*International Journal of Computational and Experimental Science and ENgineering (IJCESEN)*

*Vol. 10-No.4 (2024) pp. 4203-4214*
*http://www.ijcesen.com*



***ISSN: 2149-9144***

**Research Article**

# Short Run Dynamics In Turkish Financial Markets: The BIST 100, The Banking Index, And Key Risk Indicators

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**Article Info:**

**DOI:** 10.22399/ijcesen.5008
**Received :** 28 October 2024
**Accepted :** 23 December 2024

**Keywords**

BIST 100 Index
Banking Index
Credit Default Swaps (CDS)
VIX Index

**Abstract:**

This study examines the relationship between the BIST 100 index and the banking index, in the context of CDS premiums and the VIX index, a global uncertainty indicator. To better understand how Turkish financial markets respond to changes in risk perceptions and sector-specific dynamics, daily data from 2020 to 2023 are used. The analysis jointly applies the ARDL bounds testing approach, which allows variables to be integrated at different orders, and the Toda-Yamamoto causality method, which enables testing causality relationships independently of integration properties. The results of the ARDL bounds testing procedure suggest that the BIST 100 index does not share a long run cointegration relationship with the banking index, CDS, or the VIX index. In contrast, short-run coefficient estimates indicate that the banking index has a strong, statistically significant effect on the BIST 100. While the impact of CDS shows a delayed, asymmetric structure, the effect of the VIX index on the BIST 100 is negative and significant. The results of the Toda-Yamamoto causality analysis further indicate widespread, and in most cases bidirectional, causality among the variables. Overall, the findings suggest that the relationship between the BIST 100 index and the banking sector is characterized not by a long-run equilibrium mechanism, but rather by short-run, reciprocal, and shock-sensitive dynamics. In this respect, the study contributes to a better understanding of risk transmission channels and sectoral leadership mechanisms in Turkish equity markets.

## 1. Introduction

Intersectoral interactions in stock markets are of critical importance for understanding price formation processes and risk transmission mechanisms. The banking sector, in particular, plays a decisive role in shaping overall market indices due to its central position within the financial system, its strong linkage with the real economy through the credit channel, and its market depth. Against this background, the linkage between banking stocks listed on Borsa Istanbul (BIST) and the BIST 100 index, which serves as a broad indicator of overall market performance, has become a focal issue for both market participants and policymakers. Compared to other sectors, the banking sector exhibits a higher sensitivity to financial shocks and shifts in risk perceptions. This sensitivity becomes more pronounced through country risk indicators such as credit default swap (CDS) premiums and the VIX index (Volatility Index), which is widely regarded as a measure of global uncertainty. Increases in CDS premiums signal a deterioration in perceptions of country risk, while rises in the VIX index reflect heightened global risk aversion. These risk factors can be transmitted to the broader market through the banking sector, thereby exerting a significant influence on the short-run dynamics of the BIST 100 index.The ARDL bounds test does not yield empirical evidence supporting a stable long-run cointegrating relationship between the BIST 100 index and the banking index, CDS premiums, or the VIX index. A substantial portion of the existing literature focuses on the relationship between CDS premiums and the BIST 100 index, while the banking sector is either assessed indirectly or excluded from the analysis altogether. However, when the sectoral composition of the BIST 100 index is considered, banking stocks are observed to carry a pronounced weight in shaping both the index's direction and volatility. This observation necessitates a separate and direct examination of the relationship between the banking index and the BIST 100 index. On the other hand, analyzing relationships among financial time series solely within a long-run equilibrium framework may overlook short-term shocks and transitory dynamics prevailing in financial markets. Particularly during periods of rapidly changing risk perceptions, such relationships are likely to exhibit a short-run, shock-driven structure. Therefore, it is essential to analyze the relationship between the banking index and the BIST 100 index by jointly considering both its short run and long-run dimensions.This study explores the interaction between the BIST 100 index and the banking index by embedding the analysis within a broader risk perspective that jointly accounts for country risk, measured by CDS premiums, and global uncertainty, as reflected in the VIX index. To this end, the study adopts two complementary methodological approaches to capture both the dynamic structure and the directional nature of the relationship between the BIST 100 index and the banking index. Specifically, the ARDL approach is employed to analyze short- and long-run relationships, while the Toda–Yamamoto causality method is utilized to investigate causality among the variables. The joint application of these methods enables a more integrated assessment of short-run shocks and mutual interactions in financial markets. By focusing explicitly on the interaction between the banking index and the BIST 100 index, this study provides empirical evidence of the banking sector's pivotal role in shaping overall market behavior. Moreover, by incorporating key risk indicators such as CDS premiums and the VIX index, it sheds light on the specific risk channels through which this interaction operates.

