oil to the stock market may reverse over time, highlighting the time-varying and regime-dependent nature of the relationship. Finally, data mining-based studies support the presence of concurrent movement patterns between oil prices and the BIST 100. Aydın & Gündoğdu (2024) and Can (2025) used association rule mining techniques to identify Brent oil as one of the key macro-financial variables co-moving with the BIST 100 at high confidence levels. Although these results point primarily to co-movement rather than causality, they reinforce the role of oil prices as an important accompanying indicator for the Turkish equity market.

In summary, the existing literature suggests that the relationships among USD/TRY, the VIX, sovereign CDS premiums, oil prices, and the BIST 100 exhibit cyclical, asymmetric, and investment horizon-dependent dynamics rather than a stable, fixed-coefficient linear structure. Nevertheless, a substantial portion of prior studies relies on mean-based linear models. Asym-

metric approaches are often confined to specific shock decompositions, while time-frequency analyses are typically evaluated using average correlation or coherence measures. Similarly, quantile-based methods are frequently implemented within a single time horizon or at a single frequency level. Consequently, studies that simultaneously examine the effects of these macro-financial risk indicators on BIST 100 returns within a multivariate framework—across both different quantiles of the return distribution and multiple investment horizons—remain relatively limited. Developing holistic, regime-sensitive methodological approaches capable of identifying the specific market conditions and frequency bands in which risk factors become more pronounced—particularly during periods of crisis and heightened uncertainty—has the potential to make substantial contributions to the literature. In this regard, advanced econometric techniques such as MWQR, WQR, and WQGC, which jointly model investment horizons and quantile levels, enable a more comprehensive assessment of the impact of macro-financial variables on BIST 100 returns. Accordingly, these approaches are expected to provide meaningful methodological and empirical contributions to the existing body of research.

3. Methods, Data, and Model

Prior to implementing the primary econometric techniques, a series of comprehensive preliminary analyses and diagnostic tests was conducted to examine the dataset's statistical properties, nonlinear characteristics, and heterogeneous dynamics across different market conditions. In this framework, the BDS test (Broock et al., 1996) was employed to detect nonlinear dependence in the time series, while Quantile-Quantile (Q-Q) plots were utilized to assess distributional features and tail behavior. The stationarity properties of the variables were examined using the Wavelet Quantile Augmented Dickey-Fuller (WQADF) and Wavelet Quantile Phillips-Perron (WQPP) unit root tests developed by Adebayo & Olanrewaju (2025), which explicitly account for multiple time-frequency dimensions. Compared to conventional unit root procedures, this wavelet-quantile framework provides a more flexible and comprehensive assessment by allowing the stationarity structure to vary across short-, medium-, and long-term horizons. Following the preliminary diagnostics, the MWQR model was estimated. To further validate the MWQR results and to explore asymmetric effects across distinct frequency bands in greater detail, the WQR approach was additionally implemented. Finally, the WQGC method developed by Özkan et al. (2024) was employed to assess causal linkages between the variables across both quantile levels and time-frequency domains.

3.1. Multivariate Wavelet Quantile Regression (MWQR)

In this study, the impact of financial stress and uncertainty indicators—specifically USD/TRY, VIX, CDS, and Brent oil—on BIST100 returns is empirically examined within a multivariate framework using the Multivariate Wavelet Quantile Regression (MWQR) methodology proposed by Adebayo et al. (2025). The MWQR framework is constructed as an integrated modeling structure that combines classical quantile regression, wavelet-based time-frequency decomposition, and the inclusion of relevant control variables. The theoretical foundation of the MWQR approach builds upon the conventional quantile regression model introduced by Koenker & Bassett (1978), originally formulated for a bivariate setting, and subsequently extended into a multivariate time-frequency context by Adebayo et al. (2025):

$$\phi_{\tau}(Y|X) = \beta_0(\tau) + \beta_1(\tau)X \quad (1)$$

Here, $\phi_\tau(Y/X)$ represents the conditional τ^{th} quantile of the dependent variable Y given the independent variable X . The parameter $\beta_0(\tau)$ denotes the quantile-specific intercept, while $\beta_1(\tau)$ captures the slope coefficient at quantile τ , reflecting the heterogeneous impact of X across different points of the conditional distribution of Y . Although conventional quantile regression provides valuable insights into distributional heterogeneity, it does not account for time-scale dynamics or frequency-specific variations (Magazzino & Giolli, 2021; Matar et al., 2021). To address this limitation, Adebayo & Özkan (2024) introduced the WQR framework, which integrates quantile regression with wavelet-based time-frequency decomposition. Unlike standard quantile regression, WQR simultaneously examines the influence of X on Y across both quantiles and different time horizons. Following Percival & Walden (2000), the Maximum Overlapping Discrete Wavelet Transform (MODWT) is employed to decompose both X and Y into scale-specific components. In this study, the least asymmetric Daubechies filter of length eight, LA(8), is adopted as the baseline specification due to its superior localization properties in economic time series. Let $X[i]$ denote a signal of length T , where $T=2^J$ for some integer J . Let $h_j[i]$ and $g_j[i]$ represent the scaling and wavelet filters, respectively. At the first decomposition level, $X[i]$ is convolved with $h_1[i]$ to obtain the approximation coefficients $\alpha_1[i]$, and with $g_1[i]$ to generate the detail coefficients $d_1[i]$ of length N . This multiscale decomposition process can be formally expressed as follows (Adebayo et al., 2025):

$$\alpha_1[i] = h_1[i] * s[i] = \sum_k h_1[i - k]s[k] \quad (2)$$

$$d_1[i] = g_1[i] * s[i] = \sum_k g_1[i - k]s[k] \quad (3)$$

A similar procedure is subsequently applied to the approximation coefficients $\alpha_1[i]$, using the rescaled filters $h_2[i]$ and $g_2[i]$, which are obtained through dyadic upsampling of the original level-one filters $h_1[i]$ and $g_1[i]$. This recursive filtering process is implemented iteratively across higher decomposition levels. For values of J from 1 to J_0-1 (where $J_0 < J$), the estimated coefficients are calculated as follows:

$$\alpha_{j+1}[i] = h_{j+1}[i] * \alpha_j[i] = \sum_k h_{j+1}[i - k] \alpha_j[i] \quad (4)$$

$$d_{j+1}[i] = g_{j+1}[i] * \alpha_j[i] = \sum_k g_{j+1}[i - k] \alpha_j[i] \quad (5)$$

Here, $\alpha_{j+1}[i]$, represents the approximate coefficients obtained at the $(j+1)$ level. $h_{j+1}(i)$ is the low-pass filter adjusted for the $(j+1)$ level. $\alpha_j(i)$ are the approximate coefficients at the j level. $d_{j+1}(i)$ represents the detail coefficients obtained at the $(j+1)$ separation level. $g_{j+1}(i)$ represents the high-pass filter at the $(j+1)$ level. $h_{j+1}(i) = U(h_j[i])$ and $g_{j+1}(i) = U(g_j[i])$, indicate that the filters used at each subsequent level are obtained by upsampling the previous h_j and g_j filters. Upsampling $U(.)$, where zeros are added between each pair of consecutive observations in the time series, doubles the effective length of the filter, making it suitable for use at the next decomposition level (Adebayo et al., 2025). After performing a J -level decomposition on Y and X and obtaining the corresponding detail coefficients, quantile regression is applied to the wavy detail pairs, $d_j^Y[.]$ ve $d_j^X[.]$, for all J levels. Therefore, the wavy quantile regression is

specified as follows:ail pairs, [.] ve , for all levels. Therefore, the wavy quantile regression is specified as follows:

$$\phi_{\tau}(d_j[Y] | d_j[X]) = \beta_0(\tau) + \beta_1(\tau)X \quad (6)$$

Here, $\phi_{\tau}(d_j[Y] | d_j[X])$ represents the conditional quantile of the j^{th} level decomposition of the dependent variable Y for a given quantile τ , provided the j^{th} level decomposition of the independent variable X . The wavelet detail coefficients of Y and X are denoted by $d_j[Y]$ and $d_j[X]$. The quantile τ can take values between 0 and 1, representing different quantiles of the response variable's distribution. $\beta_0(\tau)$ and $\beta_1(\tau)$ represent the intercept parameter of the regression model and the slope parameter associated with the independent variable X (Adebayo et al., 2025). WQR makes it possible to analyze how the effect of the independent variable X on the dependent variable Y changes across different quantiles. However, this approach has a structural limitation as it does not allow for the direct inclusion of control variables in the model. To overcome this limitation, the MWQR structure is extended by adding a set of control variables, denoted by Z , to the model. The MWQR model is expressed as follows (Adebayo et al., 2025):

$$\phi_{\tau}(d_j[Y] | d_j[X], d_j[Z]) = \beta_{0,j}(\tau) + \beta_{1,j}(\tau)d_j[X] + \beta_{2,j}(\tau).d_j[Z] \quad (7)$$

Here, $\phi_{\tau}(\cdot)$ is the conditional τ -quantile function. $d_j[Y] | d_j[X]$ and $d_j[Z]$ are the MOD-WT coefficients of X , Y , and Z at scale j . $\beta_{2,j}(\tau).d_j[Z]$ represents the inner product between the vector of control variable coefficients and the control vector at that scale, and $\beta_{1,j}(\tau)$ isolates the effect of X on Y at the τ -quantile and horizon j , keeping Z constant (Adebayo et al., 2025).

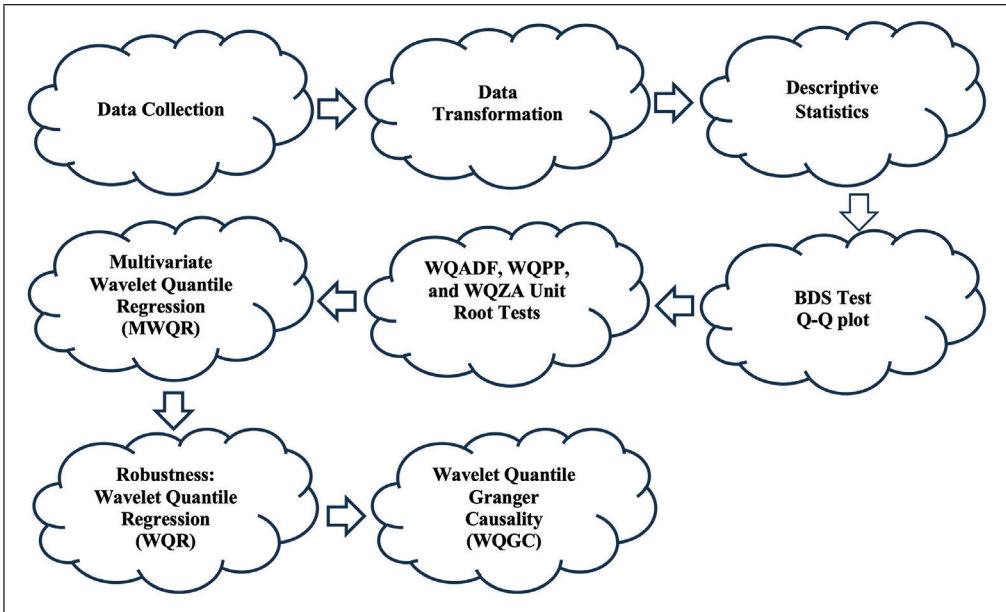
3.2. Wavelet Quantile Granger Causality

The novel Wavelet Quantile Granger Causality (WQGC) framework proposed by Özkan et al. (2024) enables the examination of causal linkages between variables across both time-frequency and quantile dimensions. Unlike Balcilar et al. (2016), which focus exclusively on the quantile domain, or Olayeni (2016), which concentrate solely on time-scale causality, the WQGC approach integrates these two perspectives within a unified modeling structure, thereby yielding a more comprehensive characterization of causal dynamics. More specifically, WQGC evaluates whether a potential Granger-causing variable exerts statistically significant effects on the conditional quantiles of the dependent variable across different time horizons. By combining wavelet decomposition with quantile-based causality testing, the method captures both distributional asymmetry and scale-dependent predictability. The implementation of the WQGC procedure proceeds in three sequential steps: Step 1. Both the dependent variable Y and the potential Granger-causing variable X are decomposed to the z level using MODWT. Step 2. Quantile (τ) series of each decomposition of the dependent variable Y , ranging from 0.05 to 0.95, are generated using the quantile method of Li et al. (2015). Step 3. Granger causality is applied using the optimal lag lengths (μ) determined by AIC for all VAR models generated between each quantile series of the decomposition of the dependent variable Y and the decomposition of the potential Granger causal variable X . These steps can be formulated as follows:

