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ORIGINAL ARTICLE

THE DYNAMIC RELATIONSHIP BETWEEN BANKING CDS PREMIUMS, THE VIX INDEX AND SOVEREIGN CDS PREMIUMS

Ayşe Nur ŞAHİNLER

Abstract
This study investigates the dynamic relationship between Türkiye's banking sector CDS premiums, the VIX index, and sovereign CDS premiums using a time-varying Granger causality framework over the period from January 4, 2008, to April 19, 2024. The results reveal that causality from the VIX to banking sector CDS premiums is predominantly negative after 2018, indicating that increases in global volatility were associated with a relative stabilization or decline in credit risk perceptions. Conversely, causality from banking sector CDS premiums to the VIX is limited and positive during specific periods of heightened institutional risk. Regarding sovereign CDS dynamics, sovereign risk generally influenced bank-level CDS premiums in isolated periods, while the credit risk of major banks, particularly İş Bank and Akbank, had a more frequent and positive impact on sovereign risk perceptions. These findings emphasize the asymmetric and evolving nature of risk transmission between global volatility, institutional credit risk, and sovereign risk in Türkiye, underlining the importance of accounting for time-varying dynamics in financial market analyses.

Keywords
Banking Sector CDS, CDS, Time-Varying Causality, VIX.

JEL Classification
C32, F30, G15.

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1. INTRODUCTION

The increasing interconnectedness of global financial markets has amplified both the speed and extent of crisis transmission across borders. Over the past few decades, one of the central concerns in international finance literature has been the spillover effects of financial crises from advanced economies to emerging markets (Hassan et al., 2017). In this context, particular attention has been paid to how crises originating in developed countries impact the financial systems of developing economies. Since the 1990s, major financial episodes including the Asian financial crisis, the sovereign defaults of Argentina and Russia, the collapse of Lehman Brothers and the ensuing global financial crisis, as well as the erosion of investor confidence in European sovereign debt markets and the Greek debt crisis have significantly shaped research on sovereign debt markets (De Boyrie and Pavlova, 2016). A common feature of these crises is their propagation through the banking sector, which lies at the core of the financial system. During the 2008 global financial crisis in particular, the banking sector's excessive exposure to structured financial products—often referred to as "toxic assets"—served as a primary transmission channel. In addition, the crisis was deepened not only by vulnerabilities in the private sector but also by fiscal imbalances in several countries. Nations such as Greece, Portugal, Ireland, Spain, and Cyprus faced severe public finance challenges, with short-term budgetary disruptions pushing them to the brink of default. In response, these governments were either compelled to seek financial assistance from institutions such as the European Central Bank (ECB), the International Monetary Fund (IMF), and the European Union (EU), or to implement comprehensive fiscal restructuring programs targeting both their banking and public sectors (Bratis et al., 2018). During this period, financially distressed governments undertook large-scale capital injections to rescue banks; however, these interventions further deteriorated their own fiscal positions. At the same time, banks suffered losses due to the declining value of sovereign bonds they held and rising funding costs. These mutually reinforcing negative effects exemplify how feedback loops between banks and sovereigns can intensify during times of financial stress. Such dynamics have underscored the need for robust analytical frameworks to better understand the complex interlinkages between governments and financial institutions, and to assess how these interactions contribute to the transmission of systemic shocks (Gross and Kok, 2013). Consequently, large-scale and disruptive financial crises have led scholars and policymakers to explore fundamental questions concerning the causes of sovereign defaults and the ways in which markets respond to such events (De Boyrie and Pavlova, 2016).

The high credit risk associated with emerging markets is one of the main reasons why researchers focus on these countries. In this context, one of the key indicators of credit risk, namely credit default swaps (CDS), and their impacts have become increasingly researched and are emerging as a popular topic in recent years. CDS is a contract between two parties, the protection buyer and the protection seller, where the protection buyer is compensated for the loss incurred due to a credit event in a reference instrument (Cont, 2010). It was developed in 1994 by J.P. Morgan Inc. to shift the credit risk exposure from its own balance sheet to the protection sellers (Augustin et al., 2016).

The pricing of CDS contracts is primarily influenced by a variety of macroeconomic factors that directly affect a country's ability to meet its debt obligations. These factors include economic growth (Podpiera & Ötker, 2011), external debt and exchange rates (Asonuma, 2014; Popov & Wiczer, 2014), public debt (Aizenman et al., 2013; Peat et al., 2015; Montez & Souza, 2020), and oil prices (Dai & Serletis, 2018; Chuffart & Hooper, 2019).

In this study, the focus is on the global volatility index and sovereign CDS, particularly their impact on banking sector CDS premiums. Theoretically, the interdependence between sovereign and banking sectors results in risk transmission through several key channels. The first of these is the sovereign exposure channel, where banks hold significant amounts of sovereign debt to manage liquidity and credit risk exposure. This creates a direct link between banks and sovereign risk, making the financial health of the government a crucial factor influencing the stability of the banking sector. The

second channel is the safety net channel, which emphasizes the role of government guarantees and central bank support in maintaining bank stability. However, as sovereign risk rises, the government's ability to assist struggling banks diminishes, potentially exacerbating financial instability. The third channel, the macroeconomic channel, demonstrates how increasing sovereign risk can lead to negative economic consequences, such as higher borrowing costs and economic contraction. This, in turn, impacts the quality of bank loan portfolios and threatens the overall stability of the banking system (Dell'Ariccia, 2018).

In parallel with this theoretical framework, the sensitivity of CDS to volatility is strongly tied to shifts in market participants' risk perceptions, a relationship that becomes especially pronounced during periods of heightened volatility. Alexander and Kaeck (2008) empirically demonstrated that increases in the VIX index lead to statistically significant widening of CDS spreads. Brunnermeier and Pedersen (2009) explain these dynamics through the interaction between market liquidity and funding liquidity. As volatility rises, funding requirements increase, restricting leverage and leading to liquidity constraints. The procyclical behavior of financial intermediaries further amplifies this process. Adrian and Shin (2010) demonstrate that when asset prices decline, financial institutions tend to contract their balance sheets, which in turn exacerbates liquidity conditions in the market. The reduction in liquidity results in higher borrowing costs, thereby elevating credit risk and, ultimately, expanding CDS spreads (Tang and Yan, 2007). Ericsson et al. (2009) also provide empirical evidence that increases in leverage ratios are positively and significantly related to wider CDS spreads, reinforcing the notion that liquidity constraints and credit risk are intrinsically linked.