## 2. Literature Review

Given that the banking sector constitutes the backbone of the financial system, it is expected to exhibit a higher degree of sensitivity to country risk. In this context, a long-run cointegration relationship has been identified between Türkiye's CDS premiums, the BIST Banking Index, and individual bank stocks. The findings indicate that increases in CDS premiums exert negative effects on the banking index and certain bank shares, while the direction and causality structure of this relationship varies across banks [1]**.** Bidirectional causality between CDS premiums and the BIST Banking Index has been detected, indicating that the banking sector is not only influenced by country risk but also contributes to shaping risk perceptions [2]**.** Similarly, the banking index has been identified as a significant determinant of CDS premiums. Taken together, these findings suggest that the banking sector functions as a central transmission channel in the relationship between CDS premiums and stock market dynamics [3]**.** Empirical studies focusing on CDS premiums and the BIST 100 index largely converge on the finding that the relationship between the two tends to be negative. Increases in CDS premiums have been found to lead to declines in the BIST 100 index, indicating that rising country risk adversely affects stock prices [4]**.** Evidence supporting this negative relationship is further reinforced by studies employing different methodological approaches. In particular, a long-run negative relationship between CDS premiums and the BIST 100 index has been identified using the ARDL framework, while increases in CDS premiums have been shown to adversely affect stock market performance under different regimes within a Markov regime-switching framework [5,6]. Similarly, CDS premiums have been found to exert negative effects on BIST indices in both the short and long run [7,8]**.** In contrast, some studies argue that no statistically significant long-run relationship exists between CDS premiums and the BIST 100 index. Empirical findings indicate the absence of a stable and linear long-run relationship based on cointegration and causality analyses, while other evidence suggests that the linkage between CDS premiums and the BIST 100 index evolves in response to regime changes and time-specific shocks [9,10]. These mixed findings indicate that the nature of the relationship is sensitive to sample periods, data frequency, and the econometric methods employed.Focusing on the direction of causality, bidirectional causality between CDS premiums and the BIST 100 index has been identified, with similar findings reported in subsequent studies [11–13]**.** Examining asymmetric effects, positive and negative shocks have been shown to affect the CDS–BIST relationship differently [14]**.** Finally, studies emphasizing the volatility dimension document the presence of causality in variance and bidirectional volatility spillovers between CDS premiums and BIST indices [15,16]**.** Taken together, these findings suggest that the CDS-BIST relationship operates not only through mean effects but also via risk and uncertainty channels.Research on the interaction between the VIX index, commonly viewed as a gauge of global uncertainty, and Borsa Istanbul generally finds a negative and statistically significant relationship [17]**.** These findings suggest that stock markets in emerging economies tend to be more fragile during periods of global risk aversion. More recent studies emphasize that the impact of the VIX on Borsa Istanbul is not linear; rather, it varies depending on market regimes, volatility conditions, and prevailing market dynamics [18,13,15].The broader literature indicates that the interaction between CDS premiums and Borsa Istanbul indices is typically negative and time varying, with evidence of causality in many cases. However, empirical findings are not uniform, as the estimated direction and magnitude of the relationship vary across econometric frameworks, sample periods, index definitions, and the global economic environment. In this respect, studies that jointly examine the banking index together with global risk indicators and country risk premiums remain relatively limited in the existing literature.By jointly analyzing the interaction between the BIST 100 index and the banking index alongside key risk indicators namely CDS premiums and the VIX index and by applying the ARDL and Toda–Yamamoto approaches in combination, this study offers a cohesive contribution that complements the existing body of literature.

## 3. Material and Methods

### 3.1. Data Set and Variables

In this study, the relationship between the BIST 100 Index and the BIST Banking Index traded on Borsa Istanbul is analyzed together with indicators of country risk and global risk perception. To this end, four main variables are employed: the BIST 100 Index (LOG_X100), the BIST Banking Index (LOG_XBANK), Türkiye's Credit Default Swap premium (LOG_CDS), and the VIX index as a global uncertainty indicator (LOG_VIX).The BIST 100 index serves as the main indicator of overall performance in the Turkish equity market. The banking index reflects the influence of the banking sector, which occupies a central position within the financial system, on overall market behavior. The CDS premium is a market-based indicator that measures country risk perception and reflects investors' risk expectations regarding the Turkish economy. The VIX index is widely used as a proxy for risk aversion behavior and the level of uncertainty in global financial markets.The analysis relies on daily data for the 2020-2023 period, which restricts the sample to dates for which all variables are jointly available. Data for the BIST 100 Index and the BIST Banking Index are obtained from the Borsa Istanbul Data Store, while CDS premiums and VIX index data are sourced from international financial data providers.

***Table 1.*** *Description of Variables and Data Sources*

| **Dependent variable** | **Independent variable** | | |
|---|---|---|---|
| LOG_X100 | LOG_XBANK | LOG_CDS | LOG_VIX |
| Borsa Istanbul (BIST) 100 Index | Borsa Istanbul (BIST) Banking Index | Credit Default Swap (CDS) Premium for Türkiye | Volatility Index (VIX) |
| Data Source: Borsa Istanbul Data Store | Data Source: Borsa Istanbul Data Store | Data Source: www.investing.com | Data Source: www.investing.com |

### 3.2. Methodology

To explore the short- and long-run behavior of the relationship between the BIST 100 index and the banking index, this study relies on time-series econometric methods. The empirical investigation begins with an assessment of the stationarity properties of the variables. It then proceeds to explore both short- and long-run relationships using the ARDL framework, which allows variables integrated at different orders to be analyzed jointly within a unified modeling structure. In the final stage, the Toda–Yamamoto causality approach is applied in order to examine the direction of causality among the variables without imposing restrictions related to their integration properties. This multi-stage methodological design enables a comprehensive analysis of financial market interactions by capturing both their dynamic behavior and directional structure.

Time-series stationarity properties are commonly examined using the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and KPSS tests.