$$d_z[Y]_t^{\tau} = \partial_{z,\tau} + \sum_{u=1}^m \delta_{z,\tau,\mu} d_z[Y]_{t-\mu}^{\tau} + \sum_{u=1}^m \beta_{z,\tau,\mu} d_z[X]_{t-\mu}^{\tau} + \varepsilon_{t,z,\tau} \quad (8)$$

Here, $\partial_{z,\pi}$ represents the constant parameter in the τ^{th} conditional quantile and the z^{th} decomposition point. $d_z[Y]_{(t-\mu)}^{\tau}$ represents the π^{th} conditional quantile of the z^{th} decomposition of the dependent variable. $d_z[X]$, shows the Granger causal relationship of the predictor variable in the z^{th} decomposition. According to these protocols, the null hypothesis in the τ^{th} conditional quantile where $\beta_{z,\pi,\mu}$ is significantly different from zero is rejected. In this z^{th} decomposition, it is stated that the explanatory variable affects the response variable with Granger causality. Figure 1 illustrates the overall methodological framework employed in this study.

Figure 1: Methodological Process



Source: Author's computation.

In this study, the time-scale classification presented in Table 1 is used as the basis for decomposing the variables across different investment horizons. Accordingly, scales D1-D3 are defined as short-term investment horizons, scales D4-D6 as medium-term investment horizons, and scales D7-D8 as long-term investment horizons. This classification is important because the effects of macro-financial variables on BIST 100 returns may differ substantially depending on the investment horizon. Short-term scales mainly reflect immediate market reactions and volatility-driven adjustments, whereas medium-term scales capture cyclical market dynamics and long-term scales represent more persistent and structural relationships. Therefore, the time-scale framework used in this study provides a strong methodological basis for examining how the effects of investor sentiment, country credit risk premium, exchange rate movements, and Brent oil price returns on the BIST 100 vary across short-, medium-, and long-term market conditions.

Table 1. Time-Scale Classification across Different Investment Horizons

Scales	Annual Frequency	Monthly Frequency	Daily Frequency
D1	2-4	2-4	2-4
D2	4-8	4-8	4-8
D3	8-16	8-16 (8m-1y4m)	8-16
D4	16-32	16-32 (1y4m-2y8m)	16-32 (3w1d-6w2d)
D5	32-64	32-64 (2y8m-5y4m)	32-64 (6w2d-12w4d)
D6	64-128	64-128 (5y4m-10y8m)	64-128 (12w4d-25w3d)
D7	128-256	128-256 (10y8m-21y4m)	128-256 (25w3d-51w1d)
D8	256-512	256-512 (21y4m-42y8m)	256-512 (36w4d-73w1d)
D9	512-1024		

Source: Crowley (2007) and Aydoğdu and Çakır (2025).

3.3. Data and Model

This study investigates the impact of the exchange rate (USD/TRY), investor sentiment (VIX), sovereign credit risk premiums (CDS), and Brent oil prices on the returns of the Istanbul Stock Exchange (BIST 100), while controlling for other commonly used macro-financial variables. The dataset consists of daily time series observations spanning the period from January 2, 2015, to January 29, 2026, for the BIST 100, USD/TRY, VIX, CDS premiums, and Brent oil prices. This sample period encompasses an episode characterized by simultaneous domestic and external shocks and heightened financial volatility in Türkiye. Major developments during this period include political uncertainty and rising security concerns following the 2015 general elections; the July 15, 2016 coup attempt; the 2017 Constitutional Referendum and the subsequent transition to a new political system, which contributed to elevated risk premiums; and the sharp exchange rate depreciation observed in 2018 in the aftermath of the Pastor Brunson crisis. Additional global and domestic events include the escalation of US-China trade tensions and the change in the Central Bank governorship in 2018; the COVID-19 pandemic in 2020; the Russia-Ukraine war beginning in 2022; the Israel-Palestine conflict in 2023; persistent inflationary pressures and increased exchange rate volatility in Türkiye as of 2024; and renewed tariff measures within the scope of US-China trade disputes in 2025. These developments generated substantial fluctuations in exchange rates, investor sentiment, sovereign risk premiums, and Brent oil prices, thereby exerting varying effects on the BIST 100 index (Altumur & Kurt Cihangir, 2025). All data were obtained from the Investing.com database. Following Altunkeski et al. (2024) and Benammar et al. (2025), continuously compounded daily returns were computed for the BIST 100, USD/TRY, and Brent oil prices. Specifically, return series were constructed as the first logarithmic differences of the respective price series. Compared with level data, logarithmic returns are widely preferred in financial econometrics because they are scale-invariant, exhibit more desirable statistical properties, and offer both theoretical and practical advantages in empirical analysis (MacKinlay, 1997). Accordingly, logarithmic return series are employed in the subsequent empirical analyses of this study, and the transformation is defined as follows:

$$r_{i,t} = \ln \left(\frac{P_{i,t}}{P_{i,t-1}} \right)$$

(9)

Here, $r_{i,t}$ represents the return of variable i^{th} in period t ; $P_{i,t}$ and $P_{i,t-1}$ represent the closing prices in periods t and $t-1$, respectively. VIX and CDS variables, representing global and country risk levels rather than short-term shocks, are included in the model at different quantiles and frequency bands to capture the effects of market-condition-dependent risk. A single empirical model has been constructed for this study. Within the model framework, the effect of each independent variable on BIST 100 returns is analyzed while keeping other common control variables constant. Accordingly, the model specifications forming the basis of the estimation results are presented below.

$$BIST100 = f(USD/TRY, \overline{VIX}, \overline{CDS}, \overline{BRENT}) \quad (10)$$

$$BIST100 = f(VIX, \overline{BRENT}, \overline{USD/TRY}, \overline{CDS}) \quad (11)$$

$$BIST100 = f(CDS, \overline{VIX}, \overline{BRENT}, \overline{USD/TRY}) \quad (12)$$

$$BIST100 = f(BRENT, \overline{VIX}, \overline{USD/TRY}, \overline{CDS}) \quad (13)$$

4. Preliminary Analysis

4.1. Descriptive Statistics and Correlation Results

Descriptive statistics for the variables are reported in Table 1. The results indicate that both the BIST 100 and USD/TRY series exhibit positive average returns over the sample period. Among these, the highest mean return is observed for USD/TRY, followed by the BIST 100, whereas Brent oil returns show a relatively low average. In terms of volatility, as measured by the standard deviation, the VIX exhibits the highest variability, suggesting that global risk appetite fluctuated considerably throughout the sample period. Among the return series, Brent oil and the BIST 100 demonstrate relatively higher volatility, while USD/TRY presents a comparatively lower—yet still economically meaningful—level of volatility. The substantial standard deviation of the CDS premium further confirms that Türkiye’s sovereign risk perception experienced notable fluctuations over time. The skewness coefficients for BIST 100, USD/TRY, and Brent oil returns are negative, indicating left-skewed distributions. This implies a higher exposure to downside risk, as extreme negative shocks occur more frequently or more severely than positive ones. Such distributional characteristics are particularly relevant in the context of financial fragility, as they signal vulnerability to abrupt market downturns. In contrast, the positive skewness observed for the VIX and CDS series suggests that upward spikes in global risk perception and sovereign risk premiums are more pronounced. Kurtosis values substantially exceeding the benchmark of 3 for the BIST 100, USD/TRY, VIX, and Brent oil indicate leptokurtic distributions and fat tails. Moreover, the robust Jarque-Bera (1980) test statistics are significant at the 1% level for all variables, leading to rejection of the null of normality.

Table 1: Descriptive Statistics

Statistics	BIST100	USD/TRY	VIX	CDS	BRENT
Minimum	-10.307	-19.504	9.140	1.552	-27.976
Maximum	9.422	14.820	82.690	9.060	19.077
1. Quartile	-0.718	-0.214	13.580	2.511	-1.141

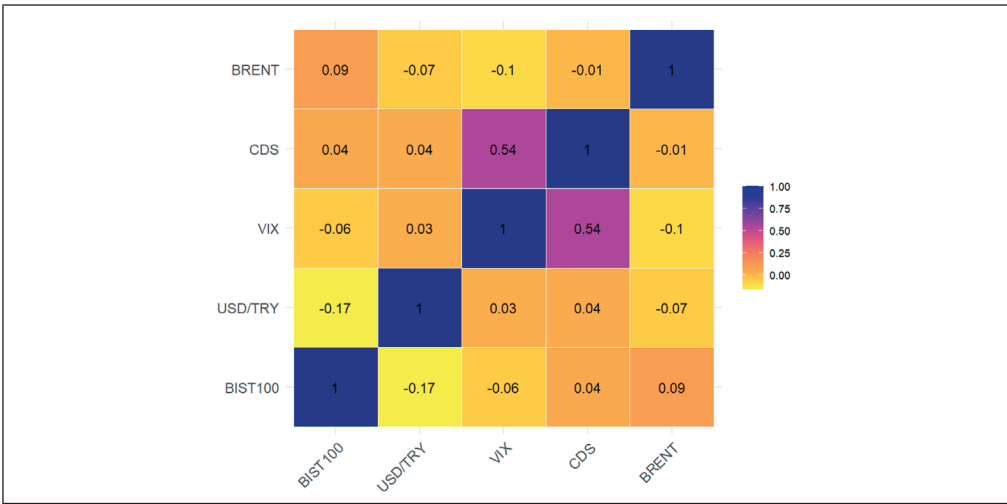
Table 1 continue

3. Quartile	0.984	0.386	21.140	4.290	1.297
Mean	0.103	0.108	18.282	3.531	0.008
Median	0.137	0.064	16.480	3.027	0.141
SE Mean	0.030	0.021	0.136	0.028	0.049
LCL Mean	0.043	0.067	18.015	3.475	-0.088
UCL Mean	0.163	0.149	18.549	3.586	0.104
Variance	2.519	1.193	50.149	2.157	6.502
Stdev	1.587	1.092	7.082	1.469	2.550
Skewness	-0.636	-0.523	2.674	1.157	-0.928
Kurtosis	4.863	65.058	13.717	0.938	14.336
Robust J-B	4053.3***	5896407,***	47866,***	986.25***	40408,***

Note: $p < ***$, %1.