The primary objective of this study is to investigate the relationship between the banking sector CDS premiums in Türkiye and the VIX index, as well as the link between sovereign CDS premiums and bank CDS premiums, by employing both full-sample analyses and time-varying models. Unlike the majority of existing studies, which predominantly focus on Türkiye's sovereign CDS premiums, this research uniquely emphasizes the banking sector's CDS dynamics. Furthermore, to the best of our knowledge, this study is among the first to explore how the direction and strength of these relationships evolve over time by incorporating time-varying coefficient analyses. In doing so, it provides a more comprehensive and dynamic understanding of financial risk transmission mechanisms in the Turkish context.

2. LITERATURE REVIEW

The 2008 financial crisis, followed by the subsequent sovereign debt crises, led to a rapid increase in research on CDS. In this section, the focus is on studies that examine the relationship between the VIX (Volatility Index) and CDS spreads, with particular emphasis on sector-specific research, especially those concerning the CDS spreads of the financial and banking sectors.

Tamakoshi and Hamori (2013) examined the relationship between sovereign CDS spreads and banking sector CDS spreads using causality analysis at both the mean and variance levels. Their analysis, covering the period from the beginning of 2008 to December 2011, found that banking sector CDS spreads exhibit a unidirectional causality towards sovereign CDS spreads both in terms of the mean and variance. However, during the crisis period, variance-based causality analysis revealed that sovereign CDS spreads had a significant causality effect on banking sector CDS spreads. In a subsequent study in 2014, the same authors analyzed the interactions between CDS spreads in the financial sector using similar econometric techniques, for the period from January 2004 to December 2011. Their results showed that CDS spreads in the banking sector had a significant impact on the CDS spreads in the service and insurance sectors, both in terms of mean and variance causality. In a later study conducted by Tamakoshi and Hamori (2016), the relationship between CDS spreads in three sectors—banking, insurance, and other financial sectors—was analyzed for the case of the UK, using the DCC-GARCH and Diebold-Yılmaz methods. The study found that the correlation between the sectors increased during the 2008 financial crisis but decreased afterward, providing evidence of

sectoral contagion effects.

Hammoudeh and Sari (2011) employed the ARDL method to examine the relationship between CDS spreads for three financial sectors (banking, financial services, and insurance), the S&P 500 stock market index, and both the 10-year Treasury bond rate and 6-month Treasury bill rate over the period from January 1, 2004, to October 4, 2009. The authors found that during the crisis period, the relationships between financial markets became more intricate, with a notable increase in short-term contagion across the markets. Specifically, the financial services sector was highlighted as crucial in maintaining stability within the system, suggesting the need for regulatory measures to ensure the sector's resilience. In contrast, the study indicated that existing regulations for the banking and insurance sectors were sufficient, as these sectors did not exhibit significant transmission of risk to long-term interest rates.

Similarly, Chen et al. (2013) and Hammoudeh et al. (2013) both investigated the dynamics of CDS spreads across the banking, financial services, and insurance sectors. However, their approaches differed significantly. Chen et al. (2013) employed Momentum-Threshold Autoregressive (M-TAR) models to capture asymmetric adjustments and cointegration among the sector CDS pairs. Their results revealed that adjustments occur more rapidly when the spreads are below the threshold, with only one CDS spread from each sector pair contributing to the long-run equilibrium. On the other hand, Hammoudeh et al. (2013) used VECM and cointegration techniques to analyze data from January 2004 to March 2009, and their findings indicated that, in the long run, the insurance sector exhibited the largest adjustments. However, in the short run, it was the banking sector that led the other sectors in CDS pricing.

Stanga (2011) employed a VAR model to analyze the relationship between sovereign and banking CDS spreads for Ireland and Spain over the period from January 2007 to March 2011. The study found a strong relationship between the two variables in both countries. According to the author, there was a robust link between sovereign and banking CDS, where an increase in bank risk was associated with a rise in sovereign risk due to the potential need for government bailouts. Consequently, while government bailout packages reduced bank risk, they elevated sovereign CDS spreads, thus increasing the public debt risk.

In a similar vein, Gross and Kok (2013) and Santamaría (2014) analyzed the transmission of financial risk between banks and sovereigns during financial crises. Gross and Kok (2013) demonstrated that during the crises of 2008 and 2011–2012, the CDS market experienced pronounced spillovers, with contagion initially flowing from banks to sovereigns. However, during the 2011–2012 sovereign debt crisis, this relationship reversed, signaling a shift in the flow of risk. Santamaría (2014), on the other hand, found that during the 2008–2009 period, private sector markets played a leading role in incorporating new information into risk pricing, but by 2010, sovereign CDS markets had assumed this leading role, marking a shift from private to public risk transfer. These findings emphasized the evolving dynamics between banks and sovereigns during financial crises, illustrating that while early in a crisis, risk transmission tended to flow from the private sector to the public, the relationship became more systemic and synchronized as the crisis deepened.

Similarly, Bratis et al. (2018) analyzed the contagion and interdependence between sovereign and banking CDS markets for 9 countries from 2008 to 2014. Using DCC-GARCH and VAR models, they found that short-term relationships were more dominant. The study also revealed that political risk and general risk factors were crucial in explaining contagion, and post-2012, Greece's systemic impact diminished. These findings corroborated earlier research, highlighting the increasing interconnectedness between sovereign and banking sectors, especially in times of crisis.

Stolbov (2016) investigated the causal relationships between sovereign CDS prices and the most significant quasi-sovereign CDS prices (Gazprom, VTB, Sberbank) in Russia, along with the global volatility factor embedded in the VIX index dynamics. The study focused on the post-bailout period from May 2009 to July 2013 and applied both time-domain (Hong test) and frequency-domain (Breitung-Candelon test) analyses. The results demonstrated that the dynamics of the VIX index had a

strong impact on all Russian CDS prices, while also receiving significant feedback from these CDS. A robust causal connection was observed between sovereign and quasi-sovereign CDS prices, with the influence of quasi-sovereigns, particularly banks, becoming more pronounced in the long run and at lower frequencies.