The general regression equation underlying the ADF test is presented below:

ADF – Constant Model:

$$\Delta y_t = \alpha + \beta y_{\{t-1\}} + \sum_{\{i=1\}_i^{\{k\}\gamma} \Delta y_{\{t-i\}}} + \varepsilon_t \quad (1)$$

ADF – Constant + Trend Model:

$$\Delta y_t = \alpha + \delta t + \beta y_{\{t-1\}} + \sum_{\{i=1\}_i^{\{k\}\gamma} \Delta y_{\{t-i\}}} + \varepsilon_t \quad (2)$$

where;

Δ: first difference operator,
t: deterministic time trend,

k: optimal lag length,
ε□: white-noise error term.

The null hypothesis is defined as $\beta = 0$, indicating the presence of a unit root in the series in the ADF test.

The Phillips-Perron (PP) test, like the ADF test, examines the unit root hypothesis; however, it addresses potential autocorrelation and heteroskedasticity in the error terms through nonparametric corrections.

The regression equations underlying the PP test are specified as follows:

PP -Constant Model: $y□ = \alpha + \beta y□_{-1} + \varepsilon□$ (3)

PP- Constant+Trend Model: $y□ = \alpha + \delta t + \beta y□_{-1} + \varepsilon□$ (4)

In contrast to the ADF test, the PP approach does not rely on lagged difference terms in its regression specification. Instead, potential autocorrelation and heteroskedasticity in the error process are corrected using Newey–West type adjustments, and statistical inference is based on the critical values reported by MacKinnon [19].

Unlike the ADF and PP tests, the KPSS test adopts stationarity as the null hypothesis. In this respect, it serves as a complementary tool for determining the integration properties of time series.

KPSS – Level Stationarity Model:

$$y_t = \mu_t + \varepsilon_t \quad (5)$$

$$\mu_t = \mu_{\{t-1\}} + u_t \quad (6)$$

KPSS – Trend Stationarity Model:

$$y_t = \mu_t + \delta t + \varepsilon_t \quad (7)$$

$$\mu_t = \mu_{\{t-1\}} + u_t \quad (8)$$

where;

μ□: random walk process,
u□: independently and identically distributed error term
ε□: stationary error component.

In the KPSS framework, stationarity either around a constant level or a deterministic trend is taken as the null hypothesis. When the test statistic exceeds its critical threshold, this assumption of stationarity is rejected. The unit root evidence shows that the variables exhibit mixed orders of integration, namely I(0) and I(1). This mixed integration structure makes the ARDL framework particularly suitable, as it permits variables integrated at different orders to be analyzed within a single modeling strategy.

Accordingly, the ARDL approach is employed in this study to examine both the short-run and long-run relationships among the variables.

The general ARDL ($p$, $q_1$, $q_2$, $q_3$) model employed in this study is specified as follows:

$$\text{LOG\_X100}_t = \alpha_0 + \sum_{i=1}^{p} \phi_i \ \text{LOG\_X100}_{t-i} + \sum_{j=0}^{q_1} \beta_j \ \text{LOG\_XBANK}_{t-j} + \sum_{k=0}^{q_2} \gamma_k \ \text{LOG\_CDS}_{t-k} + \sum_{m=0}^{q_3} \delta_m \ \text{LOG\_VIX}_{t-m} + u_t \quad (9)$$

where;

$\alpha_0$ : the constant term,
$\varphi_i$: the coefficients of the lagged dependent variable,
$\beta_j$, γ□ and δ□ : the coefficients associated with the banking index, CDS premiums, and the VIX index, respectively,
u□: the error term.

To examine the presence of a long run cointegration relationship among the variables, the ARDL framework is re-expressed in its error correction form, as presented below:

$$\Delta LOG\_X100_t = \alpha_0 + \sum_{i=1}^{p-1} \alpha_i \Delta LOG\_X100_{t-i} + \sum_{j=0}^{q_1-1} \beta_j \Delta LOG\_XBANK_{t-j} + \sum_{k=0}^{q_2-1} \gamma_k \Delta LOG\_CDS_{t-k} + \sum_{l=0}^{q_3-1} \delta_l \Delta LOG\_VIX_{t-l} + \lambda_1 LOG\_X100_{t-1} + \lambda_2 LOG\_XBANK_{t-1} + \lambda_3 LOG\_CDS_{t-1} + \lambda_4 LOG\_VIX_{t-1}$$

$$+\varepsilon_t \quad (10)$$

where;
Δ denotes the first-difference operator,
λ coefficients capture the long-run relationship through the lagged level variables,
ε□ represents the error term.

The existence of a long-run cointegration relationship is evaluated by testing whether the λ coefficients are jointly statistically significant. For this purpose, the ARDL bounds testing approach proposed by Pesaran, Shin, and Smith is employed [20].

The hypotheses of the ARDL bounds testing procedure are formulated as follows:

$$H_0: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0 \ \ (No\ cointegration)$$

$$H_1: \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq 0 \ (Cointegration\ exist)$$

The calculated F-statistic is compared with the corresponding lower and upper critical bounds reported by Pesaran, Shin, and Smith [20]. When the test fails to indicate cointegration, the analysis proceeds by focusing on the model's short-run dynamics. The Unrestricted Error Correction Model (UECM), which represents the error correction form of the ARDL framework, allows the short-run dynamics and the long-run relationship to be analyzed simultaneously.Causality relationships among the variables are analyzed using the Toda–Yamamoto approach, which provides reliable inference regardless of the integration orders of the series [21]. Within this framework, a VAR model of order (p + d_max) is estimated, where d_max denotes the maximum order of integration among the variables and p represents the optimal lag length.

