Araştırma Makalesi / Research Article

Sovereign Risk and Lending Behavior of Banking Industry: Evidence from Turkey's Credit Market

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Abstract

This study examines how sovereign risk influences Turkish commercial banks' lending behavior, focusing on asymmetric effects in commercial loan pricing. Using the Momentum Threshold Autoregressive (MTAR) model, we analyze the relationship between CDS premiums (a sovereign risk proxy) and lending variables. Results reveal strong cointegration between CDS spreads and Turkish Lira commercial loan rates, with asymmetric adjustments - banks rapidly raise rates when sovereign risk increases but show reluctance to reduce them during risk declines. While sovereign risk doesn't significantly affect loan volumes or default rates, it substantially impacts borrowing costs, demonstrating credit market rigidity. These findings highlight the procyclical nature of Turkey's credit market and validate the MTAR model's effectiveness in capturing nonlinear risk dynamics. The study contributes novel evidence that risk transmission mechanisms in emerging markets operate differently than in advanced economies, particularly in how sovereign risk primarily affects loan pricing rather than credit supply.

Keywords: *Banking, Finance, Sovereign Risk, MTAR Model*

JEL Codes: *G21, G28, E43, C32*

Ülke Riski ve Bankaların Borç Verme Davranışları: Türkiye Kredi Piyasasından Kanıtlar

Öz

Bu çalışma, ülke riskinin Türkiye'deki ticari bankaların kredi verme davranışı üzerindeki etkisini, özellikle ticari kredi faizlerindeki asimetrik etkiler açısından incelemektedir. Momentum Eşik Otoregresif (MTAR) modeli kullanılarak, CDS primleri ile kredi faiz oranları arasındaki ilişki analiz edilmiştir. Bulgular, CDS spreadleri ile Türk Lirası ticari kredi faizleri arasında güçlü bir eşbütünleşme olduğunu ve bu ilişkinin asimetrik şekilde gerçekleştiğini göstermektedir. Bankalar, ülke riski yükseldiğinde faiz oranlarını hızlıca artırmakta, ancak risk azaldığında oranları düşürmede isteksiz davranmaktadır. Ülke riski, kredi hacmi veya temerrüt oranları üzerinde anlamlı bir etki yaratmazken, borçlanma maliyetleri üzerinde belirgin bir etkiye sahiptir. Bu sonuçlar, Türkiye'de kredi piyasasının çevrimsel (procyclical) doğasını ortaya koymakta ve gelişmekte olan ülkelerde risk aktarım mekanizmalarının gelişmiş ekonomilerden farklı işlediğine dair yeni kanıtlar sunmaktadır.

Anahtar Sözcükler: *Bankacılık, Finans Ülke Riski, MTAR Modeli*

JEL kodları**:** *G21, G28, E43, C32*

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Extended Summary

Country risk exerts significant influence on national economies, shaping both the real and financial sectors. Banks, as the primary institutions for domestic borrowing, remain particularly vulnerable to sovereign credit risk since their funding costs and liquidity conditions are closely tied to the government's creditworthiness. This study, therefore, examines how sovereign risk influences the lending behavior of Turkish commercial banks toward corporate clients and assesses the resulting implications.

While extensive research has examined sovereign creditworthiness and its impact on bank funding and liquidity, relatively little attention has been paid to the reciprocal relationship between sovereign risk and bank lending practices. Evidence to date suggests that banks actively adjust their strategies to mitigate the adverse effects of deteriorating sovereign credit ratings. This paper contributes to the literature by focusing specifically on lending behavior, with an emphasis on loan pricing and interest rate dynamics.

The analysis utilizes national-level weekly data spanning from January 2014 to January 2025, sourced from the Banking Regulation and Supervision Agency, the Central Bank of Turkey, and Investing.com. Commercial loans are at the center of the study, with additional consideration given to non-performing loans and total credit volume. To capture nonlinear dynamics and asymmetric adjustments between Credit Default Swap (CDS) premiums—an essential proxy for sovereign risk—and lending indicators, the Momentum Threshold Autoregressive (MTAR) model is applied.

Empirical findings show a strong cointegration between CDS premiums and interest rates on Turkish lira-denominated commercial loans. Error correction terms indicate that deviations from equilibrium are corrected asymmetrically: banks respond more aggressively to increases in sovereign risk by raising loan interest rates but are less willing to lower them when risk decreases. Conversely, loan volumes and default rates seem less affected by changes in sovereign risk. These results emphasize the presence of asymmetric risk pricing in Turkey's credit market

The study's main contribution lies in demonstrating the usefulness of the MTAR model for analyzing the interaction between sovereign risk and credit markets. Furthermore, the results underscore the importance of CDS premiums as an indicator of market-perceived risk. By demonstrating that sovereign risk primarily affects borrowing costs rather than loan supply, the research highlights potential vulnerabilities to financial stability in emerging markets.

This paper addresses an existing gap in the literature by providing empirical evidence from a developing economy. Few studies have analyzed how sovereign risk shapes bank lending practices, particularly the pricing of commercial loans, in emerging markets. By offering detailed insights into Turkey's credit market, this research contributes to a deeper understanding of how sovereign stress affects lending behavior in the banking sector and informs policy discussions on credit access and risk management at both macro and micro

levels.