Bales (2022) analyzed the CDS spreads of 12 European and 6 American banks in conjunction with sovereign CDS spreads between 2009 and 2021. Using the Maximal Overlap Discrete Wavelet Transformation (MODWT) method, the study decomposed CDS spreads into different time scales, focusing on periods as short as six months. The findings revealed low connections in the short term, with a predominance of financially fragile banks. The introduction of the European Banking Union in 2014 weakened the short- and medium-term connections; however, the strength of the dependency in the long term significantly decreased. During the COVID-19 pandemic, the intensity of the network increased as eurozone banks acquired sovereign debt, although the strength of the dependency remained largely unaffected. This study emphasized the importance of time-frequency analysis in evaluating the risk dependence between banks and sovereigns.

Capasco (2024) examined whether financial contagion was transmitted through macroeconomic fundamentals not only in weak countries but also in strong EMU economies. For the period from 2012 to 2018, the study analyzed the impact of sovereign risk shocks in Italy on five core EMU countries using the Global Vector Autoregressive (GVAR) method. The findings revealed a "doom loop" and "bad neighbors" effect between banks and sovereign debt, with economies possessing higher deficit-to-GDP ratios being more sensitive to contagion. These results highlighted that differences in fiscal fundamentals could amplify contagion within the EMU.

Bocchman (2024) explored sovereign-bank risk spillovers in the Euro area from 2007 to 2023, using quarterly CDS data from 26 banks and sovereigns across 14 countries. Applying the Diebold and Yılmaz (2014) methodology, the study found that spillovers peaked during stress periods, such as the COVID-19 pandemic and the Russian invasion of Ukraine, but remained lower than during the sovereign debt crisis. Vulnerable sovereigns and banks, alongside higher sovereign debt holdings, were found to significantly amplify risk transmission, particularly as sovereign default risk increased.

Moser (2007) examined the relationship between the VIX index and CDS spreads for Latin American countries using panel data analysis for the period 1992-2007. The study found a positive and significant relationship between the two variables. Similarly, Pan and Singleton (2008) focused on Mexico, Türkiye, and Korea for the period from March 2001 to August 2006. Their findings suggested that the VIX index was a significant determinant of CDS spreads for these countries.

In a study by Bella et al. (2010), a panel data approach was employed to analyze 14 countries, and the results indicated that the VIX index had a positive effect on CDS spreads in the short term. This supports the findings of previous studies, including those of Moser (2007). Wang et al. (2013) also focused on Latin American countries, as in Moser's (2007) work, and found results that corroborated the earlier study, further reinforcing the connection between the VIX index and CDS spreads in this region.

In the case of Türkiye, several studies have explored this relationship. Akyol and Baltacı (2018) used the ARDL method for the period from Q2 2005 to Q4 2018 and found a positive and significant relationship between the VIX index and CDS spreads in Türkiye. Similarly, Pazarcı et al. (2022), using the same econometric method for the period from January 2002 to February 2022, obtained similar results, suggesting that the VIX index plays an influential role in CDS pricing in Türkiye.

On the other hand, Gürel (2021) conducted a structural VAR analysis for the period from January 2011 to September 2020 and found that the VIX index did not play a significant role in determining CDS spreads during this period. This contrasts with the majority of studies, highlighting the potential variability in the relationship across different time periods and countries.

Finally, Şahinler (2024), using DCC-GARCH models, analyzed the period from February 28, 2008, to November 27, 2024, and found strong evidence of a high positive correlation between the VIX index and CDS premiums, particularly during the 2008 financial crisis and the COVID-19 pan-

demic. These findings suggest that during times of significant economic distress, the VIX index becomes an important determinant of CDS premiums.

3. METHODOLOGY

The Granger causality test, originally proposed by Granger (1980), requires that all variables in the model be stationary at levels in order to reliably examine the causal relationships among them. However, differencing non-stationary series that are integrated of order one I(1) to achieve stationarity often leads to a loss of valuable long-run information. To overcome this limitation, Toda and Yamamoto (1995) developed an alternative approach that allows for the testing of parameter restrictions within a standard asymptotic framework, without requiring prior knowledge of the integration or cointegration properties of the variables. In this method, a VAR model is estimated at levels, regardless of the order of integration of the series[1].The procedure involves first selecting the optimal lag length using conventional information criteria (such as AIC or SIC), and then augmenting the VAR model by the maximum order of integration (dmax) observed among the variables, leading to the estimation of a (p + dmax) -order VAR. This strategy enables researchers to conduct causality analysis in a statistically robust manner without violating the assumptions of the asymptotic distribution theory, and has proven particularly useful in empirical applications where the variables exhibit mixed integration orders.

On the other hand, Granger (1996) emphasizes that economic structures may be subject to structural breaks over time due to internal dynamics or external shocks, and such breaks can lead to permanent changes in model parameters. In this context, time-varying methods such as rolling regressions are recommended to examine whether the relationships between variables remain stable over time (Dlamini et al., 2016). If structural stability of the model cannot be maintained, it implies that causality relationships between variables may vary across different periods. Consequently, a variable may Granger-cause another during certain sub-periods, while this causal influence may disappear in others (Aslanturk et al., 2011).