Toda–Yamamoto VAR Model:

$$Y_t = + \sum_{i=1}^{p+d_{max}} A_i Y_{t-i} + \varepsilon_t \quad (11)$$

where,

d_max :maximum order of integration among the variables,
$p$ :optimal lag length of the VAR model.
When adapted to the variables employed in this study, the vector Y□ is defined as:

Y□ = [LOG_X100□, LOG_XBANK□, LOG_CDS□, LOG_VIX□]′

$A_i$ is represents the coefficient matrices, and ε□ denotes the vector of error terms.

The joint use of the ARDL and Toda–Yamamoto approaches in this study provides a methodologically complementary framework. The ARDL framework makes it possible to analyze short- and long-run relationships within a unified modeling structure when variables are integrated at the I(0) and I(1) levels, while simultaneously allowing the presence of a long-run cointegration relationship to be examined empirically via the bounds testing approach. Importantly, even in cases where cointegration cannot be established by the ARDL bounds test, the short-run dynamics can still be analyzed in a reliable manner. By contrast, the Toda–Yamamoto approach offers a key advantage: it allows for testing causality relationships among variables independently of their integration properties and cointegration requirements. Accordingly, while the ARDL framework is employed to investigate short-run interactions, the Toda–Yamamoto method is used to identify the direction and structure of causality, thereby providing a comprehensive assessment of the underlying dynamics.

## 4. Results and Discussions

### 4.1. Unit Root Tests

When conducting stationarity analysis in time series, the appropriate specification of deterministic components is of critical importance, as it directly affects the reliability of unit root test results [22,23]. In this study, the stationarity properties of the LOG_X100, LOG_XBANK, LOG_CDS, and LOG_VIX series are evaluated following a three-stage procedure. In the first stage, graphical analysis is employed to examine the time path of the series, with particular attention to potential indicators of deterministic trends, structural breaks, or regime shifts. In the second step, unit root behavior is examined by applying the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests under both constant and constant-plus-trend specifications. In the final stage, the KPSS test is used to enhance the robustness of the inference and to reach a definitive conclusion regarding whether the series are stationary in levels or around a deterministic trend. This comprehensive approach allows the integration orders of the variables to be determined reliably and consistently. First, an examination of the time-path plots of the series (Figure 1) indicates that none of the variables follows a linear deterministic trend. Although the LOG_X100 and LOG_XBANK series display an

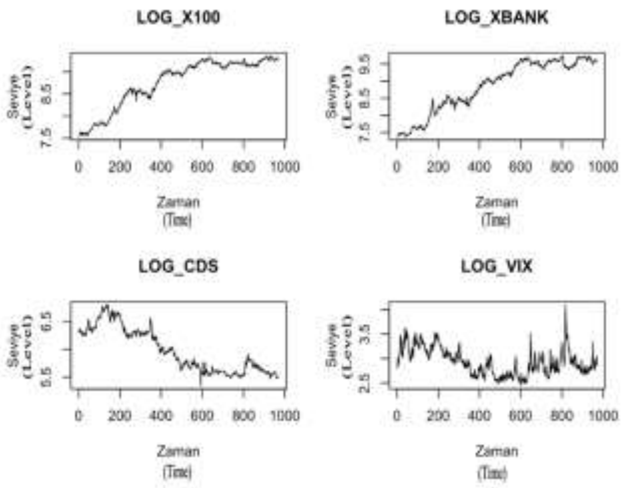


**Figure 1.** *Time Path Plots of the Series*

overall upward tendency, this movement is not linear; rather, it is characterized by episodic breaks, sharp jumps, and shifts across volatility regimes. Such behavior reflects a stochastic trend structure typical of financial time series rather than a deterministic trend. The LOG_CDS series exhibits a gradual downward tendency over the long run; however, this pattern is likewise non-linear and appears to be driven by stochastic movements associated with large-scale macro financial shocks. By its very nature, the LOG_VIX series does not display a trend and is instead dominated by high-frequency volatility shocks. Overall, the graphical evidence points to stochastic trends driven by random shocks rather than deterministic trend components.Stationarity is assessed through the ADF, PP, and KPSS tests, each estimated under model specifications that include either a constant alone or a constant together with a deterministic trend.

***Table 2.*** *Unit Root Test Results*

| Variable | ADF intercept | ADF trend | PP intercept | PP trend | KPSS level | KPSS trend | Result |
|---|---|---|---|---|---|---|---|
| LOG_X100 | τ = –2.345 (ns) | τ = –1.227 (ns) | Z = –3.535 (p≥0.10) | Z = –3.535 (p≥0.10) | **10.579*** | **2.621*** | **I(1)** |
| LOG_XBANK | τ = –1.807 (ns) | τ = –1.468 (ns) | Z = –6.456 (p≥0.10) | Z = –6.456 (p≥0.10) | **11.289*** | **2.223*** | **I(1)** |
| LOG_CDS | τ = –0.972 (ns) | τ = –2.584 (ns) | Z = –12.445 (p≥0.10) | Z = –12.445 (p≥0.10) | **10.664*** | **1.296*** | **I(1)** |
| LOG_VIX | τ = –3.845 (***) | τ = –4.345 (***) | Z = –41.180 (p<0.05) | Z = –41.180 (p<0.05) | **3.974*** | **1.555** | **I(0)** |

**Note:** τ and Z denote ADF and PP test statistics, respectively. *, **, and *** indicate significance at the 10%, 5%, and 1% levels. ns denotes non-significance. KPSS statistics exceeding critical values imply rejection of the null hypothesis of stationarity.