In conclusion, this study's findings show that sovereign credit risk mainly affects the banking system in Turkey through loan pricing rather than loan supply. Using the MTAR framework, the paper shows that banks respond asymmetrically to changes in sovereign risk: while increased risk leads to higher loan rates, decreased risk does not result in lower borrowing costs. This pricing asymmetry underscores the persistence of risk aversion in the banking sector and signals potential vulnerabilities for firms seeking affordable financing under volatile market conditions. Beyond its empirical contribution, the study contributes to the literature on sovereign-bank linkages in emerging economies by demonstrating that sovereign stress affects not only the quantity but also the cost of credit. The results also have important policy implications: strengthening sovereign credibility could reduce financing costs for the corporate sector. At the same time, regulatory frameworks aimed at enhancing banks' risk-sharing capacity could moderate asymmetric pricing behavior. Furthermore, the study points toward avenues for future research, such as comparative analyses across developing countries or the use of alternative nonlinear models to test the robustness of these findings. Overall, the paper provides substantial evidence to inform debates on financial stability, lending practices, and sovereign risk management in emerging markets.

1. Introduction

Sovereign risk concerns broadly impact both the financial and real sectors of an economy. Specifically, the banking industry is vulnerable to fluctuations in sovereign credit risk because of its direct exposure to government securities and its dependence on the government's creditworthiness for funding costs and liquidity conditions (Acharya et al., 2014; Gennaioli et al., 2014). Kirikkaleli & Gokmenoglu (2020) studied the causal relationship between sovereign credit risk and economic risk, concluding that fluctuations in Turkey's sovereign credit risk significantly impact economic risk. Their findings, derived from Toda-Yamamoto causality, Gradual Shift causality, and Wavelet Coherence tests, emphasize the predictive power of sovereign credit risk in assessing economic vulnerabilities.

The interconnection between sovereign risk and the banking sector is well-documented. The Bank for International Settlements (BIS) reported that heightened sovereign risk in late 2009 increased funding costs and worsened the funding composition of several Euro area banks due to declining sovereign creditworthiness (BIS, 2010). The literature mainly examines sovereign risk spillovers on bank funding costs, highlighting how a decline in government creditworthiness weakens bank balance sheets, raises funding costs, and reduces financial system liquidity.

While many studies examine sovereign creditworthiness and its effects on bank funding and liquidity, a gap remains in understanding its relationship with bank lending behavior. Evidence shows banks adjust operations to counteract deteriorating sovereign ratings (Altavilla et al., 2017; De Marco & Macchiavelli, 2016).

This study aims to examine the effect of sovereign risk on the lending behavior of commercial banks toward their corporate clients in Turkey and to assess the related implications. To achieve this, total loans, non-performing loans, commercial loans, and the interest rates on these loans have been analyzed collectively. Understanding how sovereign risk influences the use of commercial loans and the interest rates is expected to enhance the development of effective risk management strategies at both micro and macro levels, as well as inform policies that support businesses' access to finance during times of increased risk.

This study adds to the existing literature by presenting empirical findings on the relationship between sovereign credit risk and banks' lending behavior to businesses in an emerging market setting. Therefore, it aims to offer a deeper understanding of how the Turkish banking sector responds to changes in sovereign risk.

2. Literature Review

Understanding how sovereign risk affects banking activities, including lending, is a key concern in research about the banking industry. It is a common argument that banks become hesitant to offer loans to their customers when market conditions worsen.

Therefore, various studies in the literature examining the impact of sovereign risk on the banking sector were reviewed for this study. Finally, it remains important to observe the current situation and monitor industry development using different methods, focusing on specific markets and parts of the sovereign banking relationship, for informed policy decisions.

According to several studies, lending behavior is one of the strongest factors that transmit the influence of sovereign risk to the market. Altavilla et al. (2017) state that the impact of sovereign risk on banking practices is greater than the impact of banking activities on sovereign risk. Crosignani et al. (2020), who argue that banks with larger exposure to government bonds face higher funding costs, which limit their ability to lend during times of increased sovereign risk, exemplify this point. Furthermore, they highlight a two-way interaction between sovereign risk and bank lending behavior, especially when a high percentage of non-performing loans (NPLs) is recorded. The study by Erce et al. (2015) supports these findings, showing that banks holding a higher share of domestic government bonds experience more financial distress during periods of rising sovereign risk. This is particularly expected in economies with high levels of public debt. The empirical findings of De Marco & Macchiavelli (2016) regarding banks' NPLs suggest that a high percentage of non-performing loans and significant exposure to foreign credit increase the vulnerability of the banking sector, reinforcing the two-way risk transmission mechanism and transferring fragility back to sovereign risk. Even when sovereign risk is high, Boyd & De Nicoló (2005) argued that increased competition in the lending market can reduce borrowers' perception of risk. However, they also noted that banks might shift toward higher-risk lending as borrowers gain confidence, highlighting the complex connection between sovereign risk, credit supply, and risk-taking behavior.

There are also studies that focus on banks' balance sheet structures and their credit provisions. Acharya et al. (2014) examined the Euro area and found that banks sharply reduce lending when sovereign risk is high. The Bank for International Settlements also highlights this situation in their 2010 report, stating that financial institutions shift to safer assets and tighten loan conditions in response to sovereign risk shocks.

Huizinga et al. (2007) discovered that the procyclicality of loan loss provisions is influenced by changes in GDP growth after examining the Euro area. Their study implied that banks' risk management plans are susceptible to changes in sovereign creditworthiness.

Ekinci & Poyraz (2019) looked at 26 deposit Turkish banks' factors from 2005 to 2017 and asserted a significant correlation between bank productivity and credit risk management. Their research highlights how lending practices are adjusted according to changes in sovereign risk levels. Podstawski & Velinov (2018) also found that sovereign distress impacts banking institutions not only by credit supply channel but also by implicit bailout channel, portfolio channel, collateral channel, guarantee channel, and rating channel.