In this study, the causality relationship between bank CDS premiums and the VIX index is examined using the rolling window Granger causality analysis method, as proposed by Balcılar et al. (2010), to observe the effect of structural changes. The VAR(p) process used in the analysis is based on the model structure defined by Balcılar et al. (2010), and the methodology is expressed through Equation (1) and Equation (2).

$$CDS_t = \theta_1 + \sum_{i=1}^{p} \alpha_{1i} CDS_{t-i} + \sum_{i=p+1}^{p+dmax} \alpha_{2i} CDS_{t-i} + \sum_{i=1}^{p} \beta_{1i} VIX_{t-i} + \sum_{i=p+1}^{p+dmax} \beta_{2i} VIX_{t-i} + \varepsilon_{1t} \quad (1)$$

$$VIX_t = \theta_2 + \sum_{i=1}^{p} \gamma_{1i} VIX_{t-i} + \sum_{i=p+1}^{p+dmax} \gamma_{2i} VIX_{t-i} + \sum_{i=1}^{p} \omega_{1i} CDS_{t-i} + \sum_{i=p+1}^{p+dmax} \omega_{2i} CDS_{t-i} + \varepsilon_{2t} \quad (2)$$

In Equation (1) and Equation (2), the parameters θ_1 and θ_2 represent the constant terms; α_i, β_i, γ_i, ω_i are the variable coefficients; p is the optimal lag length; *dmax* indicates the highest degree of integration between bank CDS premiums and the VIX index; and ε_{1t} and ε_{2t} are the error terms of the model.

Balcılar et al. (2010) used the Likelihood Ratio (LR) test to examine the causality relationships between the series. To account for issues such as sample size, integration degree, and non-normality of error terms, they generated the LR test statistic using the bootstrap method proposed by Hacker and Hatemi-J (2006). After estimating the VAR model, the following null hypotheses were established to test the causality relationships between the variables:

$$H_0 = \beta_{1i}=0 \quad (3)$$

$$H_0 = \omega_{1i}=0 \quad (4)$$

Equation (3) tests the absence of Granger causality from VIX to CDS, while Equation (4) tests the absence of Granger causality from CDS to VIX. Here, the parameter β_{1i} indicates whether past values of VIX explain CDS, and the parameter ω_{1i} ishows whether past values of CDS explain VIX. The rejection of both null hypotheses suggests a bidirectional causality relationship between CDS and VIX.

[1] *This is particularly advantageous because conventional approaches often necessitate pre-testing for unit roots and cointegration relationships (Memiş Karataş, 2023)*

Balcılar et al. (2010) employed the rolling window technique to analyze time-varying causality relationships. To account for issues such as structural breaks and the potential instability of parameters over time, they applied the Granger causality test, enhanced by the bootstrap method, to each subsample $t = l, l+1, \ldots, T\ l$. Here, l represents the rolling window size, and the causality relationships are tested separately for each subsample based on time.

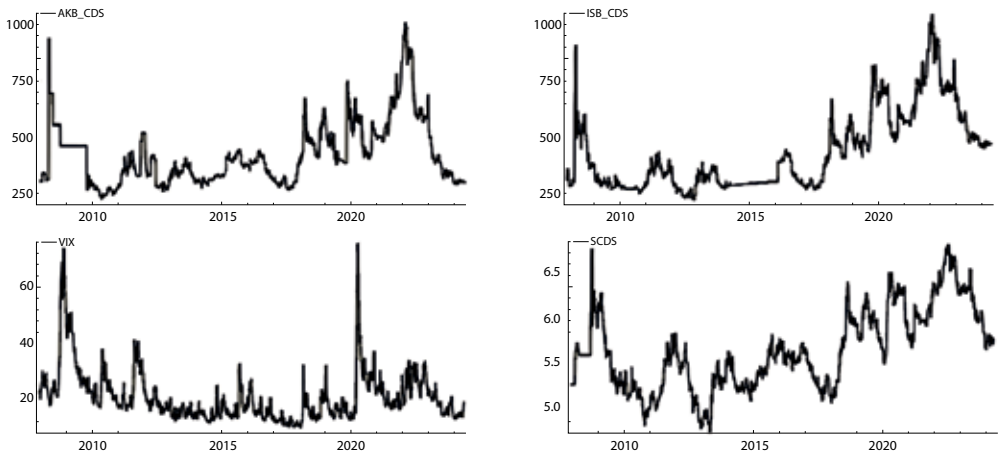
The initial window size was determined to be 61 weeks using the formula $T * (0.01 + 1.8/\sqrt{T})$ proposed by Caspi (2017). However, due to near-singular matrix errors, the window size was doubled to 122 weeks to overcome this issue. Within the rolling window approach, LR test statistics were calculated for each 122-week subsample, and the relevant bootstrap critical values were obtained. As each new weekly observation was added, the oldest observation was removed from the subsample, keeping the window fixed. Thus, each estimation was conducted on an updated and time-sensitive subsample. These steps were systematically repeated until the last observation in the dataset was reached. Using the obtained LR test statistics and bootstrap p-values, the dynamic structure of causality relationships over time was monitored, and how this structure changed across different periods was analyzed.

4. DATA AND FINDINGS

This study examines the dynamic relationship between the CDS premiums of the Turkish banking sector and the level of global uncertainty in the markets. The analysis, which covers weekly data from January 4, 2008, to April 19, 2024, utilizes the Volatility Index (VIX) calculated by the Chicago Board Options Exchange (CBOE) as a proxy for perceived global risk levels. VIX is an index based on S&P 500 index options that reflects investors' expectations of future volatility and is widely used in the literature as an indicator of global risk appetite. The CDS data for the Turkish banking sector is limited to the 5-year CDS premiums of Türkiye's İş Bank and Akbank, considering data availability and length. All data were obtained from the Refinitiv Datastream database, and to enhance economic interpretability, the analysis was conducted on the natural logarithms of the series.

Figure 1 illustrates the time-series movements of Akbank's 5-year CDS premiums (AKB_CDS), İş Bank's 5-year CDS premiums (ISB_CDS), sovereign CDS (SCDS), and the VIX index. Both AKB_CDS and ISB_CDS exhibit similar directional movements over time, with significant fluctuations in parallel with the VIX index at certain points. Particularly, during periods of increased global uncertainty such as the 2008 global financial crisis, the 2018 currency shock, and the 2020 COVID-19 pandemic, there was a notable rise in both banks' CDS premiums, aligning with the increases in the VIX index. This suggests that changes in global risk appetite influence the credit risk perception of the Turkish banking sector and that CDS premiums are highly responsive to global market volatility.