Figure 2 presents the correlation coefficients between BIST 100 returns and USD/TRY, VIX, CDS premiums, and Brent oil returns. As shown in Figure 2, the pairwise correlations are generally weak and remain at relatively low levels, indicating limited contemporaneous linear associations among the variables. The correlation coefficient between BIST 100 returns and USD/TRY is -0.17, suggesting that exchange rate depreciation exerts downward pressure on stock returns and that exchange rate shocks are negatively associated with equity market performance. Similarly, the correlation between BIST 100 returns and the VIX is -0.06, implying that changes in global risk appetite have a limited but negative contemporaneous relationship with BIST returns. In contrast, the weak positive correlation (0.04) between CDS premiums and BIST 100 returns indicates that variations in sovereign risk premiums do not exhibit strong synchronization with stock returns within a linear contemporaneous framework. Likewise, the low positive correlation (0.09) between Brent crude oil returns and the BIST 100 suggests that energy price movements have only a linear association with Turkish equity returns.

Figure 2: Correlation Matrix



4.2. Nonlinearity Test Results

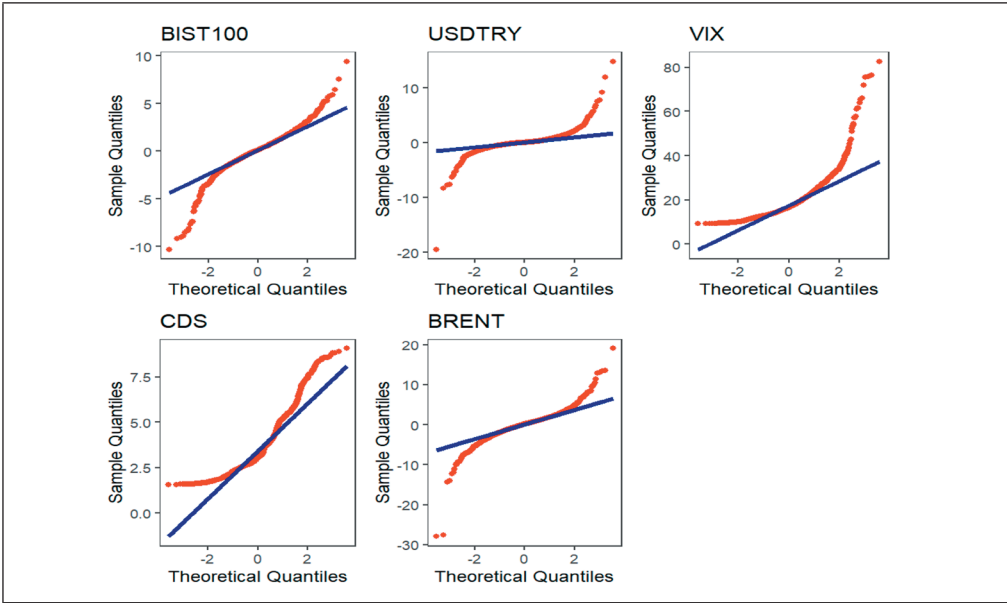
This study employs the Brock-Dechert-Scheinkman (BDS) test (Brock et al., 1996) and Q-Q plots to investigate the nonlinear properties of the variables. These procedures allow us to assess whether the BIST 100, USD/TRY, VIX, CDS premiums, and Brent oil series exhibit nonlinear dependence structures. The results of the BDS test are reported in Table 2. The test statistics are statistically significant at the 1% level for each variable across all embedding dimensions. These findings provide strong evidence against the null hypothesis of independent and identically distributed residuals, suggesting the presence of nonlinear dynamics in the series. Accordingly, conventional linear models may be insufficient to adequately capture the underlying dependence structure among these variables, thereby justifying the adoption of nonlinear modelling approaches. As a complementary robustness check, Q-Q plots are used to visually assess deviations from normality in the distribution. The results are presented in Figure 3. In the plots, the red markers represent the empirical sample quantiles, while the blue reference line corresponds to the theoretical quantiles under the assumption of normality. Systematic deviations from the reference line indicate departures from normality. As can be seen in Figure 3, all the variables show significant deviations from the normal distribution, particularly in the tails. These findings are consistent with the BDS test results and provide additional evidence of nonlinear dependence, fat-tailed behavior, and asymmetric distributional characteristics. Therefore, rejecting the normality assumption and recognizing the presence of nonlinear dynamics emphasizes the need to use advanced time-frequency and quantile-based econometric techniques to accurately model the dynamic interactions between the BIST 100 and macro-financial risk indicators, such as USD/TRY, VIX, CDS premiums, and Brent oil prices.

Table 2: BDS Test Results

Variable	BIST10	USD/TRY	VIX	CDS	BRENT
M2	2.741***	21.644***	174.712***	209.452***	9.390***
M3	2.711***	21.633***	174.848***	209.482***	9.505***
M4	2.815***	21.623***	174.962***	209.501***	9.435***
M5	2.771***	21.611***	175.101***	209.536***	9.564***
M6	2.793***	21.597***	175.237***	209.557***	9.492***

Note: p< ***, %1.

Figure 3: Q-Q Plots

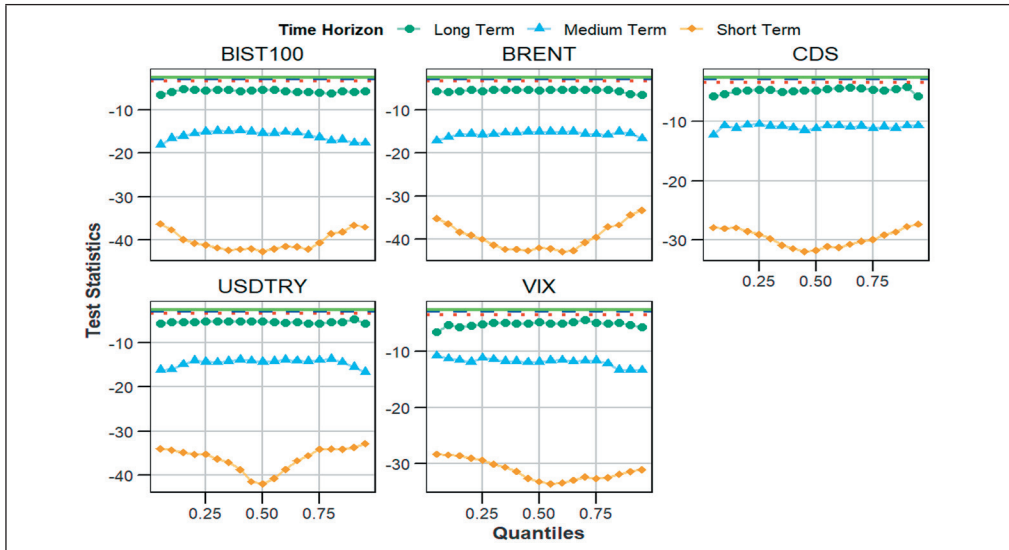


4.3. Wavelet Quantile Unit Root Test Results

Having established the presence of non-linear dynamics in the series, we employed the Wavelet Quantile ADF (WQADF) and Wavelet Quantile PP (WQPP) unit root tests developed by Adebayo & Olanrewaju (2025). These tests were chosen because they incorporate information from both the time and frequency domains simultaneously, enabling a thorough investigation of stationarity across various quantiles and investment horizons. Unlike the conventional ADF test, which assumes time-invariant relationships, the wavelet decomposition framework enables the separation of short-, medium-, and long-term dynamics. As stationarity properties may differ across time horizons and distributional quantiles, this approach offers a more flexible and economically meaningful evaluation of behavior variability under various market conditions (Adebayo & Olanrewaju, 2025). The WQADF results (see Figure 4) show that the BIST 100, USD/TRY, VIX, CDS, and Brent oil series are all significantly below the critical values in the short term (orange line) at various quantile levels. This implies that the null hypothesis of a unit root is rejected, confirming short-term stationarity. In the medium term, the test statistics fall below the critical thresholds for most quantile ranges (light blue line), suggesting that the variables are stationary across a broad range of the conditional distribution. Similarly, in the long term (dark green line), the test statistics remain below the critical values for most quantile levels, confirming the persistence of quantile-based stationarity over longer investment horizons. To ensure robustness, the stationarity properties were re-examined using the WQPP test across the same quantile and frequency dimensions. The findings in Figure 5 largely align with the WQADF results, indicating that both methods yield consistent, mutually reinforcing evidence. Furthermore, the Zivot-Andrews wavelet quantile (WQZA) test was used to identify any potential structural breaks in the short, medium, and long term. Figure 6 shows the results of the WQZA test. The test statistics were all significantly below the 10% critical value, lead-

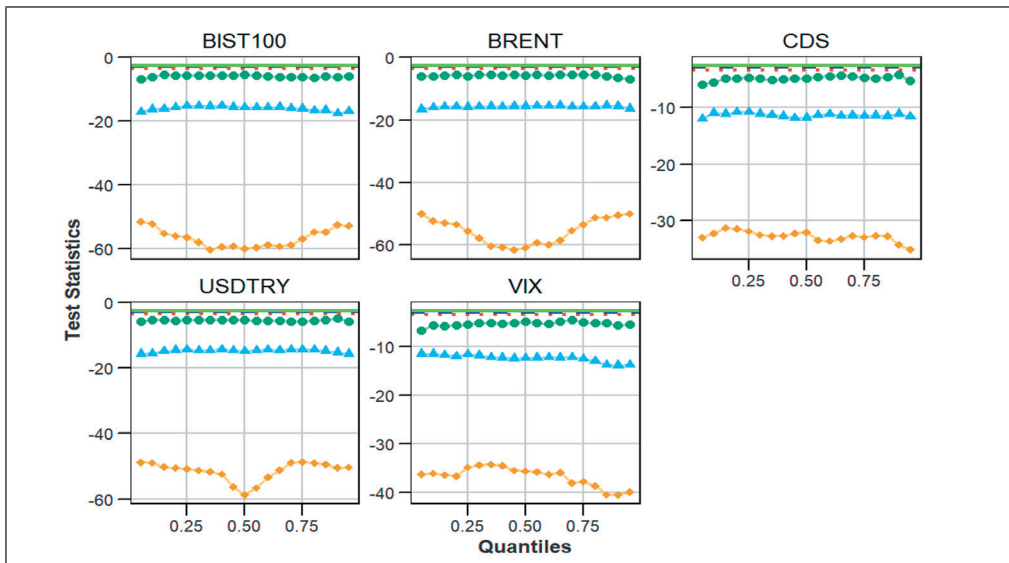
ing to the rejection of the unit root hypothesis for all quantile levels and investment horizons. Additionally, the estimated structural break dates for the BIST 100, USD/TRY, VIX, CDS, and Brent oil series cluster within specific periods.