Crosignani et al. (2017) considered banks' liquidity levels and concluded that banks with larger liquidity buffers were better equipped to sustain lending levels when sovereign risk rose. This emphasizes that liquidity management is crucial for eliminating the negative consequences of sovereign distress.

According to these studies, the main way that sovereign risk impacts bank balance sheets is via lending practices, and this situation adversely affects financial stability in the countries. Therefore, to lessen this adverse effect, strong and efficient risk management is needed. Due to the increased funding costs brought by sovereign distress, banks frequently turn off the credit valves and tighten the credit requirements.

Some of the world's leading financial institutions monitor the connection between sovereign risk and bank lending and develop integrated approaches to assess sovereign risk. The Banking Industry Country Risk Assessment (BICRA) methodology was created by S&P (2013) for this purpose. They acknowledge that the resilience of the banking sector and sovereign creditworthiness are closely linked. Regulatory agencies in Turkey consider the relationship between sovereign risk and bank lending and recognize the importance for Turkish banking industry members. The Guide for the Management of Country Risk, issued by the Banking Regulation and Supervision Agency (BRSA) in 2016, offers a comprehensive framework for evaluating and mitigating sovereign risk in Turkish banks (International Monetary Fund., 2017). To shield financial institutions from excessive sovereign risk exposure, this approach highlights the need for strong risk management procedures such as higher capital buffers, stress testing, and diversification of sovereign debt portfolios.

Regulations emphasize the importance of stress testing in determining sovereign risk exposure. According to the International Monetary Fund. (2017), stress tests are crucial for spotting weaknesses in banks' sovereign debt portfolios, especially in developing nations like Turkey where sovereign risk is still a significant worry. Stress tests assess how resilient banks' balance sheets are and how well they can continue lending under pressure by simulating unfavorable events like sovereign downgrades or defaults. These exercises, which offer practical insights into the potential ripple effects of sovereign risk on the banking industry, have become a cornerstone of regulatory frameworks worldwide.

Despite regulatory improvements, many questions remain about the extent of sovereign risk transferred to banking systems, particularly in developing countries. The effectiveness of stress tests in capturing the complex, nonlinear sovereign-bank linkages is disputed. This underscores the need for advanced modeling techniques that incorporate fiscal policy, macroeconomic conditions, and banking stability (Apergis et al., 2019; Budnik et al., 2022; Kale & Eken, 2022).

The literature confirms a link between bank lending practices and sovereign risk, highlighting the importance of effective risk management and regulation due to their reinforcing relationship. Research should focus on filling knowledge gaps and improving

sovereign-bank relationship management. Emerging markets like Turkey, with unique political and economic traits, provide valuable case studies. Future work should develop reliable stress testing frameworks and examine how political and macroeconomic factors, along with regulatory actions, influence sovereign risk and systemic stability, aiding policymakers in building more resilient financial systems.

Few studies, however, have explored how sovereign risk affects bank lending practices in developing countries, especially in terms of loan interest rates. As a result, the impact on emerging markets like Turkey is not well understood. This study aims to fill that gap by providing actual data on the relationship between sovereign risk and bank lending practices in Turkey's credit market. By analyzing patterns in commercial credit supply, this research will enhance our understanding of how sovereign distress influences the lending behaviors of banks.

Recent studies have greatly enhanced our understanding of how sovereign risk affects bank lending behavior. Yue et al. (2023) use natural catastrophe analysis to show that sovereign risk shocks significantly decrease the supply of bank credit, especially for riskier borrowers. To reduce risk exposure, smaller European banks systematically shifted their portfolios during the sovereign debt crisis by replacing lending with the purchase of government bonds, as demonstrated by Pietrovito & Pozzolo (2023). Guo & Pei (2023) present new evidence of cross-border effects, showing how banking systems in lending countries suffer from sovereign defaults in borrowing countries through trade and financial ties. In analyzing the different impacts of the COVID-19 pandemic, Hardy & Zhu (2023) note that central bank interventions temporarily broke the usual bank-sovereign link, although this could have long-term stability implications. Supporting these findings, Herasymenko's (2023) analysis of Ukraine offers a valuable perspective from an emerging market, illustrating how sovereign risk and macroeconomic instability interact to influence industrial lending trends, with banks becoming more sensitive to sovereign risk during recessions. While emphasizing the role of institutional and macroeconomic factors in shaping these relationships, these studies together highlight the complex ways sovereign risk spreads to bank lending.

3. Method, Variables and Data

3.1. Method

This study employs the Momentum Threshold Autoregressive (MTAR) model to investigate the nonlinear relationship between sovereign risk - Credit Default Swap (CDS) premiums of Turkey, which was used as a Proxy variable - and various financial variables in Turkey's credit market, indicated below in the variables and data section. The MTAR model is a strong econometric tool capable of capturing asymmetric adjustments and regime-dependent dynamics, which are particularly relevant in financial markets where responses to shocks often differ depending on the direction and magnitude of the change Enders & Granger, 1998; Enders & Siklos, 2001).

The MTAR model allows for different adjustment speeds depending on whether deviations from equilibrium are positive or negative. This is crucial in financial markets, where reactions to increases in sovereign risk (e.g., rising CDS premiums) may differ significantly from reactions to decreases (e.g., falling CDS premiums) (Enders & Siklos, 2001; Tsay, 1989).

The model identifies threshold values that separate different regimes, such as low-volatility and high-volatility periods. This is particularly useful for understanding how financial variables behave under different market conditions (Hansen, 1999). For instance, during periods of high sovereign risk (e.g., economic or political instability), the relationship between CDS premiums and lending rates may become more prominent, while it may become less pronounced in stable periods.