Figure 1
Time-Series Plots for VIX and CDS premiums



The Table 1 presents the descriptive statistics for the AKB_CDS, ISB_CDS, and VIX index. When examining the mean values of the series, it is observed that ISB_CDS (432.68) is slightly higher than that of AKB_CDS (416.91). The distribution of the CDS premiums is positively skewed, with maximum values showing a significant increase, particularly during crisis periods (AKB_CDS: 1002.49, ISB_CDS: 1083.12). İş Bankası's CDS spread has a higher standard deviation (184.96), indicating more volatility in its credit risk perception compared to Akbank. The standard deviation of the VIX index (9.06) remains lower, reflecting the overall market volatility. The skewness and kurtosis values indicate that all four series exhibit outliers and show significant deviations from normal distribution. Jarque-Bera test results suggest that all datasets significantly deviate from normal distribution.

Table 1

Descriptive Statistics

	AKB_CDS	ISB_CDS	SCDS	VIX
Mean	416.908	432.67	305.26	20.148
Maximum	1002.49	1083.12	874.399	74.62
Minimum	220.49	210	111.62	9.34
Standard Dev.	139.75	184.95	149.06	9.06
Kurtosis	1.399	1.134	4.347	2.33
Skewness	5.239	3.587	1.283	10.712
Jarque-Bera	457.24***	195.3***	298.17***	2892.7***

*Notes: *** indicates 1% significance level*

To ascertain the integration levels of the time series, the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Zivot-Andrews unit root tests, which account for potential sharp breaks, were employed. The outcomes of these tests are presented in Table 2. According to the ADF test results, both the AKB_CDS and ISB_CDS series are found to exhibit non-stationarity at the level in both the constant and constant & trend models. The PP test further reveals that, in the constant model, the AKB_CDS series is non-stationary; however, it becomes stationary at the 10% significance level when a constant & trend are included in the model. Given the examination of the series' time plots, which indicate fluctuations around the mean without a pronounced trend, the constant model is deemed more appropriate for analysis. When evaluating the results for the SCDS series, the ADF unit root test indicates stationarity at the 10% significance level in both models. Similarly, the PP test suggests stationarity only in the model with constant and trend, while in the structural break model, stationarity is observed at the 10% level only in the model with a constant. After first differencing, the series becomes stationary at the 1% significance level. In contrast, the VIX index is found to be stationary at the 1% significance level in both the ADF and PP tests. The results from the Zivot-Andrews test, which incorporates structural breaks, corroborate these findings, indicating that the AKB_CDS and ISB_CDS series are non-stationary at the level, while the VIX index remains stationary at the 1% significance level. Furthermore, both the AKB_CDS and ISB_CDS series are become stationary upon first differencing in both models. These findings suggest that the bank CDS premiums and the VIX index exhibit different integration properties, highlighting the necessity to account for these discrepancies in subsequent analyses.

Table 2
Unit Root Test Results

Variables	ADF		PP		Zivot-Andrews	
AKB_CDS	Constant	Constant & Trend	Constant	Constant & Trend	Constant	Constant & Trend
AKB_CDS	-2.526	-2.528	-3.836	-3.389*	-4.098 (27.10.2017)	-4.541 (14.05.2021)
Δ AKB_CDS	-11.173***	-11.182***	-32.343***	-32.335***		
ISB_CDS	-2.186	-2.989	-2.219	-3.025	-4.468 (27.10.2017)	-4.259 (27.10.2017)
Δ ISB_CDS	-31.310***	-31.292***	-31.381***	-31.362***		
SCDS	-2.699* (0.074)	-3.302* (0.06)	-2.552 (0.103)	-3.186* (0.087)	-4.506* (27.10.2017)	-4.349 (27.10.2017)
ΔSCDS	-18.597 (0.000)	-18.588 (0.000)	-30.466 (0.000)	-30.449 (0.000)		
VIX	-4.570***	-4.665***	-4.649***	-4.778***	-6.280*** (19.07.2019)	-6.472*** (19.07.2019)

*Note: *** and * indicate statistical significance at 1 and 10%, respectively*

Given the different integration orders of the series, the lag lengths employed in the VAR models based on the Toda and Yamamoto (1995) methodology were selected by considering the maximum order of integration (d_{max}) among the variables. Accordingly, the optimal lag length $(p + d_{max})$[2] was set to 4 for the VIX–AKB_CDS model, 6 for the VIX–ISB_CDS model, and 2 for both SCDS–AKB_CDS and SCDS–ISB_CDS relationships. The causality results based on the full sample period are reported in Table 3. The findings reveal a unidirectional Granger causality running from AKB_CDS to the VIX index at the 5% significance level, suggesting that changes in Akbank's credit risk premium may carry information that affects global risk sentiment. However, no significant causal relationship is detected in the reverse direction—from VIX to AKB_CDS. Regarding İş Bank, the analysis identifies a causal relationship from VIX to ISB_CDS at the 10% significance level. No causality is found from ISB_CDS to VIX, indicating an asymmetry in the transmission of credit risk between global and domestic markets. Moreover, the results concerning the causal interactions between sovereign CDS (SCDS) and the banking sector CDSs (AKB_CDS and ISB_CDS) are particularly noteworthy. The evidence strongly supports unidirectional causality from both AKB_CDS and ISB_CDS to SCDS at the 1% significance level, implying that bank-level credit risk premia significantly influence sovereign credit risk perceptions. These findings suggest that, particularly in emerging market contexts like Türkiye, the banking sector may serve as a leading indicator for sovereign risk. This supports the notion that financial sector vulnerabilities can precede broader macro-financial instability, thereby underscoring the systemic importance of bank CDS premiums in monitoring overall market sentiment.