Figure 4: Wavelet Quantile ADF Unit Root Results

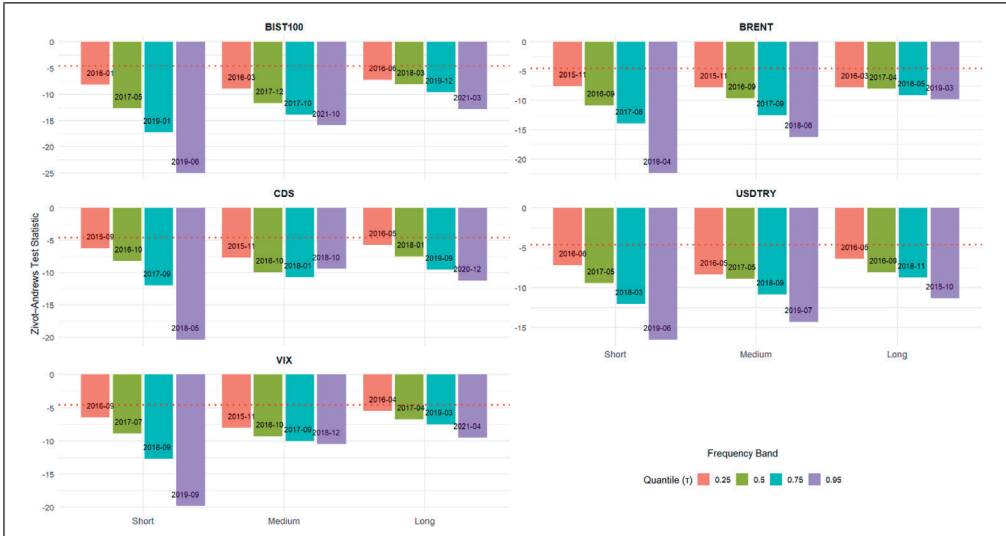


Source: Short-term (orange), medium-term (light blue), and long-term (dark green circles) components of each variable. The horizontal lines represent critical values for significance levels: -3.49 (red dotted line for 1%), -2.89 (black dashed line for 5%), and -2.58 (green solid line for 10%).

Figure 5: Wavelet Quantile PP Unit Root Results



Source: Short-term (orange), medium-term (light blue), and long-term (dark green circles) components of each variable. The horizontal lines represent critical values for significance levels: -3.49 (red dotted line for 1%), -2.89 (black dashed line for 5%), and -2.58 (green solid line for 10%).

Figure 6: Wavelet Quantile Zivot Andrew Test Result

5. Empirical Results

This section analyzes the effects of USD/TRY, VIX, CDS, and Brent oil variables on BIST 100 returns using MWQR, WQR, and WQGC methods, which simultaneously account for heterogeneity across different investment horizons and quantile dimensions. The empirical findings are presented accordingly. In this context, the MWQR results reveal the multivariate effects of the variables across different quantile levels and investment horizons, while the WQR findings capture asymmetric coefficient dynamics under frequency decomposition. The WQGC analysis further evaluates how the causal relationships between these variables and BIST 100 returns vary across quantiles and investment horizons. For a detailed graphical representation of the empirical findings, see Figure 7(a-d) for the MWQR results, Figure 8(a-d) for the WQR results, and Figure 9(a-d) for the WQGC results, all of which are presented in the Appendix.

5.1. Multivariate Wavelet Quantile Regression Results

Figure 7a shows that, once VIX, CDS, and Brent oil have been taken into account, USD/TRY returns have a negative and statistically significant impact on BIST 100 returns at all investment horizons. This negative effect is particularly pronounced in the short term across the quantile range of $\tau = 0.05-0.80$, with the strongest impact observed in the lower and middle quantiles ($\tau = 0.10-0.30$ and $\tau = 0.50-0.80$). This suggests that exchange rate shocks can exacerbate losses during bear market conditions. In the medium term, the negative effect extends further across the distribution ($\tau = 0.10-0.95$) and is most pronounced in the 0.20-0.80 range. These results suggest that exchange rate increases generate immediate balance sheet pressures and exert persistent effects through expectations and risk premium channels. In the long term, the negative relationship remains evident across nearly all quantiles ($\tau = 0.10-0.95$), with a particularly strong impact in the middle quantiles ($\tau = 0.50-0.70$). This suggests that depreciation of the Turkish lira leads to higher risk premia being incorporated into equity valuations

on the Istanbul Stock Exchange, creating sustained downward pressure on returns. Overall, the findings do not support the conventional hypothesis that a competitive exchange rate stimulates stock market performance. In fact, the results demonstrate that USD/TRY depreciation acts as a downward risk factor for BIST 100 returns, particularly at lower quantiles, even after controlling for global risk indicators such as VIX, CDS, and Brent oil. Therefore, there is no evidence to suggest that an 'inflationary hedge' mechanism exists in the Turkish equity market. Instead, exchange rate shocks appear to increase risk and suppress returns, particularly under weak market conditions.

Figure 7b shows that VIX has a negative, statistically significant impact on BIST 100 returns after controlling for USD/TRY, CDS, and Brent oil across short-, medium-, and long-term investment horizons. In the short term, the negative effect of VIX is observed across almost the entire distribution ($\tau = 0.05-0.95$), particularly in the lower ($\tau = 0.05-0.20$) and upper ($\tau = 0.80-0.95$) quantiles. This suggests that increases in global volatility put downward pressure on returns during both bearish and bullish market conditions. In the medium term, the magnitude of the negative effect is relatively weaker than in the short term, but remains statistically significant across a broad range of quantiles ($\tau = 0.10-0.95$). This indicates that global risk shocks are not merely transitory disturbances, but rather exert more persistent effects on asset pricing through expectation formation and risk premium adjustments. Similarly, in the long term, the negative impact, while comparatively moderate, remains statistically significant across the low, middle, and high quantiles ($\tau = 0.10-0.90$). The consistency of this effect across the distribution implies that VIX functions as a systemic risk factor for the Turkish equity market rather than operating exclusively during crisis episodes. Therefore, these findings provide empirical evidence that the BIST 100 is strongly integrated into global financial cycles. Periods of declining global risk appetite, as indicated by increases in the VIX index, result in widespread downward pricing pressure across the entire return distribution.

Figure 7c shows that, after controlling for the other variables, the impact of the CDS premium on BIST 100 returns is strong, negative, and statistically significant across short-, medium-, and long-term investment horizons. In the short term, the country risk premium has a pronounced negative effect, particularly in the lower quantiles ($\tau = 0.10-0.30$), where the relationship is statistically significant. This suggests that increases in sovereign risk exacerbate losses in a bear market. The negative effect also persists across the middle quantiles ($\tau = 0.40-0.80$), indicating that CDS-induced pressure is a stable negative pricing factor even during relatively normal market phases. While the negative impact continues in the upper quantiles ($\tau = 0.90-0.95$), it is not statistically significant at these levels. In the medium term, the negative effect remains evident in the lower quantiles, although statistical significance weakens. By contrast, in the middle and upper quantiles ($\tau = 0.40-0.70$ and $\tau = 0.80-0.95$), the negative relationship remains statistically significant, albeit smaller in magnitude compared to the short term. This pattern suggests that increases in country risk exert downward pressure on equity returns, not only during periods of market stress but also under normal and favorable conditions. The results imply that sovereign risk is systematically incorporated into asset pricing and functions as a structural discount factor in equity valuation. In the long term, the negative impact of the CDS premium persists across the entire quantile distribution. The presence of a consistently negative relationship indicates that rising country risk exerts permanent, structural downward pressure on BIST 100 returns rather than merely causing transitory fluctuations. From a finan-

cial perspective, this finding suggests that higher sovereign risk increases the cost of capital, distorts risk perception, and leads to persistently lower market valuations.

Figure 7d shows that controlling for USD/TRY, VIX, and CDS limits the impact of Brent oil returns on BIST 100 returns to a positive effect in the short term and a positive, statistically significant effect in the medium and long term. In the short term, Brent oil returns exhibit a weak positive relationship with BIST 100 returns across low, middle, and high quantiles; however, the coefficients are not statistically significant. This suggests that short-term oil price increases do not generate a clear directional response in the equity market. In other words, oil shocks are not immediately priced as either a pure cost shock or a growth signal. Instead, the adverse cost channel and positive global demand expectations appear to offset each other in the short term, resulting in an economically modest and statistically insignificant effect. In the medium term, the impact of Brent oil returns becomes positive and statistically significant across the entire quantile distribution ($\tau = 0.05-0.95$). The stronger effects observed in specific quantiles suggest that oil price increases are increasingly interpreted as signals of expanding global economic activity and rising external demand. Similarly, in the long term, the positive and statistically significant relationship persists across all quantiles, with a relatively stronger magnitude in the lower and middle quantiles. This pattern suggests that rising oil prices are perceived as indicators of cyclical recovery and improving global growth prospects, particularly under weak market conditions. Although Türkiye is a structurally energy-importing economy, where higher oil prices are theoretically expected to depress stock returns through the cost channel, the MWQR results indicate that the relationship is not unidirectional. Although Brent oil returns have only a limited short-term influence, they are increasingly being priced as an indicator of the real economy and business cycles in the medium and long term, reflecting global growth and demand dynamics. These findings suggest that Brent oil returns have a different transmission mechanism to financial risk indicators such as USD/TRY, VIX and CDS. Rather than functioning purely as a cost shock, increases in the oil price support BIST 100 returns in the medium and long term by signalling stronger global economic conditions. Therefore, explaining the impact of oil prices through a cost-based framework alone is insufficient. This effect evolves over time and in different market conditions, becoming more systematic and economically meaningful as the investment horizon lengthens

5.2. Wavelet Quantile Regression Results

To validate the findings obtained from the Wavelet Quantile Regression (WQR) method, the WQR approach was also employed. Figure 8 (a-d) shows the results. Overall, the WQR estimates are consistent with the MWQR findings and reinforce the main empirical conclusions. The results indicate that USD/TRY returns have a statistically significant negative effect on BIST 100 returns over short-, medium-, and long-term investment horizons and across low, middle, and high quantiles. This suggests that currency depreciation exerts persistent downward pressure, particularly during periods of normal or weak market performance, operating through valuation and risk-premium channels. Similarly, the VIX index has a statistically significant negative impact on BIST 100 returns across all investment horizons and wide quantile ranges. The effect is strongest in the short term, remaining significant in the medium and long term, though weaker. This pattern implies that deteriorations in global risk appetite exert downward pressure on Turkish equity returns during both crisis and expansionary market phases.