The relationship between sovereign risk and lending behavior can vary depending on the prevailing economic or financial regime, which may be more relevant in emerging market economies like Turkey. The MTAR model has demonstrated its ability to capture the state-dependent behavior of financial variables (Caner & Hansen, 2001).

The error correction process in the MTAR model measures how quickly variables stabilize after a shock. This allows the examination of both long-term equilibrium relationships and short-term dynamics (Enders & Granger, 1998). When sovereign risk rises, for example, the model can show if lending rate deviations from equilibrium are adjusted more rapidly than when risk decreases.

In this study, the MTAR model examines the relationship between CDS premiums (as a measure of sovereign risk) and key financial variables, such as commercial loan interest rates, loan volumes, and default rates in Turkey's credit market. The model is especially suitable for this analysis. Since financial markets often demonstrate nonlinear behavior, the MTAR model captures this nonlinearity by allowing for threshold effects and asymmetry adjustments (Enders & Siklos, 2001; Balke & Fomby, 1997). By analyzing asymmetric responses to sovereign risk, the model helps determine whether Turkish banks react differently to rising and falling sovereign risk (Enders & Granger, 1998).

The MTAR model provides a deeper understanding of how sovereign risk influences lending behavior in different market conditions by dividing the data into various regimes, such as low-risk and high-risk periods. Recognizing the procyclicality of credit markets—where lending practices may worsen economic swings—is especially important (Hansen, 1999).

The MTAR model simplifies the process of identifying long-term equilibrium relationships between financial factors and sovereign risk. For example, the model can demonstrate whether CDS premiums and commercial loan interest rates maintain a consistent, long-term relationship and how deviations from this equilibrium are adjusted over time (Enders & Siklos, 2001).

The MTAR model, unlike traditional Threshold Autoregressive (TAR) or Smooth Transition Autoregressive (STAR) models, is especially useful when asymmetric adjustments happen based on the direction of shocks rather than their size. Because bad news often causes financial variables to respond more strongly than good news, this is particularly important for sovereign risk assessments.

3.2. Variables and Data

The data used in this research were collected from multiple sources, including the Central Bank of Turkey, the Banking Regulation and Supervision Agency, and Investing.com. All time series data span the period from January 2014 to January 2025 and are recorded on a weekly basis. All loan amounts and interest rates used in this study are denominated in Turkish Lira (TRY), consistent with the domestic credit market framework.

A Momentum Threshold Autoregressive (MTAR) model is employed to analyze non-linear adjustments and asymmetric dynamics between CDS and the selected financial variables. The following table shows a list of variables used in the study:

Table 1

List of Variables

Code	Name of Variables in Turkish	Name of Variables in English	Data Source
LTL	Krediler - Toplam Krediler	Loans – Total Loans	BDDK
LCP	Krediler - Tüketici Kredileri ve Bireysel Kredi Kartları	Loans – Consumer Loans and Personal Credit Cards	BDDK
LIC	Krediler - Taksitli Tic. Krd. ve Kurumsal Kredi Kartları	Loans – Installment Commercial Loans and Corporate Credit Cards	BDDK
PRC	Takipteki Alacaklar - Tüketici Kredileri ve Bireysel Kredi Kartları	Non-Performin Loans (NPLs) – Consumer Loans and Personal Credit Cards	BDDK
PRCO	Takipteki Alacaklar - Ticari ve Diğer Krediler	Non-Performin Loans (NPLs) – Commercial and Other Loans	BDDK
PRSP	Takipteki Alacaklar - Takipteki Alacaklar Özel Karşılığı	Non-Performin Loans (NPLs) – Special Provision for Doubtful Receivables	BDDK
CDS	Ülke Risk Göstergesi Olarak Kredi Temerrüt Takas Primleri	Credit Default Swap Premiums as Country Risk Indicator	INVESTING
TLCK	TL Ticari Kredi Faiz Oranları	Turkish Lira Commercial Loan Interest Rates (Overall)	TCMB
TLCL	TL Ticari Kredi Faiz Oranları (KMH & Kurumsal Kredi Kartları Hariç)	Turkish Lira Commercial Loan Interest Rates (Excluding Overdraft Accounts & Corporate Credit Cards)	TCMB

3.3. Nonlinear MTAR Cointegration Test, Error Correction Model, and Causality

Cointegration is a key method used in both linear and nonlinear time series analysis. In recent econometric research, cointegration has mainly been applied within a linear framework. Likewise, error correction models (ECMs) based on cointegration relationships are also examined linearly.

To achieve stationarity, non-stationary time series are often differenced. However, this method can lead to a loss of long-term information. Therefore, the concept of cointegration was introduced. Cointegration is defined as the situation where a combination of non-stationary series becomes stationary (Güriş, 2020).

For example, consider the regression equation:

$$Y_t=\beta_1+\beta_2 X_t+\mu_t \quad (1)$$

If Y_t and X_t are both integrated of order d (i.e., I(d)), and d is the same for both series, then these two series may be cointegrated.

The cointegration test proposed by Granger (1987) involves two variables, Y_t and X_t . If both Y_t and X_t are non-stationary, they are differenced until they become stationary. The number of differences required to achieve stationarity is known as the order of integration. If $X_t \sim I(d)$ and $Y_t \sim I(d)$ and both have the same order of integration d, they may be cointegrated. The regression between Xt and Yt can be expressed as:

$$Y_t=\alpha+\beta X_t+\varepsilon_t \quad (2)$$

If the error term εt from this equation is stationary, it indicates a long-term equilibrium relationship between the two series.

However, linear error correction models face three main limitations:

1. The adjustment on the right-hand side of the equation is symmetric.
2. The equilibrium is assumed to be unique in the long run.
3. The equilibrium correction is a constant function of past equilibrium errors.