The unit root test results for the LOG_VIX series indicate a limited degree of divergence across the applied tests. Both the ADF and PP tests provide strong evidence that the LOG_VIX series is stationary under models with an intercept as well as with an intercept and a deterministic trend. In contrast, the KPSS test rejects the null hypothesis of stationarity, a result that is consistent with the well documented tendency of the KPSS test to over-reject stationarity in financial time series characterized by high volatility and abrupt jumps. Given the inherent structure of the VIX index, which embodies high-frequency volatility shocks, the KPSS test is likely to yield more sensitive outcomes for this series.Accordingly, in determining the order of integration of LOG_VIX, the consistent results obtained from the ADF and PP tests are jointly evaluated together with the theoretical properties of the series and the graphical analysis, leading to the classification of LOG_VIX as an I(0) process. By contrast, the LOG_X100, LOG_XBANK, and LOG_CDS series are identified as non-stationary based on the ADF test results, while the KPSS test further rejects the null hypothesis of level stationarity for these variables, indicating integration of order one. Although the CDS series appears stationary at level according to the PP test, the combined evidence from the ADF statistic and the trend-based KPSS test suggests that treating this series as I(1) is methodologically more appropriate. Accordingly, LOG_X100, LOG_XBANK, and LOG_CDS are classified as I(1) variables, whereas LOG_VIX is regarded as integrated of order zero.Taken together, the empirical results show that the variables are characterized by mixed integration orders, specifically I(0) and I(1). From a methodological standpoint, this justifies the use of the ARDL bounds testing approach proposed by Pesaran, Shin, and Smith, as it allows the joint modeling of I(0) and I(1) variables without requiring any series to be integrated of order I(2) [20]. Moreover, the fact that the dependent variable is integrated of order I(1) further reinforces the suitability of the ARDL methodology for long-run relationship analysis.The appropriate lag structure for the ARDL model is selected based on the Akaike Information Criterion (AIC), following the framework proposed by Pesaran, Shin, and Smith [20]. For this purpose, all possible ARDL(p, $q_1$ , $q_2$ , $q_3$ ) specifications are evaluated by allowing up to a maximum of five lags for the dependent variable (LOG_X100) and up to five lags for each explanatory variable (LOG_XBANK, LOG_CDS, and LOG_VIX).

***Table 3.*** *ARDL Top 10 Model*

| Model | LOG X100 | LOG XBANK | LOG CDS | LOG VIX | AIC |
|---|---|---|---|---|---|
| **1** | 3 | 2 | 2 | 1 | **–5802.450** |
| **2** | 3 | 3 | 2 | 1 | –5801.856 |
| **3** | 2 | 2 | 2 | 1 | –5801.510 |
| **4** | 3 | 2 | 3 | 1 | –5800.682 |
| **5** | 3 | 2 | 2 | 2 | –5800.509 |
| **6** | 1 | 1 | 0 | 1 | –5800.422 |
| **7** | 3 | 3 | 2 | 2 | –5799.910 |
| **8** | 2 | 2 | 2 | 2 | –5799.747 |
| **9** | 2 | 1 | 2 | 1 | –5799.576 |
| **10** | 1 | 2 | 0 | 1 | –5798.903 |

Based on the comparison of AIC values, the ARDL(3,2,2,1) specification is identified as the model with the lowest AIC among all competing alternatives (AIC = -5802.450). For this reason, the analysis is conducted using the ARDL(3,2,2,1) specification as the baseline model for examining both short and long-run relationships.

## 4.2. ARDL Bounds Test and Long Run Coefficient Estimates

Under the ARDL(3,2,2,1) specification, long-run coefficients are obtained through the error-correction representation. Their economic relevance, however, hinges on whether a cointegration relationship exists among the variables. For this reason, the ARDL bounds test must first establish the presence of cointegration before any long-run interpretation can be made [20].

***Table 4.*** *Long-Run Coefficient Estimates From the ARDL Model*

| | COEFFIC. | STD. ERR. | T-STAT. | P | SIG. |
|---|---|---|---|---|---|
| **LOG_ XBANK** | 0.8584 | 0.1033 | 8.3131 | 0.000 | *** |
| **LOG_ CDS** | 0.4957 | 0.2198 | 2.2556 | 0.024 | ** |
| **LOG_ VIX** | -0.2396 | 0.1321 | -1.8134 | 0.069 | * |

**Note**: Statistical sign. at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

***Table 5.*** *ARDL Bounds Test Results (case iii: constant and trend)*

| F-statistic | k | P-value | Lower bound (%1) | Upper bound (%1) |
|---|---|---|---|---|
| **2.2945** | 3 | 0.4271 | 5.15 | 6.36 |

The bounds test results show that the computed F-statistic (2.2945) remains below the lower critical bound across all conventional significance levels. Based on the critical values reported by Pesaran, Shin, and Smith, this outcome indicates that the model does not exhibit a cointegration relationship [20]. Consequently, there is no statistical evidence supporting the existence of a long-run equilibrium between LOG_X100 and the explanatory variables LOG_XBANK, LOG_CDS, and LOG_VIX. In light of this result, the long-run coefficient estimates are not interpreted in economic terms.Nevertheless, the ARDL framework remains suitable for analyzing short-run dynamics even in the absence of cointegration [20]. In line with this argument, short-run interactions among the variables are examined through the UECM representation, and the results are interpreted not as indicators of a long-run equilibrium relationship but rather as reflections of short-run and transitory market dynamics. Consequently, the primary focus of the analysis shifts toward the evaluation of short-run dynamics and the application of the Toda-Yamamoto causality test, which is well-suited for assessing long-run causality in the absence of cointegration.