Similarly, the impact of the CDS premium on BIST 100 returns is predominantly negative and statistically significant. While the effect is more pronounced in the short term, its continued — albeit weaker — significance in the medium and long term suggests that increases in sovereign risk generate sustained pressure through the cost-of-capital and discount-rate channels. In contrast, Brent oil returns exhibit a more nuanced pattern. Although the effect is limited in certain quantiles, it remains positive and statistically significant across broad segments of the distribution, particularly in the medium and long term. This positive association suggests that oil price increases are not just seen as negative cost shocks but also as signals of stronger global demand and economic activity. However, the heat map evidence reveals a more heterogeneous and weaker effect in the short term and during strong expansionary phases, where market performance is already robust. Taken together, the results suggest that financial risk indicators (USD/TRY, VIX, and CDS) function as structural headwinds for BIST 100 returns across time horizons. In contrast, Brent oil returns are more closely aligned with real business cycle dynamics and global growth expectations. In this respect, the WQR findings provide robust empirical support for the conclusions derived from the MWQR analysis.

5.3. Wavelet Quantile Causality Results

The WQGC approach is an advanced econometric framework that enables the examination of causal relationships between variables across different investment horizons and quantile levels. Unlike the traditional Granger causality test (Granger, 1969), which evaluates causality in a one-dimensional setting based on mean dynamics, the WQGC method allows identification of causality across both temporal (frequency) and distributional dimensions. Consequently, it becomes possible to determine not only whether causality exists, but also at which investment horizon and under which market regime (i.e., quantile level of the dependent variable) the causal effect materializes. The WQGC findings are presented using heat maps and frequency-quantile plots, where color intensity and highlighted regions indicate statistically significant causal relationships within specific frequency-quantile combinations (Özkan et al., 2024). Figure 9 reports the causality results from USD/TRY, VIX, CDS, and Brent oil returns to BIST 100 returns. The heat maps reveal substantial heterogeneity in causal dynamics across investment horizons and quantile levels. The causal effect from USD/TRY returns to BIST 100 returns is statistically significant across a broad range of the distribution at the short-term horizon. In the medium term, the causal effect becomes more concentrated in the middle quantiles, whereas in the long term it appears more selective and partially heterogeneous. The causal influence of VIX on BIST 100 returns is strong and statistically significant across nearly all quantiles at both short- and medium-term horizons. Although relatively weaker in the long term, the effect largely persists, indicating sustained global risk transmission. Similarly, causality from CDS to BIST 100 returns is particularly strong across the entire distribution in the short term. In the medium term, statistical significance becomes more concentrated in the lower and middle quantiles, while in the long term, the effect weakens but remains present. In contrast, the causal relationship between Brent oil returns and BIST 100 returns exhibits a limited, heterogeneous pattern in the short term. In the medium term, significance increases—especially in the lower and middle quantiles—and, in the long term, a strong, statistically significant causal relationship emerges across a substantial portion of the quantile distribution.

6. Conclusion and Policy Recommendations

This study examines the sensitivity of the Turkish stock market to macro-financial shocks within a multidimensional framework. More specifically, it analyses the effects of investor sentiment, sovereign credit risk premiums, exchange rate movements, and Brent oil returns on BIST 100 returns, across different investment horizons and various return distribution quantiles. The empirical analysis uses daily data from 2 January 2015 to 29 January 2026. To capture the nonlinearity and regime dependence of financial time series, the multivariate wavelet quantile regression (MWQR) approach developed by Adebayo (2025) is employed. Additionally, Wavelet Quantile Regression (WQR) is employed to explore univariate distributional dynamics further, and Wavelet Quantile Granger Causality (WQGC) is applied to examine the causal structure across the frequency and quantile dimensions. This comprehensive methodological framework enables assessment of the effects of macrofinance on the BIST 100 not only at the conditional mean level, but also across different investment horizons and distinct return distribution segments. Consequently, the study provides a holistic, distribution-sensitive evaluation that extends beyond conventional, linear, one-dimensional approaches commonly adopted in the literature.

The MWQR findings clearly demonstrate the negative impact of macro-financial risk factors on BIST 100 returns. In particular, after controlling for other variables, increases in the USD/TRY exchange rate have a negative, statistically significant effect across all investment horizons. This impact is particularly evident in the short term and in lower-return (bear market) quantiles. The results suggest that exchange rate shocks do not generate an inflationary hedge to balance the system; rather, they amplify perceptions of financial fragility, increase the risk premium, and put downward pressure on equity valuations. Similarly, the effect of investor sentiment is not confined to crisis periods. The sentiment indicator exhibits a negative, statistically significant influence across nearly all quantiles, including during expansionary market phases. This suggests that deteriorations in investor confidence systematically impact stock returns beyond episodic stress events. The CDS premium has a strong negative impact, particularly in the short term and within lower quantiles, while continuing to act as a structural discount factor in the long term. This pattern implies that sovereign risk is persistently embedded in equity pricing through the cost-of-capital and required-return channels. In contrast, the most notable finding relates to Brent oil prices. While Türkiye's status as an energy-importing economy would, in theory, imply a negative effect through the cost channel, the empirical results reveal a positive, statistically significant relationship between oil prices and BIST 100 returns, particularly in the medium and long term. This suggests that oil price increases are not solely interpreted as adverse cost shocks but also as leading indicators of global demand strength and growth momentum. The strong alignment between the WQR and MWQR results further confirms that financial risk indicators act as structural headwinds for the Turkish equity market, whereas oil returns tend to co-move with real economic cycle dynamics over time. This methodological consistency enhances the robustness of the empirical findings and demonstrates that the conclusions are not sensitive to the specific econometric framework employed.

The WQGC analysis shows that these relationships vary over time (frequency) and across distributions. Causality from USD/TRY to BIST 100 returns is particularly strong in the short term and remains statistically significant across almost the entire quantile distribution. The causal influence of VIX exhibits a robust, pervasive structure in both the short- and

medium-term, operating across bear, normal, and bull market conditions. Similarly, short-term causality from CDS premiums to the stock market is evident across market regimes. In the medium term, however, the effect becomes more concentrated in the lower and middle quantiles, suggesting stronger transmission during weaker market states. In contrast, the causal effect of Brent oil returns is relatively limited in the short term. Nevertheless, it becomes statistically significant in the medium and long term, particularly when oil price movements reflect growth-related signals, and extends across a broad segment of the quantile distribution. Overall, these findings demonstrate that the Turkish stock market's response to macro-financial shocks varies substantially across investment horizons and market regimes. The results also imply that risk transmission mechanisms operate through a multi-layered, state-dependent structure rather than a uniform or linear one.

The findings of this study largely coincide with the empirical evidence reported in the existing literature. The negative impact of the USD/TRY exchange rate on the BIST 100 is consistent with the findings of Aktaş and Akdağ (2013), Güngör and Polat (2020), and Tufaner (2021), confirming that exchange rate increases exert a suppressive effect on the stock market. This result is also in line with Gürbüz (2024), who documents a long-term negative effect, and Şeker (2021), who emphasizes the adverse impact of short-term exchange rate shocks. In this context, the present study contributes to the literature by adding a distribution-based perspective, showing that exchange rate risk affects the market through both a short-term volatility channel and a long-term discount-rate mechanism, with the magnitude of this effect varying across quantile levels. Similarly, the negative and asymmetric effect of the VIX index is consistent with the findings of Sarıtaş and Nazlıoğlu (2019) and Karaçayır (2025). Moreover, this result supports the evidence provided by Hatipoğlu and Tekin (2017), who show that the effect of global risk deepens during crisis periods, and Gülcemal (2025), who identifies the BIST 100 as a net receiver of global risk shocks. The negative impact of CDS premiums also confirms the findings of Topaloğlu and Ege (2020) and Şeyranlıoğlu and Çilek (2023), while being consistent with the regime-sensitive risk-pressure argument advanced by Eren and Başar (2016) and Altemur and Kurt Cihangir (2025). The positive finding regarding Brent oil price returns is also in strong agreement with more recent and cyclical interpretations in the literature. Given that Türkiye is a net energy-importing economy, increases in Brent oil price returns may theoretically be expected to exert negative pressure on BIST 100 returns through production costs, the current account balance, inflation expectations, and discount rates. This expectation is consistent with studies emphasizing that oil price shocks adversely affect stock markets through the cost channel. However, the findings of this study show that, once other macro-financial variables are controlled for, Brent oil price returns exert a positive and statistically significant effect on BIST 100 returns, particularly in the medium and long term. This indicates that the oil-stock market relationship cannot be explained solely through the cost channel. At this point, it is essential to distinguish between the cost channel and the global demand channel. While short-term increases in Brent oil price returns may put pressure on firms' cost structures and profit expectations by raising import costs, in the medium and long term, positive Brent oil price returns may also be priced as a signal of strengthening global economic activity, external demand, and growth expectations. Indeed, in line with the findings of Bekereci et al. (2025) and Aydoğdu (2025), the relationship between Brent oil price returns and the BIST 100 appears to exhibit positive co-movement depending on cyclical conditions and investment horizons. This

result suggests that positive oil price returns are not always perceived merely as cost shocks. Rather, it is consistent with Aydın (2025) and Can (2025), who argue that rising energy demand during periods of global economic recovery may positively affect stock markets through growth expectations. Therefore, this study shows that the effect of Brent oil price returns on the BIST 100 is context-dependent and sensitive to market regimes and investment horizons. More importantly, by demonstrating that Brent oil price returns can be positively priced through the global demand channel in the medium and long term, even in an energy-importing country such as Türkiye, the study offers a broader framework that goes beyond the one-dimensional cost-channel hypothesis in the literature.

These results demonstrate that the sustainable performance of the stock market is closely linked to macro-financial risk indicators. The effects of the risk premium, exchange rate movements, and investor sentiment on BIST 100 returns, which depend on the regime and maturity, highlight the need for flexible, condition-sensitive policy frameworks and investment strategies. In this respect, the study has important implications for policymakers, portfolio managers, and investors. For policymakers in particular, the findings suggest that persistent shifts significantly influence risk perceptions in the BIST 100. In particular, the negative pressure exerted by credit default swap premiums and exchange rate depreciation indicates that financial stability is fundamentally tied to macroeconomic credibility. Rather than relying on temporary measures to attract short-term capital inflows, economic management would be better served by prioritizing structural reforms that reduce the sovereign risk premium in the medium and long term. Strengthening fiscal discipline, maintaining consistent price-stability policies, and improving institutional predictability could help alleviate the structural discount applied to capital markets. Furthermore, the evidence suggests that exchange rate instability creates financial vulnerabilities that outweigh any potential competitive advantages. This highlights the importance of tackling inflation and ensuring exchange rate stability for capital markets to function healthily. Using macroprudential instruments effectively, developing derivatives markets for risk hedging, and expanding the institutional investor base could further enhance resilience against external shocks.