These limitations have led to the development of nonlinear error correction models (Escribano, 2004)**.**

The concept of nonlinear cointegration was first introduced by Balke and Fomby (1997), who combined cointegration with nonlinearity. According to their research, an error correction model (ECM) is used if a cointegration relationship exists. This approach explains the response to deviations from equilibrium. In nonlinear cointegration models, there is no continuous correction mechanism. The error correction mechanism is activated only when deviations from equilibrium exceed a certain threshold. In other words, when deviations surpass a critical value, economic factors intervene to restore equilibrium, as the benefits of correction outweigh the costs (Caner & Hansen, 2001)**.**

Enders & Siklos (2001) introduced the Momentum Threshold Autoregressive (MTAR) model in their threshold cointegration studies. The MTAR model allows for

asymmetric adjustments in the error correction mechanism (Koy et al., 2022).

Consider the first-order integrated variables $X_{1t},\ldots,X_{nt}$. The long-term relationship between these variables can be expressed as:

$$Y1t=\beta0+\beta1X1t+\beta2X2t+\cdots+\beta nXnt+\mu t \quad (3)$$

For a long-term relationship to exist, μt*μt* must be stationary. The MTAR model, which allows for asymmetric adjustments, is expressed as:

$$\Delta\mu t=It\rho1\mu t-1+(1-It)\rho2\mu t-1+\varepsilon t \quad (4)$$

Here, I_t is an indicator function, and ρ1 and ρ2 are the adjustment coefficients for positive and negative shocks, respectively. If ρ1=ρ2, the adjustment is symmetric (Enders & Siklos, 2001)**.** The indicator function is defined as:

$I_t = 1$ if $\mu t\text{-}1 \geq \tau$
0 if $\mu t\text{-}1 < \tau$
where τ is the unknown threshold value. If the threshold is set to zero, the function becomes:
$I_t = 1$ if $\Delta\mu t\text{-}1 \geq \tau$
2 if $\Delta\mu t\text{-}1 < \tau$,

The function **$\Delta\mu t\text{-}1 \geq \tau$** indicates that positive deviations are equal to or greater than the threshold value. The function **$\Delta\mu t\text{-}1 < \tau$**, shows that negative deviations are smaller than the estimated threshold value (Tsagkanos & Siriopoulos, 2015)

Instead of estimating the threshold value based on logical inference, if it is taken as **0**, the function becomes:

$I_t = 1$ if $\Delta\varepsilon t\text{-}1 \geq 0$,
$I_t = 0$ if $\Delta\varepsilon t\text{-}1 < 0$.

For stationarity, the following conditions must be met: $\rho1<0$, $\rho_2<0$, and $(1+\rho_1)(1+\rho_2)<1$ (Gregory & Hansen, 1996). The MTAR model captures asymmetric movements in the series and allows for asymmetric adjustments. If autocorrelation is detected, the model is extended as follows:

$$\Delta\mu_t=I_{t\rho}1\mu_{t-1}+(1-I_t)\rho_2\mu_{t-1}+\sum i=1p\gamma i\Delta\mu t-i+\varepsilon t \quad (5)$$

where p is the optimal lag length determined using the Akaike Information Criterion (AIC).

Enders & Siklos (2001) used the t-statistic to test for cointegration. The F-statistic tests the null hypothesis $\rho1=\rho2=0$. If the null hypothesis is rejected, nonlinear cointegration is confirmed. The asymmetry of the cointegration relationship is tested using $\rho1=\rho2$. Since the distribution of the test statistic is non-standard, it is compared with the critical values provided by Enders & Siklos (2001) which are tabulated in their study (Escanciano & Escribano, 2009).

3.4. Stationarity

The concept of stationarity in time series can be examined using unit root tests. Before conducting any analysis, it is crucial to determine whether the series is stationary.

In this study, the Momentum Threshold Autoregressive (MTAR) model, a nonlinear asymmetric unit root test developed by Enders & Granger (1998) was used for unit root analysis. The model is expressed as:

$$\Delta Y_t = I_{t\rho 1} Y_{t-1} + (1 - I_t)\rho 2 Y_{t-1} + \varepsilon_t \qquad t = 1,2,\ldots,T \tag{6}$$

where I_t is an indicator function defined as:

$$I_t = \begin{cases} 1 & \text{if } \Delta Y_{t-1} \geq 0 \\ 0 & \text{if } \Delta Y_{t-1} < 0 \end{cases}$$

The null hypothesis H0:ρ1=ρ2=0 (unit root exists) is tested against the alternative hypothesis H1:ρ1≠ρ2≠0 (stationarity exists).

Enders & Granger (1998) developed a three-step procedure for unit root testing:

Step 1: A regression is constructed for the series Y_t with a constant term to obtain the error terms. An indicator function is created based on whether these error terms are positive or negative. The MTAR model is then estimated, and the F-statistic is calculated to test the null hypothesis $\rho_1=\rho_2=0$. The resulting statistic is compared with the critical values tabulated by Enders & Granger (1998).

Step 2: If the alternative hypothesis is accepted, the joint distribution of ρ_1 and ρ_2 approximates a multivariate normal distribution, allowing asymmetric adjustments to be tested against symmetric ones. Thus, the null hypothesis $\rho_1=\rho_2=0$ can be tested using the F-statistic.