2 *Dmax is determined using unit root tests, and optimal p value is selected based on AIC*

Table 3

Toda-Yamamoto Causality Test Results

	MWALD	P-Value
VIX ⇏ AKB_CDS	0.510	0.966
AKCDS ⇏ VIX	12.172**	0.023
VIX ⇏ ISB_CDS	10.665*	0.093
ISB_CDS ⇏ VIX	10.119	0.130
SCDS ⇏ AKB_CDS	0.982	0.611
AKCDS ⇏ SCDS	17.247***	0.002
SCDS ⇏ ISB_CDS	0.562	0.759
ISB_CDS ⇏ CCDS	17.759***	0.001

*Note: ***, **, and * indicate statistical significance at 1 %, 5%, and 10%, respectively*

Table 4 reports the parameter stability test results and the associated p-values derived from a VAR model, where the dependent variables are bank CDS premiums and VIX, respectively. Following Balcilar et al. (2010), the p-values were obtained through Monte Carlo simulations based on 2,000 bootstrap samples generated from a constant-parameter VAR model. The Sup-LR, Mean-LR, and Exp-LR tests require a trimming and thus, the test statistics were calculated over the [0.10, 0.90] interval. Based on the results presented in Table 4, the Sup-LR, Mean-LR, and Exp-LR statistics reject the null hypothesis of parameter stability for the VIX index at the 1% significance level across both models, indicating parameter instability. For the AKB_CDS series, while the Sup-LR and Exp-LR statistics reject the null hypothesis at the 5% level, the Mean-LR test does so only at the 10% level. Regarding the ISB_CDS series, the Sup-LR test fails to reject the null hypothesis at 10%, 5%, and 1% significance level, implying stability, whereas the Exp-LR and Mean-LR tests reject the null at the 5% level, indicating possible instability over time. In Models 3 and 4, sovereign CDS (SCDS) premiums are found to be unstable at the 5% significance level, while the AKB_CDS and ISB_CDS series demonstrate parameter stability. Overall, the majority of test results indicate that both bank CDS premiums and the VIX index exhibit parameter instability, suggesting that the relationships between these variables evolve over time. Consequently, employing models that allow for time-varying parameters can provide a more appropriate empirical framework. Consistent with these findings, time-varying Granger causality tests have been additionally conducted.

Table 4

Parameter Stability Test Results

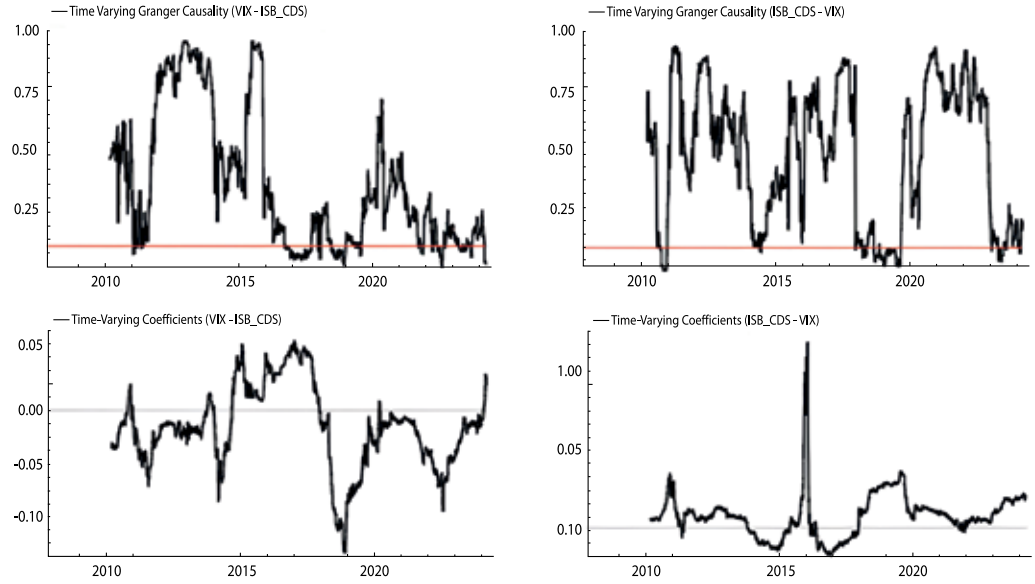
		Sup LR	Exp LR	Mean LR
Model 1 (AKB_CDS; VIX	AKB_cds	4.525* (0.092)	0.865* (0.089)	1.654* (0.064)
	VIX	4.324*** (0.004)	1.179*** (0.003)	2.066*** (0.005)
Model 2 (ISB_CDS; VIX)	ISB_CDS	3.355* (0.084)	0.683 (0.166)	1.294 (0.192)
	VIX	2.731* (0.079)	0.829** (0.038)	1.572** (0.043)
Model 3 (AKB_CDS; SCDS)	AKB_CDS	2.247 (0.391)	0.767 (0.126)	1.507* (0.094)
	SCDS	5.298*** (0.010)	1.077** (0.031)	1.799** (0.047)
Model 4 (ISB_CDS; SCDS)	ISB_CDS	2.025 (0.533)	0.568 (0.332)	1.055 (0.329)
	SCDS	5.091*** (0.009)	0.981** (0.042)	1.634* (0.067)

*Note: ***, **, and * indicate statistical significance at 1 %, 5%, and 10%, respectively*

In this study, sub-period analyses were conducted by determining the window size as 61 observations, following the formula proposed by Caspi (2017). However, due to issues related to near-singular matrices, the window length was doubled to 122 observations to enable the computation of test statistics. Figure 2 illustrates the time-varying causality relationship and corresponding coefficient dynamics between the VIX index and İş Bank's CDS premiums (ISB_CDS). The results indicate significant causality from VIX to ISB_CDS in several periods, including March 2011; from 2016 to 2017; from July 2018 to January 2019; December 2021; from July to August 2022; from late April to September 2023; and in April 2024. An analysis of the time-varying coefficients reveals that prior to 2018, the causality coefficients were predominantly positive, implying that increases in global market volatility (VIX) led to a rise in İş Bank's credit risk perception. However, after 2018, the relationship shifted to negative, suggesting that heightened global volatility corresponded to a reduction or stabilization in İş Bank's risk premiums. This shift may be attributed to structural changes in the Turkish banking sector, stronger regulatory measures, or a decoupling effect wherein local financial dynamics diverged from global market movements. Conversely, when assessing the causality running from ISB_CDS to VIX, significant relationships were detected during December 2010, between May and June 2018, and from October 2018 to October 2019. In these periods, increases in İş Bank's CDS premiums positively affected the VIX, indicating that heightened perceptions of institutional risk within Türkiye contributed to an increase in global market volatility. Overall, the findings suggest that during periods of financial stress or global uncertainty, the relationship between institutional credit risk and market volatility becomes more pronounced and exhibits dynamic, time-varying characteristics.