The findings reveal that static and uniform strategies are unlikely to deliver consistent performance across different market regimes, which is important for investors and portfolio managers to understand. Portfolio positioning should therefore be adjusted according to the investment horizon and the current market situation. Regarding oil prices, the results suggest that price increases should not automatically be interpreted as cost-driven sell signals. Instead, they may reflect improving global demand conditions, particularly in the medium- to long-term. Evaluating commodity price movements within a sectoral and cyclical framework may therefore yield more informed investment decisions. Conversely, given that heightened global volatility, as captured by VIX, exerts persistent downward pressure on BIST 100 returns, the use of derivative instruments and portfolio diversification strategies during periods of elevated uncertainty emerges as a prudent risk management approach. Maturity-sensitive causality findings also indicate that exchange rate movements and CDS spreads are more important for short-term investors. At the same time, global growth and commodity dynamics are more important for long-term investment strategies. In summary, enhancing confidence and predictability within the macroeconomic policy framework and adopting flexible, regime-sensitive investment strategies can contribute to more stable, sustainable market performance.

Despite using a comprehensive dataset and advanced econometric techniques, this study has several limitations. Firstly, the set of macro-financial variables is limited to USD/TRY, VIX, CDS, and Brent oil returns. Other relevant macroeconomic indicators, such as interest rates, policy rates, bond returns, industrial production, and credit growth, are excluded in order to maintain the focus of the model. Secondly, while daily data effectively captures short-term market dynamics, it may not fully reflect long-term structural macroeconomic changes. Thirdly, the sample period (2015-2026) covers several episodes of extreme volatility and systemic shocks in the Turkish economy. As such, caution should be exercised when generalizing the estimated coefficients to more stable macroeconomic environments. Future research incorporating broader sets of variables, alternative data frequencies, and comparative analyses of emerging markets could further enrich the literature.

Conflict of Interests

There is no conflict of interest between the authors or any third-party individuals or institutions.

Ethics Committee Approval

This research does not have a part that needs approval of the ethics committee.

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References

- Adebayo, T. S., & Olanrewaju, V. O. (2025). Journey toward affordable and modern energy: Role of income inequality and technological innovation. *Environmental Progress & Sustainable Energy*, 44(2), e14555. <https://doi.org/10.1002/ep.14555>
- Adebayo, T. S., & Özkan, O. (2024). Investigating the influence of socioeconomic conditions, renewable energy and eco-innovation on environmental degradation in the United States: A wavelet quantile-based analysis. *Journal of Cleaner Production*, 434, 140321. <https://doi.org/10.1016/j.jclepro.2023.140321>
- Adebayo, T. S., Abbas, S., Olanrewaju, V. O., & Uzun, B. (2025). Unpacking policy ambiguities in residential and commercial renewable energy adoption: a novel multivariate wavelet quantile regression analysis. *Applied Economics*, 1-22. <https://doi.org/10.1080/00036846.2025.2590632>
- Akgüneş, A. O. (2021). VIX endeksinde meydana gelen değişimlerin BIST endeksleri üzerine etkisi: ARDL sınır testi yaklaşımı. *Yönetim ve Ekonomi Araştırmaları Dergisi*, 19(1), 237-252. <https://doi.org/10.11611/yead.877076>
- Aktaş, H., Kayalıdere, K., & Karataş, Y. (2018). Petrol, dolar kuru ve hisse senedi piyasası arasındaki ortalama-oylaklık yayılım etkisi: Bist100 üzerine bir uygulama. *Journal of Accounting and Taxation Studies*, 354-377. <https://doi.org/10.29067/muvu.374610>
- Aktaş, M., & Akdağ, S. (2013). Türkiye’de ekonomik faktörlerin hisse senedi fiyatları ile ilişkilerinin araştırılması. *International Journal of Social Science Research*, 2(1), 50-67. <https://izlik.org/JA95AE84GL>
- Altumur, N., & Cihangir, Ç. K. (2025). Yatırımcı duyarlılığı ve ülke kredi riskinin borsa sektör endekslerine etkisi: kantil-kantil regresyon yöntemi uygulaması. *Hitit Sosyal Bilimler Dergisi*, (Advanced Online Publication), 721-739. <https://doi.org/10.17218/hititsbd.1712472>
- Altunkeski, B. K., Dibooglu, S., Cevik, E. I., Kilic, Y., & Bagan, M. F. (2024). Quantile connectedness between VIX and global stock markets. *Borsa Istanbul Review*, 24, 71-79. <https://doi.org/10.1016/j.bir.2024.07.006>
- Aydın, M. (2025). BİST100 endeksi ile VIX korku endeksi arasındaki dönemsel dinamik ilişkisinin incelenmesi: TVP-VAR modeli uygulaması. *Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 18(4), 1166-1181. <https://doi.org/10.25287/ohuibf.1632391>

- Aydın, Z. B., & Gündoğdu, E. (2024). Borsa İstanbul endekslerinin dolar, euro, altın ve brent petrol değişkenleriyle birliktelik analizi. *International Journal of Social Inquiry*, 17(1), 105-118. <https://doi.org/10.37093/ijsi.1339748>
- Aydoğdu, A. (2025). Risk şokları ve Türkiye'deki finansal varlıklar arasındaki yayılım etkisinin TVP-VAR Dayalı wavelet uyum analizi ile incelenmesi. *Ekonomi Politika ve Finans Araştırmaları Dergisi*, 10(1), 303-331. <https://doi.org/10.30784/epfad.1595233>
- Aydoğdu, A., & Çakır, H. M. (2025). Volatility modelling of cryptocurrencies according to different investment horizons: The case of bitcoin. *Journal of Mehmet Akif Ersoy University Economics and Administrative Sciences Faculty*, 12(2), 724-749. <https://doi.org/10.30798/makuiibf.1609311>
- Balcılar, M., Gupta, R., & Pierdzioch, C. (2016). Does uncertainty move the gold price? New evidence from a nonparametric causality-in-quantiles test. *Resources Policy*, 49, 74-80. <https://doi.org/10.1016/j.resourpol.2016.04.004>
- Benammar, R., Elmekki, A., Arfaoui, N., & Boubaker, A. (2025). The impact of geopolitical risk and uncertainty on cryptocurrency: Evidence from the Russia-Ukraine war. *Journal of Public Affairs*, 25(2), e70024. <https://doi.org/10.1002/pa.70024>
- Bildirici, M. E., Salman, M., & Ersin, Ö. Ö. (2022). Nonlinear contagion and causality nexus between oil, gold, VIX investor sentiment, exchange rate and stock market returns: The MS-GARCH copula causality method. *Mathematics*, 10(21), 4035. <https://doi.org/10.3390/math10214035>
- Boyacıoğlu, N., Höl, A. Ö., & Gülcan, N. (2023). Pay senedi, emtia, döviz ve dijital para piyasaları arasındaki ilişkinin incelenmesi: Türkiye örneği. *İstanbul Gelişim Üniversitesi Sosyal Bilimler Dergisi*, 10(1), 73-92. <https://doi.org/10.17336/igusbd.950999>
- Broock, W. A., Scheinkman, J. A., Dechert, W. D., & LeBaron, B. (1996). A test for independence based on the correlation dimension. *Econometric reviews*, 15(3), 197-235. <https://doi.org/10.1080/07474939608800353>
- Camgöz, M. (2023). Revealing volatility spillover effects between CDS premiums and equity markets in developed and developing countries: VAR-BEKK-GARCH model approach. *Trends in Business and Economics*, 37(2), 98-110. <https://doi.org/10.5152/TBE.2022.221748>
- Can, Ş. (2025). Bitcoin ile BIST100, altın, gümüş, dolar, ham petrol ve brent petrol değişkenlerinin birlikte hareketlerinin veri madenciliği ile incelenmesi. *Yönetim ve Ekonomi Dergisi*, 32(3), 585-619. <https://doi.org/10.18657/yonveek.1525519>
- Crowley, P. M. (2007). A guide to wavelets for economists. *Journal of Economic Surveys*, 21(2), 207-267.
- Çakar, R., & Şahin, E. E. (2025). Dalgacık yöntemleri kullanılarak makroekonomik göstergelerin hisse senedi endeksleri üzerindeki etkisinin analizi: Katılım30 ve BIST100 örneği. *İnönü University International Journal of Social Sciences*, 14(1). <https://doi.org/10.54282/inijoss.1643855>
- Çetinkaya, Y., & Üçler, G. (2024). Kredi temerrüt takas primi (CDS) ve korku endeksinin (VIX) Borsa İstanbul endeksleri üzerine etkisi. Necmettin Erbakan Üniversitesi Siyasal Bilgiler Fakültesi Dergisi, 6(2), 402-419. <https://doi.org/10.51124/jneusbf.2024.95>
- Demir, Y., & Dinç, M. (2021). Kredi temerrüt swapları, döviz kuru ile borsa İstanbul arasındaki ilişkinin analizi. *Yaşar Üniversitesi E-Dergisi*, 16(64), 1642-1656. <https://doi.org/10.19168/jyasar.934285>
- Eren, M., & Başar, S. (2016). Makroekonomik faktörler ve kredi temerrüt takaslarının BIST-100 endeksi üzerindeki etkisi: ARDL yaklaşımı. *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 30(3). <https://izlik.org/JA63LR95NN>
- Gazel, S. (2017). Stratejik emtialar ve finansal değişkenler: Türkiye için bir ARDL sınır testi yaklaşımı. *Gazi Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 19(2), 544-563. <https://izlik.org/JA56TN44SG>
- Granger, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: journal of the Econometric Society*, 424-438. <https://doi.org/10.2307/1912791>
- Gül, S., Yıldırım, S., & Hattapoğlu, M. (2024). Yatırımcı duyarlılığı ve BIST100 endeksi arasındaki ilişki: Toda Yamamoto nedensellik uygulaması. *Anadolu Üniversitesi Sosyal Bilimler Dergisi*, 24(4), 1589-1616. <https://doi.org/10.18037/ausbd.1508532>