Step 3: The error terms must be checked at this stage. Tests are conducted to determine whether the residuals exhibit white noise properties. If autocorrelation is detected in the error terms, the process returns to Step 2, and the following model is estimated:

$$\Delta Y\hat{}t = It\rho 1(Y\hat{}t-1) + (1-It)\rho 2 Y\hat{}t-1 + \gamma 1 \Delta Y\hat{}t-1 + \cdots + \Delta Y\hat{}t-p + \varepsilon t \tag{7}$$

The lag lengths are determined using information criteria such as Akaike (AIC) and Schwarz (BIC). If the critical value is smaller than the calculated test statistic, the null hypothesis H_0 (based on the presence of a unit root) is rejected, indicating the absence of a unit root (Güriş, 2020).

Case=1 represents raw data, case=2 represents demeaned data, and case=3 represents data detrended from mean and trend. Max_lags denote the number of lags, while lsm=1 and lsm=2 represent the Akaike (AIC) and Schwarz (BIC) information criteria, respectively.

3.5. Unit Root Test Results

The **unit root test** examines whether the time series variables are **stationary or non-stationary**, which is crucial for determining their suitability for cointegration analysis. The tests were conducted for **three different cases**: raw data (**Case = 1**), demeaned data (**Case = 2**), and data detrended from both mean and trend (**Case = 3**).

For **raw data (Case = 1)**, the test statistics are compared with the Enders & Granger (1998) critical values: **2.51 at the 10% level, 3.21 at the 5% level, and 4.85 at the 1% level**. If the test statistic is lower than the corresponding critical value, the **null hypothesis (H_0) of a unit root is accepted**, indicating that the variable is non-stationary. Similarly, for **demeaned data (Case = 2)**, the critical values are **4.05 (10%), 4.95 (5%), and 6.91 (1%)**, while for **detrended data (Case = 3)**, the values are **5.60 (10%), 6.57 (5%), and 8.74 (1%)**.

The unit root test results indicate that CDS premiums (Credit Default Swap, CDS) remain non-stationary across all three cases, as their test statistics do not exceed the critical values. In contrast, **Total Loans (LTL), Consumer Loans (LCP), and Installment Commercial Loans (LIC) are found to be stationary**, with test statistics consistently surpassing the critical values, leading to the rejection of the null hypothesis. **Past Due Receivables (PRC, PRCO, PRSP) exhibit mixed results**, where PRC appears non-stationary in raw data (Case 1) but becomes stationary when adjusted for trend (Case 2 and Case 3). Meanwhile, **PRCO and PRSP remain non-stationary** at lower significance levels, suggesting that external factors influence their long-term properties.

Table 2
MTAR Model Unit Root Test Analysis Results

	Case=1	Case=2	Case=3
Citical Values	**2.51 (0.10) / 3.21 (0.05) / 4.85 (0.01)**	**4.05 (0.10) / 4.95 (0.05) / 6.91 (0.01)**	**5.60 (0.10) / 6.57 (0.05) / 8.74 (0.01)**
CDS	0.586349	2.557.696	2.720.929
LTL	1.437.005	9.083.322	2.104.705
LCP	1.897.203	1.431.422	5.874.805
LIC	1.206.461	9.259.135	3.993.984
PRC	740.331	1.307.849	1.126.767
PRCO	1.281.737	2.884.907	3.593.904
PRSP	3.916.492	1.549.613	6.244.335
TLCL	4.996.023	4.083.835	4.814.345
TLCK	2.698.444	1.249.718	1.278.444

Similarly, **Turkish Lira Commercial Loan Interest Rates (TLCK and TLCL) are largely non-stationary**, with TLCL only approaching stationarity at higher significance levels. Given that several variables exhibit non-stationarity, **first differences were taken to transform the data into a stationary form**, ensuring the validity of the

cointegration analysis. Subsequently, the MTAR Cointegration Analysis was applied to examine long-term equilibrium relationships between CDS premiums and key banking sector variables, helping to assess the impact of sovereign risk on lending behavior in Turkey's financial market.

4. Results, Analysis and Evaluations

Total Loans (LTL) and CDS: The MTAR model does **not** indicate a significant cointegration relationship between total loans and sovereign risk (**p = 0.1695**). This suggests that changes in CDS premiums do not systematically impact total loan volumes in the long run. Although error correction terms (**ECT1 = 0.0072, p < 0.001; ECT2 = 0.0079, p < 0.001**) are significant, implying short-term adjustments, the absence of cointegration indicates that these adjustments do not sustain a long-term equilibrium. The dataset exhibits a **high regime prevalence of 59.3%**, highlighting the dominance of financial volatility.

This finding implies that while short-term changes in sovereign risk may have an impact on total loan volumes, there is no consistent long-term relationship, suggesting that Turkish banks may give other considerations—like domestic economic conditions or regulatory policies—more weight than sovereign risk when deciding on total lending levels.

Consumer Loans and Personal Credit Cards (LCP) and CDS: No significant cointegration exists between consumer loans and CDS (**p = 0.1360**). Although the adjustment coefficients differ between regimes (**phiL.1 and phiH.1**), they do not establish a stable long-term relationship. The error correction terms (**ECT1 = 0.0151, p < 0.001; ECT2 = 0.0055, p < 0.001**) indicate asymmetric short-term adjustments, suggesting that consumer lending responds differently to positive and negative shocks in sovereign risk. The **high-volatile regime dominates at 60.7%**, further reinforcing that external risk factors influence credit conditions.

The absence of a long-term association suggests that consumer loans are less susceptible to sovereign risk, which may be because they depend on domestic economic fundamentals and have shorter maturities. Asymmetric adjustments, however, show that banks might tighten consumer credit more forcefully when sovereign risk is increasing.