## 4.3. Short Run Coefficient Estimates (UECM)

The short-run coefficients obtained from the UECM representation of the ARDL(3,2,2,1) model indicate that the BIST 100 index exhibits a structure that is sensitive, in the short run, both to its own past realizations and to key variables reflecting financial market conditions.

***Table 6.*** *Short Run Coefficient Estimates of the ARDL(3,2,2,1) Model (UECM)*

| Variable | Coeff. | Std. err. | t-stat | P | Sig. |
|---|---|---|---|---|---|
| d(LOG_ X100(-1)) | 0.0091 | 0.032 | 0.286 | 0.77 | |
| d(LOG_ X100(-2)) | *-0.0564* | *0.019* | *-2.878* | *0.00* | *** |
| d(LOG_ XBANK) | 0.5356 | 0.013 | 39.007 | 0.00 | *** |
| d(LOG_ XBANK(-1)) | *-0.0429* | *0.022* | *-1.946* | *0.05* | * |
| d(LOG_CD) | -0.0005 | 0.013 | -0.038 | 0.96 | |
| d(LOG_ CDS(-1)) | -0.0419 | 0.013 | -3.197 | 0.00 | *** |
| d(LOG_VIX) | -0.0223 | 0.005 | -4.256 | 0.00 | *** |

Note: Significance levels are denoted as * p < 0.10, ** p < 0.05, and *** p < 0.01.

The lagged values of the BIST 100 index provide informative insights into its short-run dynamics. The insignificance of the coefficient on d(LOG_X100(-1)) indicates that short-term movements from the immediately preceding period do not exert a statistically meaningful effect on the current period. By contrast, the coefficient on the second lag is negative and statistically significant at the 1% level, suggesting that price movements from two periods earlier generate a corrective effect in the short run.The banking index emerges as the most influential determinant in the short-run dynamics. The coefficient on d(LOG_XBANK) is large in magnitude and statistically significant at the 1% level, indicating that contemporaneous changes in the banking sector are transmitted directly and strongly to the BIST 100 index. The negative sign and borderline statistical significance of the one-period lagged coefficient suggest that shocks originating in the banking sector tend to be partially corrected in the subsequent period.Short-run effects associated with CDS premiums indicate that changes in country risk are transmitted to the BIST 100 index through a delayed and asymmetric transmission mechanism. While the contemporaneous effect of CDS premiums is statistically insignificant, the one-period lagged coefficient is negative and economically strong.As expected, the VIX variable exerts a negative and statistically significant effect in the short run. This finding confirms that periods of global risk aversion generate immediate downward pressure on the BIST 100 index.Overall, the short-run coefficient estimates indicate that movements in the BIST 100 index are jointly shaped by its own internal dynamics and prevailing global financial conditions. Given that the bounds test does not provide evidence of cointegration, these relationships should be interpreted strictly as short-run interactions rather than manifestations of a stable long-run equilibrium.

### 4.4. ARDL Diagnostic Test Results

This section reports the results of the diagnostic checks conducted on the residuals to evaluate the robustness of the ARDL(3,2,2,1) specification. In order for the model to provide a reliable representation of short-run dynamics, the residuals are expected to satisfy the standard assumptions regarding serial independence, constant variance, normality, and stationarity.The Breusch–Godfrey serial correlation test is employed to examine whether residual autocorrelation up to the fourth order is present in the model. The LM statistic obtained from the Breusch–Godfrey test (LM = 9.1263, p = 0.0580) lies at the margin of the 5% significance level, indicating that the null hypothesis of no autocorrelation cannot be rejected.

***Table 7.*** *ARDL diagnostic test results*

| *Test* | *Test statistic* | *Degrees of freedom* | *P-value* | *Conclusion* |
|---|---|---|---|---|
| *Breusch–Godfrey Serial Correlation Test (LM)* | 9.1263 | 4 | 0.0580 | No serial correlation (borderline) |
| *Breusch–Pagan Heteroskedasticity Test* | 62.978 | 11 | 0.00000000258 | Presence of heteroskedasticity |
| *Jarque–Bera Normality Test* | 466.17 | 2 | < 0.0001 | Residuals are not normally distributed |
| *ADF Residual Stationarity Test (None)* | −14.0716 | — | < 0.01 | Residuals are stationary |