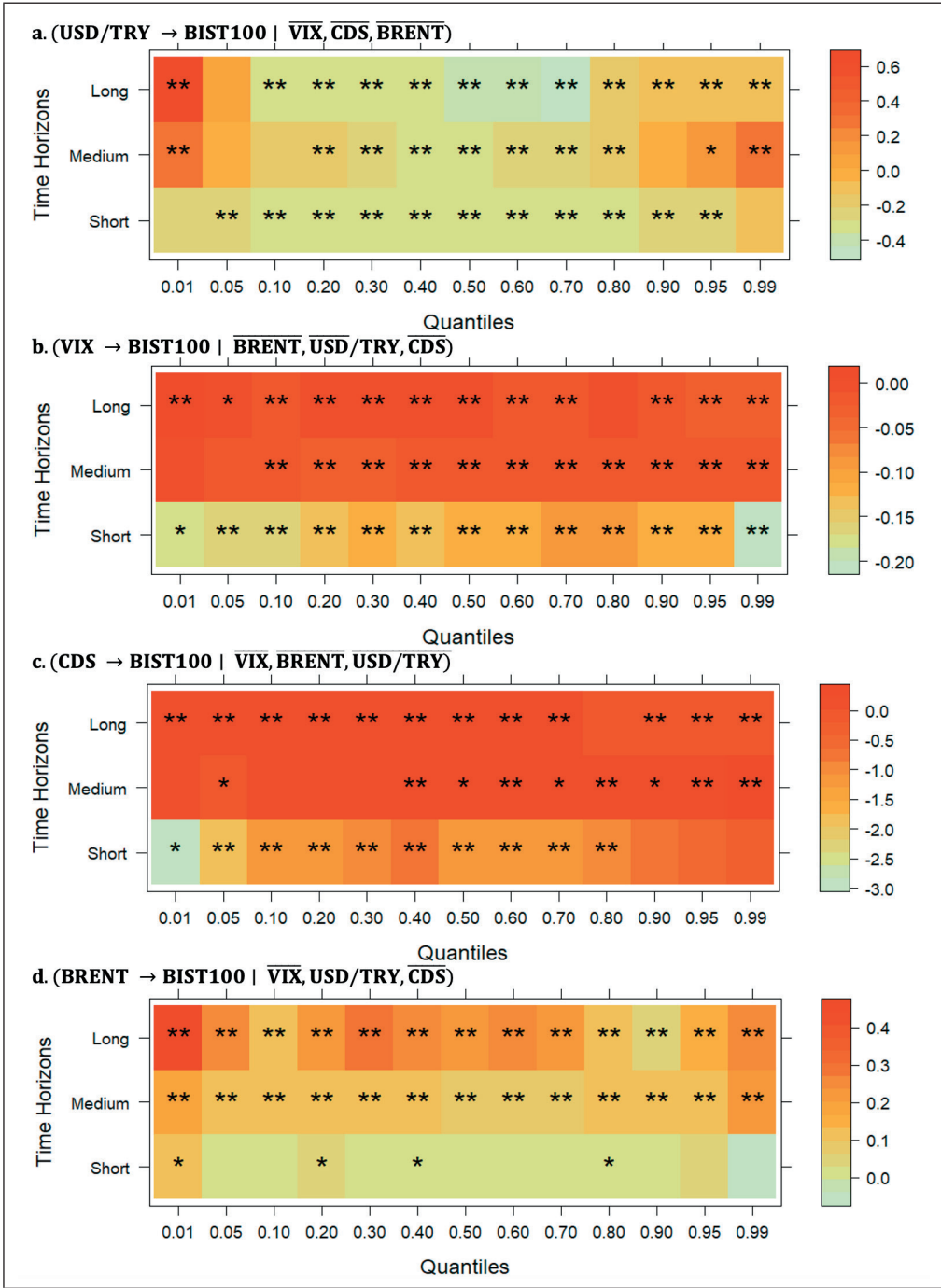
- Gülcemal, T. (2025). Evaluating the Dynamic Connectedness of Borsa İstanbul Stocks and Uncertainty Indices: A QVAR Analysis. *Cumhuriyet University Journal of Economics & Administrative Sciences/Cumhuriyet Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 26(4). <https://doi.org/10.37880/cumuiibf.1749548>
- Güler, S., & Nalın, H. T. (2013). Petrol fiyatlarının İMKB endeksleri üzerindeki etkisi. *Ekonomik ve Sosyal Araştırmalar Dergisi*, 79-97. <https://izlik.org/JA66ZY58FM>
- Güney, S., & Ilgın, K. S. (2019). Yatırım araçlarının BİST-100 endeksi üzerindeki etkisinin değerlendirilmesi. *Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, (53), 226-245. <https://doi.org/10.18070/erciyesiibd.449164>
- Güngör, B., & Polat, A. (2020). Geleneksel yatırım araçlarının hisse senedi fiyatlarına etkisi: BİST'te sektörel bazda karşılaştırmalı bir analiz. *Bingöl üniversitesi iktisadi ve idari bilimler fakültesi dergisi*, 4(1), 79-105. <https://doi.org/10.33399/biibfad.707110>
- Gürbüz, A. (2024). BIST 100 ve katılım 50 endekslerinin döviz kuru, CDS risk primi, CBOE oynaklık endeksi (VIX) ve petrol fiyatları arasındaki ilişkinin incelenmesi. *Kahramanmaraş Süttü İmam Üniversitesi Sosyal Bilimler Dergisi*, 21(2), 769-782. <https://doi.org/10.33437/ksusbd.1400787>
- Han, A. (2025). VIX ile finansal ve makroekonomik göstergeler arasındaki ilişkinin incelenmesi: simetrik ve asimetrik nedensellik analizleri. *Yönetim ve Ekonomi Dergisi*, 32(1), 1-16. <https://doi.org/10.18657/yonveek.1497970>
- İlkhan, C., Çevikgil, D., Aydın, B., & Zeren, F. (2022). Altın fiyatları, ABD doları ve BIST 100 endeksi arasındaki ilişkinin incelenmesi: Türkiye örneği. *Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi*, 3(1), 46-53. <https://izlik.org/JA83DD68FK>
- İltaş, Y., & Güzel, F. (2021). Borsa endeksi ve belirsizlik göstergeleri arasındaki nedensellik ilişkisi: Türkiye örneği. *Hacettepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 39(3), 411-424. <https://doi.org/10.17065/huniibf.821072>
- Jarque, C. M., & Bera, A. K. (1980). Efficient tests for normality, homoscedasticity and serial independence of regression residuals. *Economics letters*, 6(3), 255-259. [https://doi.org/10.1016/0165-1765\(80\)90024-5](https://doi.org/10.1016/0165-1765(80)90024-5)
- Kakacak, K., & Meriç, E., & Temizel, F., Petrol Fiyatlarının BIST100 Endeksi Üzerine Etkisinin Var Yöntemi İle Analizi, *BMIJ*, (2020), 8(5): 3751-3771 doi: <http://dx.doi.org/10.15295/bmij.v8i5.1532>
- Karaca, C. (2024). BİST 100 endeksi üzerinde faiz oranı, altın fiyatı ve döviz kurunun etkisi: fourier ARDL ve fourier kantil nedensellik analizinden kanıtlar. *Pamukkale Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, (65), 9-30. <https://doi.org/10.30794/pausbed.1508076>
- Karaçayır, E. (2025). Analysis of the relationship between credit default swaps (CDS), the fear index (VIX), and BIST 100 using the wavelet coherence model. *Anadolu Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 26(2), 547-568. <https://doi.org/10.53443/anadoluiibf.1625517>
- Kaya, A., & Çoşkun, A. (2015). VIX endeksi menkul kıymet borsalarının bir nedeni midir? Borsa İstanbul örneği. *Cumhuriyet Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 16(1), 175-186. <https://izlik.org/JA22YG45YE>
- Kaya, E. (2015). Borsa İstanbul (BIST) 100 endeksi ile zımni volatilité (VIX) endeksi arasındaki eş-bütünleşme ve granger nedensellik. *Karamanoğlu Mehmetbey Üniversitesi sosyal ve ekonomik araştırmalar dergisi*, 2015(1), 1-6. <https://doi.org/10.18493/kmusekad.24268>
- Kılıç, M., Bekereci, N. E., & Gürbüz, A. (2025). DeFi, Petrol, Altın ve VIX Korku Endeksinin Kırılgan Beşli Ülkelerindeki Hisse Senedi Piyasalarıyla Bağlantısı: Bir Dalgacık Tutarlılığı Analizi. *Ekonomi Politika ve Finans Araştırmaları Dergisi*, 10(1), 332-358. <https://doi.org/10.30784/ep-fad.1598165>
- Koenker, R., & Bassett Jr, G. (1978). Regression quantiles. *Econometrica: journal of the Econometric Society*, 33-50. <https://doi.org/10.2307/1913643>
- Korkmaz, Ö. U., & Başcı, E. S. Petrol fiyatları ve BİST endeksleri arasındaki ilişkinin tespiti. *Turizm Ekonomi ve İşletme Araştırmaları Dergisi*, 5(2), 213-226. <https://izlik.org/JA38HC55CY>

- Kök, D., & Nazlıoğlu, E. H. (2020). Finansal piyasalarda asimetrik nedensellik: BIST100, VIX ve döviz kuru örneği. *Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 55, 245-262. <https://doi.org/10.18070/erciyesiibd.659871>
- Li, G., Li, Y., & Tsai, C. L. (2015). Quantile correlations and quantile autoregressive modeling. *Journal of the American Statistical Association*, 110(509), 246-261. <https://doi.org/10.1080/01621459.2014.892007>
- MacKinlay, A. C. (1997). Event studies in economics and finance. *Journal of economic literature*, 35(1), 13-39. <https://www.jstor.org/stable/2729691>
- Magazzino, C., & Giolli, L. (2021). The relationship among railway networks, energy consumption, and real added value in Italy. Evidence from ARDL and Wavelet analysis. *Research in Transportation Economics*, 90, 101126. <https://doi.org/10.1016/j.retrec.2021.101126>
- Matar, A., Fareed, Z., Magazzino, C., Al-Rdaydeh, M., & Schneider, N. (2023). Assessing the co-movements between electricity use and carbon emissions in the GCC area: evidence from a wavelet coherence method. *Environmental Modeling & Assessment*, 28(3), 407-428. <https://doi.org/10.21203/rs.3.rs-1095996/v1>
- Münyas, T. (2022). VIX korku endeksi ve gelişmekte olan ülke borsaları üzerine ampirik bir analizi. *İstanbul Ticaret Üniversitesi Sosyal Bilimler Dergisi*, 21(43), 1-19. <https://doi.org/10.46928/itacusbe.796019>
- Olayeni, O. R. (2016). Causality in continuous wavelet transform without spectral matrix factorization: theory and application. *Computational Economics*, 47(3), 321-340. <https://doi.org/10.1007/s10614-015-9489-4>
- Önem, H. B. (2022). Döviz kurları ve CDS primi oynaklığının BIST endekslerine yayılım etkisi. *Mehmet Akif Ersoy Üniversitesi Uygulamalı Bilimler Dergisi*, 6 (2), 274-293. <https://doi.org/10.31200/makuubd.1117597>
- Özaydın, O. (2024). Türkiye'nin seçilmiş makro finans değişkenleri üzerine nedensellik analizi: Yapay sınır ağları ve doğrusal nedensellik yöntemleri. *Optimum Ekonomi ve Yönetim Bilimleri Dergisi*, 11(2), 349-365. <https://doi.org/10.17541/optimum.1452225>
- Özhan, E., Özbey, F., & Kandır, S. (2023). VIX korku endeksi ile seçilmiş varlık getirileri arasındaki ilişkilerin araştırılması. *Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 16(2), 297-308. <https://doi.org/10.25287/ohuiibf.1148874>
- Özkan, O., Degirmenci, T., Destek, M. A., & Aydın, M. (2024). Unlocking time-quantile impact of energy vulnerability, financial development, and political globalization on environmental sustainability in Türkiye: Evidence from different pollution indicators. *Journal of Environmental Management*, 365, 121499. <https://doi.org/10.1016/j.jenvman.2024.121499>
- Özkan, O., Tuygun, İ., & Al, Y. (2025). Enerji ve Metal Oynaklıkları ile Türk Borsası Arasındaki İlişkinin Jeopolitik Belirsizlikler Altında İncelenmesi. *Hitit Sosyal Bilimler Dergisi*, 18(2), 450-467. <https://doi.org/10.17218/hititsbd.1552535>
- Özmerdivanlı, A. (2021). Covid-19 pandemisi ile çeşitli finansal göstergeler arasındaki nedensellik ilişkisi: Türkiye örneği. *Ekonomi Politika ve Finans Araştırmaları Dergisi*, 6(IERFM Özel Sayısı), 172-191. <https://doi.org/10.30784/epfad.1022647>
- Percival, D. B., and A. T. Walden. 2000. *Wavelet Methods for Time Series Analysis*. Cambridge University Press.
- Saparca, Ü., & Yenipazarlı, A. (2023). CDS primi, döviz kuru ve BIST 100 endeksi arasındaki nedensellik ilişkisi: Türkiye örneği. *Adnan Menderes Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 10(2), 30-44. <https://doi.org/10.30803/adusobed.1345429>
- Sarı, S. (2024). Ülke ekonomilerinde bir gösterge olarak kredi temerrüt takası (CDS) ve makro belirleyicileri: Türkiye örneği. *Sosyal Bilimler Araştırmaları Dergisi*, 19(1), 10-20. <https://doi.org/10.48145/gopsbad.1420335>
- Sarıtaş, H., & Nazlıoğlu, E. H. (2019). Korku endeksi, hisse senedi piyasası ve döviz kuru ilişkisi: Türkiye için ampirik bir analiz. *Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 12(4), 542-551. <https://doi.org/10.25287/ohuiibf.538592>