Installment Commercial Loans and Corporate Credit Cards (LIC) and CDS: The results confirm **no significant cointegration** between installment commercial loans and CDS (**p = 0.0754**), indicating that changes in sovereign risk are not systematically linked to commercial loan volumes. The error correction terms (**ECT1 = 0.0069, p < 0.001; ECT2 = 0.0096, p < 0.001**) suggest short-term adjustments, with commercial loan responses differing based on risk conditions. The **high regime proportion is 61.22%**, reinforcing the market's exposure to financial stress.

This result indicates that corporate demand or sector-specific factors have a greater impact on commercial loan volumes than sovereign risk. The high prevalence of regimes

suggests that short-term lending behavior may still be affected by periods of financial hardship.

Past Due Receivables PRC and CDS: No cointegration is detected between past-due consumer loans and CDS (**p = 0.2829**). However, error correction terms (**ECT1 = 0.0238, p < 0.001; ECT2 = 0.0229, p < 0.001**) are significant, indicating short-term adjustments despite the lack of a long-term link. The **high regime dominates at 65.39%**, suggesting that sovereign risk influences short-term default risk during volatile periods.

Sovereign risk may increase short-term delinquency rates during times of increased financial instability, demonstrating the sensitivity of consumer lending to economic shocks, even while it has no long-term effect on consumer loan defaults.

Past Due Receivables PRCO and CDS: Commercial past-due receivables also exhibit **no cointegration with CDS** (**p = 0.5295**), and adjustment coefficients are not statistically significant. Despite weak adjustments (**ECT1 = 0.0039, p = 0.0803; ECT2 = 0.0040, p = 0.0197**), no stable link between sovereign risk and non-performing commercial loans is observed. The high regime share is **56.35%**, reflecting exposure to risk but without a structured equilibrium.

This finding suggests that firm-specific or sectoral factors may have a greater impact on commercial loan defaults than sovereign risk. Nonetheless, the high regime share implies that times of financial strain can still be a factor in the rise in non-performing loans.

Past Due Receivables PRSP and CDS: Special provisions for doubtful receivables **do not** exhibit a significant long-term relationship with sovereign risk (**p = 0.3345**). While error correction terms (**ECT1 = 0.0071, p < 0.001; ECT2 = 0.0067, p < 0.001**) are statistically significant, their small magnitude suggests limited adjustments. The **high regime is prevalent at 57.39%**, indicating that provisions respond more dynamically in times of financial stress.

The weak long-term correlation implies that there is no direct correlation between sovereign risk and banks' provisioning policies. The dynamic response during times of high volatility, however, emphasizes how financial stress influences risk management tactics.

Commercial Loan Interest Rates TLCK (Turkish Lira Commercial Loan Interest Rates) **and CDS:** Cointegration between TLCK and CDS (p = 0.0343) confirms a stable long-term relationship. The error correction terms (**ECT1 = 0.0050, p = 0.388; ECT2 = 0.0179, p < 0.001**) show asymmetric adjustments, meaning that commercial loan rates respond significantly to negative shocks in sovereign risk but not to positive ones. The **high regime proportion is 53.91%**, indicating that CDS volatility plays a key role in shaping borrowing costs.

This research highlights the rigidity of Turkey's credit market, as banks exhibit a cautious approach to lending during uncertain times by raising rates quickly in reaction to rising sovereign risk but being reluctant to lower them when risk declines.

Commercial Loan Interest Rates TLCL (Turkish Lira Commercial Loan Interest Rates - Excluding Overdraft Accounts & Corporate Credit Cards) **and CDS: :** A strong cointegration relationship is confirmed (**p = 0.0019**), showing that sovereign risk systematically affects this category of loan interest rates. The error correction terms (**ECT1 = 0.0001, p = 0.987; ECT2 = 0.0241, p < 0.001**) reinforce asymmetric responses, where interest rates increase rapidly in response to rising CDS levels but do not decrease proportionally when risk declines. The high regime proportion is **50.96%**, indicating that CDS-induced volatility significantly influences TLCL rates.

The unequal response demonstrates how Turkey's credit market is procyclical, with banks prioritizing risk avoidance over loan expansion during times of rising sovereign risk, which drives up borrowing costs for companies.

Table 3

MTAR Cointegration Results

Variable Pair	Threshold Value	Proportion in Low Regime	Proportion in High Regime	F-Statistic (ρ1 = ρ2 = 0)	p-value	Conclusion
LTL – CDS	0	40.7%	59.3%	8.602	0.1695	No Cointegration
LCP – CDS	0	39.3%	60.7%	18.565	0.1360	No Cointegration
LIC – CDS	0	38.78%	61.22%	14.731	0.0754	No Cointegration
PRC – CDS	0	34.61%	65.39%	84.067	0.2829	No Cointegration
PRCO – CDS	0	43.65%	56.35%	0.426	0.5295	No Cointegration
PRSP – CDS	0	42.61%	57.39%	1.085	0.3345	No Cointegration
TLCK – CDS	0	46.09%	53.91%	2.415	0.0343	Cointegration
TLCL – CDS	0	49.04%	50.96%	4.821	0.0019	Cointegration

Notes: High regime probability: The percentage of observations in the high-volatility regime. **Low regime probability:** The percentage of observations in the low-volatility regime. **P value:** Significance of adjustment coefficients in each regime. **p1 = p2 = 0:** Tests whether both adjustment coefficients are zero (rejected if significant). **p1 = p2:** Tests whether adjustment coefficients are equal across regimes (rejected if asymmetric).