Figure 2

Time Varying Causality Graph (ISB_CDS-VIX)



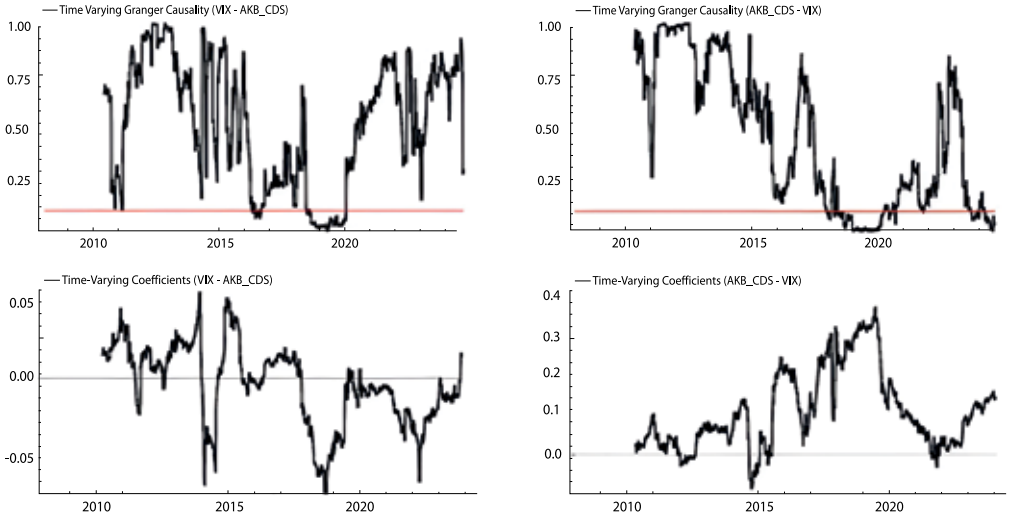
Note: The red line represents the 10% significance level

In Figure 3, the time-varying causality relationship between the VIX index and Akbank's CDS premiums is presented. The results indicate a significant causality from the VIX to Akbank's CDS premiums between early 2016 and the summer of that year. Moreover, from March 2018 until 2020, a bidirectional causality was detected, suggesting mutual influence between global market volatility and Akbank's perceived credit risk during this period. Additionally, unidirectional causality running from Akbank's CDS premiums to the VIX index was observed during March–April 2020, from May to September 2023, and at the beginning of 2024. In these periods, the causality coefficients were found to be positive, indicating that increases in Akbank's credit risk contributed to rises in global market volatility. In contrast, during the periods when causality ran from the VIX to Akbank's CDS premiums, the coefficients were negative, implying that rising global volatility was associated with a relative stabilization or decrease in Akbank's credit risk perception.

These results may be explained by the distinct economic and financial conditions characterizing the corresponding periods. The negative causality from VIX to Akbank's CDS premiums after 2018 could be attributed to Akbank's improved resilience against external shocks, strengthened by regulatory reforms and enhanced risk management practices within the Turkish banking sector. Furthermore, the periods of positive causality from Akbank's CDS premiums to the VIX coincide with times of heightened uncertainty in emerging markets, where deteriorations in the financial health of major banks may have contributed to a broader increase in global risk aversion. The bidirectional causality observed between 2018 and 2020 may reflect the intertwined effects of domestic vulnerabilities and global market turbulence during the post-crisis recovery and the COVID-19 pandemic outbreak, where feedback loops between local institutions and international markets became more pronounced.

Figure 3

Time Varying Causality Graph (AKB_CDS-VIX)



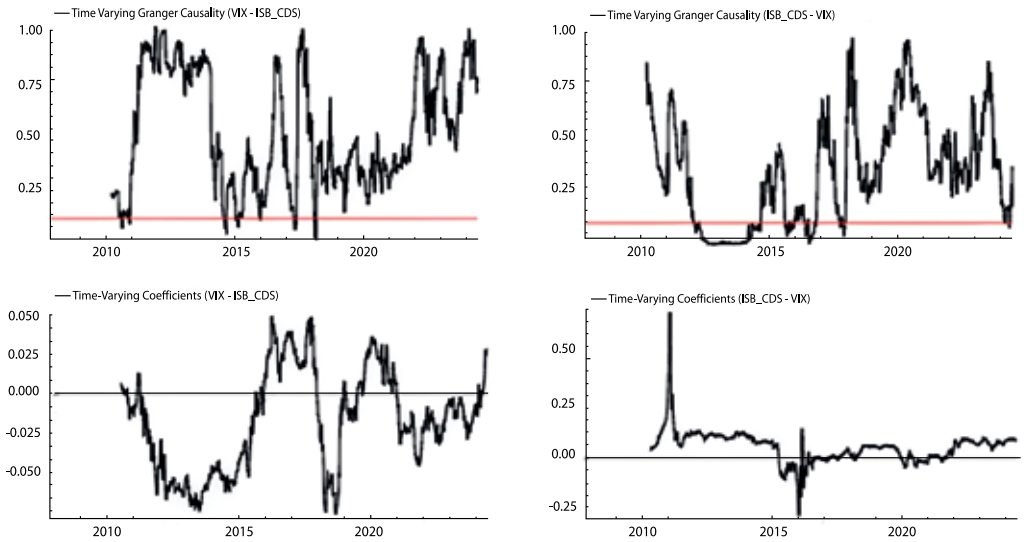
Note: The red line represents the 10% significance level

Figure 4 presents the time-varying causality relationship and the associated dynamic coefficients between sovereign CDS premiums and İş Bank's CDS premiums. The analysis reveals that, towards the end of 2010, there was a significant causality running from sovereign CDS premiums to İş Bank's CDS premiums, with a positive coefficient. Subsequently, during the periods of August–September 2014 and February–March 2015, causality persisted but the coefficients turned negative, suggesting that increases in sovereign risk were associated with a relative stabilization or improvement in İş Bank's credit risk. Later, in May 2017 and February 2018, positive causality reemerged, indicating that İş Bank's credit risk became once again sensitive to sovereign risk dynamics.