Given the model's dynamic structure, this outcome is acceptable and does not hinder the interpretation of the short-run coefficients. In contrast, the Breusch-Pagan test yields a statistically significant result (BP = 62.978, p < 0.01), indicating a violation of the homoskedasticity assumption for the error terms. Nevertheless, the presence of heteroskedasticity does not undermine the consistency of the ARDL estimates; rather, it may bias the standard error estimates. Accordingly, the use of White heteroskedasticity-robust standard errors is recommended in further inference.The Breusch-Godfrey serial correlation test is employed to examine whether residual autocorrelation up to the fourth order is present in the model. The LM statistic obtained from the Breusch-Godfrey test (LM = 9.1263, p = 0.0580) lies at the margin of the 5% significance level, indicating that the null hypothesis of no autocorrelation cannot be rejected. Given the dynamic structure of the model, this outcome can be regarded as acceptable and does not hinder the interpretation of the short-run coefficients. In contrast, the Breusch-Pagan test yields a statistically significant result (BP = 62.978, p < 0.01), pointing to a violation of the homoskedasticity assumption in the error terms. Nevertheless, the presence of heteroskedasticity does not undermine the consistency of the ARDL estimates; rather, it may bias the standard error estimates. Accordingly, the use of White heteroskedasticity-robust standard errors is recommended for further inference.The Jarque-Bera normality test applied to examine the distributional properties of the residuals indicates a departure from normality (JB = 466.17, p < 0.001). Given the relatively large sample size (T = 969), deviations from the normality assumption are unlikely to materially affect the consistency of the estimators, although caution is warranted when interpreting t-statistics. Finally, the residual-based ADF stationarity test, which is critical for model validity, yields a test statistic of −14.0716. This value lies well below the relevant critical thresholds, providing strong evidence that the residuals are stationary, i.e., integrated of order zero. Overall, this finding confirms that the ARDL specification adequately captures the short-run dynamics and that the model is correctly specified.Overall, the diagnostic test results indicate that the model does not suffer from autocorrelation and that the residuals are stationary, implying that the estimated short-run coefficients are econometrically valid.

### 4.4. Toda-Yamamoto Causality Analysis

To examine the causal directions among the variables, the study employs the augmented VAR approach [21]. This framework is particularly appealing because it allows Wald-based causality tests to be conducted reliably even when the variables exhibit different orders of integration. Based on the unit root test results, all series are found to be integrated of order I(0) or I(1), and the maximum integration order is therefore set to dmax = 1. Given that the optimal lag length is determined as p = 2, the causality analysis is conducted using a VAR (3) specification.

The causality test outcomes are presented in Table 8. Taken together, the results indicate the presence of strong causal linkages among the financial indicators, with bidirectional relationships prevailing in most cases. First, the banking index (LOG_XBANK) is identified as a Granger cause of all other variables in the model (F = 2.1283, p = 0.02416). This result indicates that shocks originating in the banking sector are capable of exerting decisive effects on the BIST 100 index, CDS premiums, and global risk indicators. Similarly, CDS premiums are found to Granger-cause all variables included in the system (F = 2.0124, p = 0.03420). Given the dominant role of country risk premia in shaping financial market dynamics, particularly in emerging market economies, this finding is largely consistent with the existing literature.

***Table 8.*** *Toda–Yamamoto Causality Test Results*

| *Direction of causality* | *F-statistic* | *df1* | *df2* | *P-value* | *Conclusion* |
|---|---|---|---|---|---|
| *LOG_XBANK → (LOG_X100, LOG_CDS, LOG_VIX)* | 2.1283 | 9 | 3812 | 0.0242 | Causality exists |
| *LOG_CDS → (LOG_X100, LOG_XBANK, LOG_VIX)* | 2.0124 | 9 | 3812 | 0.0342 | Causality exists |
| *LOG_VIX → (LOG_X100, LOG_XBANK, LOG_CDS)* | 5.6157 | 9 | 3812 | 9.64e−08 | Causality exists |
| *LOG_X100 → (LOG_XBANK, LOG_CDS, LOG_VIX)* | 3.0360 | 9 | 3812 | 0.0013 | Causality exists |