Table 4

MTAR Error Correction Results

Variable Pair	ECT1 (Positive Shocks)	ECT2 (Negative Shocks)	DX Coefficient	DY Coefficient	AIC	BIC	R-squared
LTL – CDS	0.0072***	0.0079***	406.5***	-0.1459***	14171.44	14197.58	0.2375
LCP – CDS	0.0151***	0.0055***	12.84	-0.0321	11942.00	11942.00	0.2962
LIC – CDS	0.0069***	0.0096***	39.31**	0.0049	11911.00	11911.00	0.3322
PRC – CDS	0.0238***	0.0229***	0.1244	-0.0170	7204.00	7204.00	0.5107
PRCO – CDS	0.0039*	0.0040**	4.161*	0.0436	10002.00	10002.00	0.0250
PRSP – CDS	0.0071***	0.0067***	4.241**	0.0969*	9806.00	9806.00	0.1317
TLCK – CDS	0.0050	0.0179***	0.0020	-0.2143***	356.00	356.00	0.0578
TLCL – CDS	0.0001	0.0241***	0.0026	-0.2208***	458.00	458.00	0.0639

Notes: ECT1 and ECT2: Error correction terms indicating long-term equilibrium relationships in case of positive and negative shocks, respectively. **Dx and Dy:** Short-term dynamics of the variables. They represent the coefficients for the lagged differences of the independent and dependent variables, respectively. **AIC and BIC:** Akaike and Bayesian Information Criteria, respectively. They are information criteria used for model selection (values should be reported). ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. **R-squared** indicates the goodness of fit for the model. The **F-statistic** tests the null hypothesis of no cointegration ($\rho1 = \rho2 = 0$). If the p-value is less than 0.05, cointegration is present.

5. Conclusion

This study offers empirical insights into the impact of sovereign risk on the lending behavior of Turkish banks. The results highlight that only Turkish Lira Commercial Loan Interest Rates (TLCK and TLCL) have a strong long-term equilibrium relationship with CDS premiums. In contrast, variables such as Total Loans, Consumer Loans and Personal Credit Cards, Installment Commercial Loans and Corporate Credit Cards, Non-Performing Loans (NPLs) – Consumer Loans and Personal Credit Cards, Non-Performing Loans (NPLs) – Commercial and Other Loans, and Non-Performing Loans (NPLs) – Special Provision for Doubtful Receivables do not exhibit similar cointegration.

The uneven adjustment of commercial loan rates—where banks quickly raise rates during times of sovereign stress but are hesitant to lower them during stable periods—aligns with findings by Altavilla et al. (2017) and Crosignani et al. (2020) on the procyclical lending behaviors of Eurozone banks. However, our research clearly highlights this rigidity within an emerging market context, supporting Podstawski & Velinov (2018)'s view that sovereign risk spreads through different channels, such as pricing rigidity. The success of the MTAR model in capturing this nonlinear behavior (Enders & Siklos, 2001) underscores its importance for emerging markets with changing sovereign risk profiles.

These findings show that while sovereign risk does not directly influence total lending volume or default rates, it significantly impacts the cost of borrowing for businesses in the Turkish economy. Furthermore, the error correction mechanism (ECM) results confirm a downward rigidity in commercial loan pricing, indicating asymmetric adjustments. This suggests that interest rates respond more strongly to increases in sovereign risk than to decreases.

Academics, financial institutions, and policymakers may use these findings in their work, considering these concluding remarks: First, as evidenced by the cointegration between CDS premiums and TLCK/TLCL, Turkish banks incorporate sovereign risk into interest rate pricing, which causes borrowing costs to fluctuate with changing CDS levels. Second, the delayed adjustment of lending rates to decreasing sovereign risk and the rapid response to deteriorating sovereign risk should be viewed as cost management factors for commercial bank customers and risk managers. Structural obstacles that could harm financial stability and limit loan accessibility during economic recovery—due to this kind of interest rate rigidity—may need to be addressed

by policymakers. Since when banks prioritize risk containment over credit expansion, it can increase the procyclicality of lending during recessions.

This article makes three key contributions to literature. First, it provides empirical evidence of an asymmetric long-term relationship between sovereign risk and commercial loan pricing in emerging markets. Second, it demonstrates how the MTAR model can be used to evaluate nonlinear financial risk transmission. Third, unlike many existing studies, our findings challenge traditional financial theories that assume credit default swaps (CDS) fully capture market risk. Instead, we show that sovereign risk selectively impacts lending rates rather than credit availability.

Based on these results, future research should investigate how regulatory frameworks can enhance credit transmission and minimize lending rate rigidities. Additionally, further studies might analyze how macroeconomic shocks, like inflation and currency rate volatility, affect the link between CDS and loan pricing. Cross-national comparative research can also clarify the differences in sovereign risk transmission across various financial systems. Our findings offer strong empirical evidence that sovereign risk in Turkey primarily impacts borrowing costs rather than credit availability. The inconsistent response of interest rates to changes in sovereign risk indicates rigidities in commercial loan pricing. This insight has significant implications for developing economies, as such dynamics can influence risk management strategies, the effectiveness of monetary policy, and overall financial stability.

This research adds to the literature on the sovereign-bank relationship by showing that in Turkey—unlike in advanced economies—sovereign risk primarily influences loan pricing rather than loan volumes. These findings challenge linear risk transmission models and support using MTAR-based frameworks to analyze emerging markets. To prevent sovereign risk from worsening financial instability during recovery periods, policymakers need to address rate stickiness.

The most notable finding of this study is the asymmetric effect of sovereign risk on commercial loan interest rates in Turkey. Banks quickly raise interest rates when risk increases but are slow to lower them when risk declines. This shows the rigidity and procyclical nature of Turkey's credit market. Unlike studies in advanced economies, this research indicates that in emerging markets like Turkey, sovereign risk mainly influences borrowing costs rather than credit supply. This insight offers policymakers an important reference for developing strategies to reduce the indirect impact of sovereign risk on financial stability.

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