Conversely, examining the causality from İş Bank's CDS premiums to sovereign CDS premiums, significant causality was detected from March 2012 to September 2014, from August to December 2015, and from January to June 2016. In all these periods, the coefficients were positive, implying that increases in İş Bank's credit risk contributed to a widening of sovereign CDS premiums. These findings suggest that during periods of heightened systemic risk, major banks' credit deterioration exerted a significant influence on country-level risk perceptions.

Figure 4

Time Varying Causality Graph (ISB_CDS-SCDS)

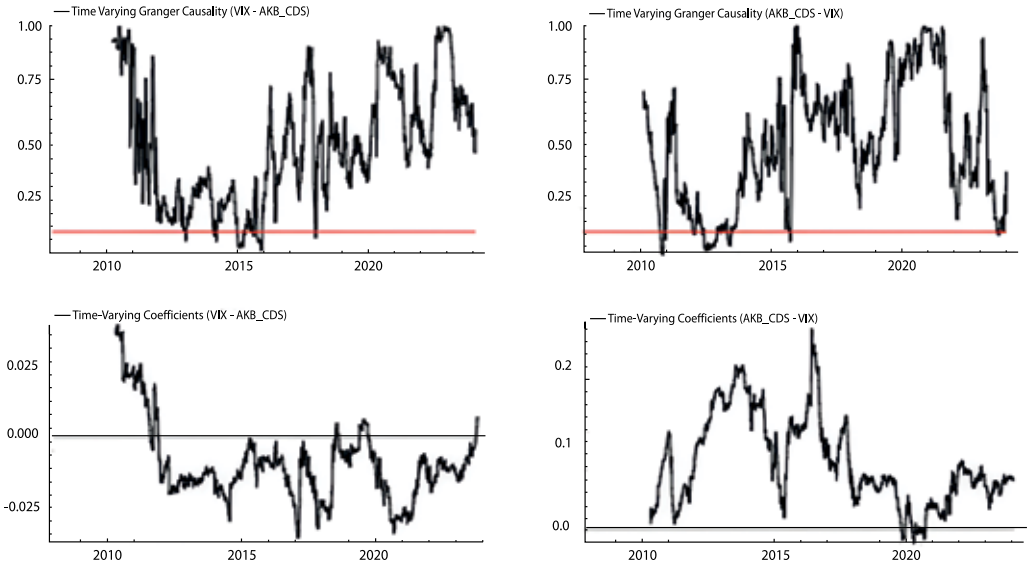


Note: The red line represents the 10% significance level

Figure 5 illustrates the time-varying causality relationship and corresponding dynamic coefficients between SCDS premiums and AKB_CDS premiums. The results indicate that causality from SCDS premiums to AKB_CDS premiums was observed only in very limited periods, specifically during March–April 2014 and in February and November 2015. During these episodes, the causality coefficients were negative, suggesting that increases in sovereign risk were associated with relative improvements or reduced risk perception for Akbank, possibly reflecting stronger fundamentals or firm-specific resilience against sovereign risk fluctuations. Conversely, causality running from AKB_CDS premiums to SCDS premiums was detected over broader and more consistent periods. Specifically, significant causality was observed from December 2010 to February 2011, in April 2012, up until March 2013, and again in September 2013. During all these periods, the coefficients were positive, indicating that increases in Akbank's credit risk contributed to the widening of SCDS premiums. This suggests that during times of elevated financial stress or banking sector vulnerabilities, Akbank's creditworthiness had systemic implications for the overall perception of sovereign risk. Overall, these findings highlight an asymmetrical causality structure: while sovereign risk affected Akbank's CDS in only a few isolated periods and mostly with a negative impact, Akbank's own credit risk exerted a more frequent and direct influence on sovereign credit risk during the sample period.

Figure 5

Time Varying Causality Graph



Note: The red line represents the 10% significance level

5. CONCLUSION

This study investigates the dynamic linkages between the credit default swap (CDS) premiums of Türkiye's major banks, sovereign CDS premiums, and global financial volatility (proxied by the VIX index) over the period from January 4, 2008, to April 19, 2024. By employing the time-varying Granger causality approach proposed by Balcilar et al. (2010), we provide empirical evidence that the direction of these relationships have evolved substantially, especially during episodes of financial turbulence such as the 2018 Turkish currency crisis, the COVID-19 pandemic, and periods of geopolitical instability.

One of the main findings is the shifting nature of the relationship between global market volatility and institutional credit risk. Prior to 2018, increases in the VIX index, which signal heightened global risk aversion, consistently translated into higher CDS premiums for İş Bank and Akbank, in line with previous research (e.g., Moser, 2007; Pan & Singleton, 2008) on the sensitivity of emerging

markets to external shocks. However, post-2018, this causality reversed or weakened, suggesting that Türkiye's banking sector has developed greater resilience to global financial fluctuations. This structural shift may be attributed to enhanced regulatory frameworks, improved capital adequacy, and reduced foreign exchange mismatches. In contrast, the relationship between sovereign and bank CDS premiums displays a more complex and asymmetric structure. While sovereign CDS premiums occasionally influenced bank-level risk (notably in 2010–2011 and 2014–2015), the CDS premiums of major banks exerted a more consistent and stronger impact on sovereign premiums, especially during systemic stress periods between 2012 and 2019. Comparing with existing studies, our results align with Gürel (2021) and Bratis et al. (2018), who emphasized time-varying dynamics, but diverge from Şahinler (2024), who found a more stable relationship. This underscores the importance of dynamic models in accurately capturing financial linkages in emerging markets like Türkiye.

These findings have important implications for both policymakers and financial institutions. The decoupling of bank CDS premiums from global volatility after 2018 suggests that macroprudential reforms may have contributed to strengthening domestic resilience. However, the persistence of reverse causality from bank CDS premiums to sovereign premiums highlights the continued need for effective oversight of systemically important financial institutions. Regulatory authorities should adopt a proactive stance, implementing dynamic capital buffers, targeted stress testing, and enhanced surveillance of banks' exposure to sovereign risk, especially in a macroeconomic environment characterized by high inflation, exchange rate volatility, and unconventional policy measures.

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