The strongest causality relationship identified in the study pertains to the VIX index (F = 5.6157, p < 0.0001). This result suggests that fluctuations in global risk appetite are transmitted to Turkish financial markets both rapidly and forcefully. Considering the well-documented sensitivity of emerging economies to capital flows and volatility shocks, the pronounced influence of the VIX reflects an expected market mechanism. The strong causal linkages running from the VIX to all other variables further confirm the high exposure of Turkish financial markets to global volatility conditions.In addition, the BIST 100 index itself is found to be a Granger cause of the other variables, including the banking index and CDS premiums (F = 3.0360, p = 0.00127). This finding implies the presence of feedback effects, whereby domestic market conditions and index movements actively shape broader financial indicators. Taken together, the results indicate a bidirectional flow of information between the banking index and the BIST 100 index. Accordingly, the banking sector not only serves as a leading indicator that anticipates overall market movements but is also simultaneously influenced by prevailing market conditions. This pattern highlights that the price discovery process in Borsa Istanbul is inherently interactive and dynamic in nature.The empirical evidence obtained in this study broadly aligns with the existing literature on the interaction between CDS premiums, the banking sector, and equity markets, while also pointing to notable differences in how the structure of this relationship manifests itself. Previous studies generally document a negative and statistically significant association between CDS premiums and Borsa Istanbul indices [4,11,9]. However, there is no clear consensus as to whether this relationship is driven by a stable long-run equilibrium mechanism or is instead dominated by short-run dynamics.The results of the ARDL bounds test applied in this study indicate that there is no evidence of a long-run cointegration relationship between LOG_X100 and the explanatory variables LOG_XBANK, LOG_CDS, and LOG_VIX. This finding diverges from international empirical studies that identify long-run cointegration relationships across different country samples using the ARDL framework [24]. At the same time, the results are fully consistent with the methodological foundations of the ARDL approach developed by Pesaran and Shin, which does not presuppose the existence of cointegration but instead allows it to be tested empirically [25]. Moreover, the findings are consistent with studies suggesting that the relationship between CDS premiums and stock markets is driven predominantly by short-run, shock-driven, and transitory dynamics rather than by a stable long-run equilibrium mechanism [4,11,9]. In particular, during periods of heightened financial stress and uncertainty, rapid shifts in risk perceptions make it difficult for a persistent long-run equilibrium to emerge between CDS premiums and stock markets.Short-run coefficient estimates reveal that the effect of the banking index (LOG_XBANK) on the BIST 100 index is remarkably strong in both economic magnitude and statistical significance. This finding is consistent with studies emphasizing the central and decisive role of the banking sector in Turkish financial markets [4,9]. The strong and immediate transmission of contemporaneous changes in the banking index to the BIST 100 suggests that the banking sector functions as a leading indicator of overall market movements, pricing them ahead of the broader index. By contrast, the negative sign of the one-period lagged effect indicates that short-term shocks originating in the banking sector tend to be partially corrected in the subsequent period, consistent with earlier studies highlighting short-run adjustment and stabilization mechanisms [11].Short-run evidence related to CDS premiums indicates that changes in country risk are transmitted to equity markets not instantaneously, but through a delayed and asymmetric transmission mechanism. While the contemporaneous effect of CDS premiums is statistically insignificant, the one-period lagged coefficient is negative and highly significant, suggesting that deteriorations in risk perceptions are reflected in market prices only after a certain adjustment process. This finding is consistent with studies that characterize the CDS–BIST relationship as a lagged and short-run interaction rather than an immediate response [4,11].The findings obtained for the VIX index, employed as a measure of global uncertainty, are likewise in line with the existing literature. The negative and economically strong short-run effect of the VIX on the BIST 100 is consistent with Türkiye-focused studies showing that equity markets in emerging economies come under pressure during periods of global risk aversion [17,9]. This result is also consistent with the international literature documenting that global financial shocks are transmitted to stock markets through volatility and causality channels [18]. Taken together, these findings indicate that global volatility shocks are transmitted to Turkish financial markets in a direct and rapid manner.The Toda-Yamamoto causality results point to widespread causal linkages among the variables, with bidirectional relationships emerging in many cases. Most notably, the two-way causality observed between the banking index and the BIST 100 suggests that financial market dynamics are shaped by ongoing mutual interactions and feedback effects. This finding is consistent with the Granger framework, which establishes the theoretical foundations of causality, and with methodological studies demonstrating that causality tests can be conducted reliably regardless of the integration properties of the series [26,27]. In the context of Turkish financial markets, this evidence is also consistent with empirical studies documenting reciprocal interactions between the banking sector and equity markets [4]. Moreover, the strong causality relationships running from the VIX to all variables are consistent with the international literature emphasizing the sensitivity of financial markets to global risk shocks and the transmission of volatility, while the Türkiye-specific evidence further supports this broader framework [18,9].Overall, the findings indicate that the relationship among CDS premiums, the banking sector, and the BIST 100 index is characterized not by a long-run equilibrium linkage but rather by short-run, reciprocal, and shock-sensitive dynamics. In this respect, the results support strands of the CDS-equity market literature that question the existence of a stable long-term equilibrium and instead emphasize the predominance of short-run dynamics [4,11,9].

## 5. Conclusions

This study provides empirical insights into the short- and long-term behavior of Turkish financial markets by exploring the link between the BIST 100 index and the banking index, while explicitly accounting for key risk indicators such as CDS premiums and the VIX index. Using daily data covering the 2020-2023 period, the joint application of the ARDL and Toda–Yamamoto approaches allows the structure of this relationship and the direction of causality to be assessed in an integrated manner. Unit root tests indicate that the variables are integrated at the I(0) and I(1) levels. The outcomes of the ARDL bounds testing procedure indicate that the BIST 100 index does not exhibit a long-run cointegration relationship with the banking index, CDS premiums, or the VIX index. This finding suggests that, in Turkish equity markets, the link between risk perceptions and pricing behavior is shaped not by a persistent equilibrium mechanism, but predominantly by short-run, shock-sensitive dynamics. Short-run coefficient estimates further show that the impact of the banking index on the BIST 100 is remarkably strong in both economic magnitude and statistical significance. The rapid transmission of contemporaneous changes in the banking index to the BIST 100 highlights the leading role of the banking sector in guiding overall market movements. Findings related to CDS premiums indicate that changes in country risk are transmitted to stock markets through a delayed and asymmetric adjustment process. Finally, the negative and statistically significant effect of the VIX index confirms that Turkish equity markets come under pronounced pressure during periods of global risk aversion.The results of the Toda–Yamamoto causality analysis reveal the presence of widespread and, in most cases, bidirectional causality relationships among the variables. In particular, the bidirectional causality between the banking index and the BIST 100 index indicates that market dynamics are shaped by mutual interactions and feedback mechanisms. The causality links identified from CDS premiums and the VIX index toward the other variables further confirm the high sensitivity of Turkish financial markets to both country-specific risk and global uncertainty.Overall, this study shows that the relationship among CDS premiums, the banking sector, and the BIST 100 index is characterized not by a long-run equilibrium structure but by a short-run, reciprocal, and shock-sensitive pattern. By emphasizing the central role of the banking sector in influencing overall market behavior and by considering CDS premiums and the VIX index together as key sources of risk, this study makes a complementary and cohesive contribution to the literature on Turkish financial markets.

## Author Statements:


- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
- **Acknowledgement:** The authors declare that they have nobody or no-company to acknowledge.
- **Author contributions:** The authors declare that they have equal right on this paper.
- **Funding information:** The authors declare that there is no funding to be acknowledged.
- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.


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