- Sever, O. (2025). Dynamic interactions between global risk indicators and the Turkish stock market. *Izmir Democracy University Social Sciences Journal*, 8(2), 299-322. <https://doi.org/10.61127/idosos.1791105>
- Sönmez, Y., Baydaş, Y., & Kılıç, E. (2023). CDS primleri ile seçili BIST endeksleri arasındaki volatilite yayılımı. *Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, (64), 29-34. <https://doi.org/10.18070/erciyesiibd.1173962>
- Şahinler, A. N. (2025). CDS Primleri ve BİST100 Endeksi Arasında Risk durumunda Nedensellik İlişkisi. *İğdır Üniversitesi Sosyal Bilimler Dergisi*, (39), 109-128. <https://doi.org/10.54600/igdirsos-bilder.1617731>
- Şeker, K. (2021). Türkiye’de finansal sistemden sağlanan çeşitli getirilerin VAR modeli ile etkileşimlerinin analizi. *Muhasebe ve Finansman Dergisi*, (92), 183-206. <https://doi.org/10.25095/mufad.947821>
- Şeyranlıoğlu, O., & Çilek, A. (2023). Kredi temerrüt takası (CDS) ile Borsa İstanbul seçili pay endeksleri arasındaki etkileşim. *JOEEP: Journal of Emerging Economies and Policy*, 8(1), 213-229. <https://izlik.org/JA29JK25NK>
- Tekin, B. (2025). Do economic uncertainty and political risk steer CDS dynamics? An analysis of the Türkiye CDS. *International Journal of Islamic and Middle Eastern Finance and Management*, 18(2), 249-270. <https://doi.org/10.1108/IMEFM-05-2024-0215>
- Tekin, B., & Hatipoğlu, M. (2017). VIX endeksi, döviz kuru ve petrol fiyatlarının BİST 100 endeksi üzerindeki etkileri: Bir kuantil regresyon yaklaşımı. *Ordu Üniversitesi Sosyal Bilimler Enstitüsü Sosyal Bilimler Araştırmaları Dergisi*, 7(3), 627-634. <https://izlik.org/JA89YH32ML>
- Topaloğlu, E. E., & Ege, İ. (2020). Kredi temerrüt swapları (CDS) ile Borsa İstanbul 100 endeksi arasındaki ilişki: Kısa ve uzun dönemli zaman serisi analizleri. *İşletme Araştırmaları Dergisi*, 12(2), 1373-1393. <https://doi.org/10.20491/isarder.2020.918>
- Topaloğlu, E. E., Şahin, S., & Görgel, B. (2024). Kredi Temerrüt Takasları (CDS) ile Enflasyon, BIST100 Endeksi ve CBOE VIX Endeksi İlişkisi: Türkiye Üzerine Bir Uygulama. *Muhasebe ve Finansman Dergisi*, (104), 71-94. <https://doi.org/10.25095/mufad.1500311>
- Tufaner, M. B. (2021). Kredi risk primi, döviz kurları ve bazı emtiaların BİST100 Performansına etkisi. *Finansal Araştırmalar ve Çalışmalar Dergisi*, 13(25), 798-810. <https://doi.org/10.14784/maru-facd.976489>
- Tuna, A. (2022). The effects of volatilities in oil price, gold price and VIX index on Turkish BIST 100 stock index in pandemic period. *İstanbul İktisat Dergisi-Istanbul Journal of Economics*, 72(1). <http://doi.org/10.26650/istjecon2021-1034794>
- Tuncay, M. (2025). On the brink of a new world order: Turkish capital markets facing asymmetric shocks of uncertainty factors. *Niğantaşı Üniversitesi Sosyal Bilimler Dergisi*, 13(Özel Sayı), 219-237. <https://doi.org/10.52122/nisantasisbd.1807876>
- Ünal, A. E., Nas, S., & Heybeli, M. (2022). Seçilmiş makroekonomik değişkenler ve beklenti endekslerinin BİST 100 endeksi üzerine etkisi. *Sosyoekonomi*, 30(54), 443-466. <https://doi.org/10.17233/sosyoekonomi.2022.04.23>
- Yavuz, A. E., & Sağlam, A. (2020). Petrol fiyatlarındaki şokların BIST100 endeksi üzerine etkisi. *Ekonomi ve Finansal Araştırmalar Dergisi*, 2(2), 156-172. <https://dergipark.org.tr/en/pub/jeft/article/1029401>
- Yıldırım, E., & Çekiç, A. İ. (2019). Altın, ham petrol, GVZ ve OVX’in Türk finansal piyasalarına simetrik ve asimetrik etkileri. *Uluslararası Yönetim İktisat ve İşletme Dergisi*, 15(3), 714-731. <https://doi.org/10.17130/ijmeh.2019355047>
- Yıldız, B. (2025). Ekonomik belirsizlik altında sermaye piyasası ile bileşik öncü göstergeler arasındaki ilişki: BIST üzerine bir inceleme. *Maliye ve Finans Yazıları*, (124), 394-424. <https://doi.org/10.33203/mfy.1746671>
- Yılmaz, M. Y., & Akıncı, G. Y. (2024). Enerji sektörlerinin piyasalara etkisi (enerji sektörleri ile BİST100 ilişkisi). *Ünye İktisadi ve İdari Bilimler Fakültesi Dergisi*, 6(1), 20-34. <https://izlik.org/JA95TK33ZY>

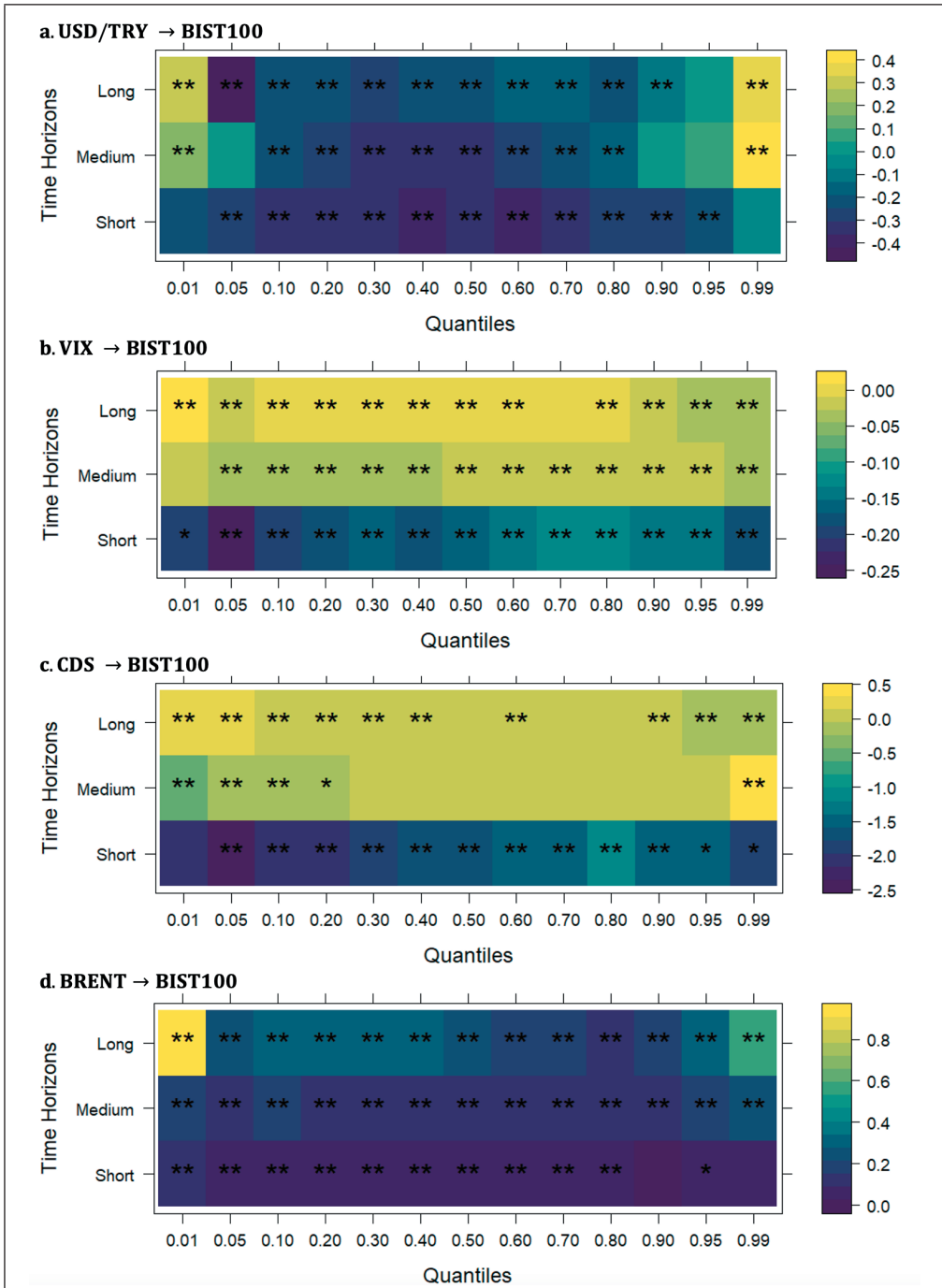
Appendix

Figure 7: MWQR Results



Note: The heatmaps display the estimated slope coefficients in ascending order, ranging from light green to red. The vertical and horizontal axes represent time horizons and quantiles, respectively.

Figure 8: WQR Results



Note: The heatmaps display the estimated slope coefficients in ascending order, ranging from bright yellow to deep purple. The vertical and horizontal axes represent time horizons and quantiles, respectively.

Figure 9: WQGC Results

