IRSTI 06.51.01 https://doi.org/10.26577/FJSS2024v9i2a8

L. Sezal

Kahramanmaraş Sütçü İmam University, Kahramanmaraş, Turkey
e-mail: leventsezal@ksu.edu.tr

DOES CURRENCY VOLATILITY AFFECT NON-PERFORMING LOANS? EVIDENCE FROM THE TURKISH BANKING SECTOR

Received: March 19, 2024
1st Revision: April 8, 2024
Accepted: May 1, 2024

Abstract. This study aims to econometrically investigate the relationship between non-performing loans and Euro and USD indices in Turkey. The data set of the study consists of the Turkish banking sector non-performing loan ratio and Euro and American Dollar (USD) indices variables for the period 01/2003-09/2023. Time series analyses were used to test the relationship between the variables. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests were applied to the data. Since the series became stationary at different levels, the ARDL (Autoregressive Distributed Lag Bound Test) test, one of the cointegration tests, was applied. Afterward, whether there is causality between the variables and if there is a causality relationship, the determination of the direction of causality is mutually tested with the "Granger Causality" method. According to the results of the research, a cointegration relationship was found between the non-performing loan ratios of the Turkish banking system and the Euro and USD indices. In the long run, it is concluded that a 1% increase in the Euro index is associated with a 2.93% decrease in non-performing loan ratios. On the other hand, in the short run, Euro and USD index values have no effect on non-performing loan ratios. According to the results of the Granger causality test, a unidirectional Granger causality relationship was detected between non-performing loan ratios and the Euro index. A similar unidirectional causality relationship was also found between the Euro index and the USD index.

Key words: Non-performing Loans, Exchange Rate, ARDL Boundary Test, Granger Causality Test.

Introduction

Nowadays, with the effect of globalization, the relations between financial markets across countries have become increasingly complex. In this context, the impact of exchange rate fluctuations on economic indicators has become an important research topic. Many financial institutions are vulnerable to exchange rate fluctuations, such as banks and corporations, which are affected by exchange rate fluctuations. In particular, fluctuations in exchange rates directly affect banks operating in international markets and transacting in foreign currencies. Changes in exchange rates affect banks not only through international transactions but also indirectly through competition in foreign markets, loan demand, and other banking activities.

Banks are financial institutions that act as intermediaries in efficiently channeling the idle funds held by savers to investors who need these funds (Koyuncu & Saka, 2011, p.113). In other words, they are enterprises that act as a bridge between those who supply funds and those who demand funds (Selimler & Kale, 2018, p. 275). It is possible to define a loan as a loan given to enterprises and individuals for a certain price to be repaid in a predetermined term (Black et al., 2009, p.39; Tanınmış & Sözer, 2011, p.43). In this respect, the banking sector is the most important institution that directs the transfer of funds within the financial system (Şahbaz & İnkaya, 2014, p. 69). In the banking sector, the loan item is one of the most basic products offered by banks and the majority of these loans are provided by savers who deposit their idle funds in banks. In this way, the funds in the hands of savers are used effectively (Koyuncu & Saka, 2011, p.113). In order for banks to continue their activities and increase their profitability, they need to ensure the return of the loans they have given. Failure to ensure the return of loans may bring serious risks in the banking sector and thus in the economy.

Article 5 of the "Regulation on Principles and Procedures for the Determination of the Qualifications of Loans and Other Receivables and the Provisions to be set aside for these Loans and Other Receivables by Banks" published in the Official Gazette dated

01.11.2006 and numbered 26333 states that: "In the event that the borrower has more than one loan granted by the same bank and any of these loans is considered as non-performing loans due to the classification made, all loans of the borrower from the bank shall be classified in the same group as non-performing loans". In the continuation of the same article, loans that are more than ninety days past due or due for payment are also classified as "Non-Performing Loans" (Official Newspaper, 2006).

"Non-performing loans", in other words non-performing loans (NPL), bring along some risks for banks. The most important of these are profitability and liquidity risks. For non-performing loans that are not repaid and fall into non-performing loans, banks set aside provisions at certain ratios and recognise them as expenses, thus affecting profitability. On the other hand, loans that are expected to be repaid on time create liquidity risk for banks since they cannot be repaid on time.

Banks are obliged to set aside provisions at the rates stipulated by the law for both retail and commercial loans that become problematic. As the number of overdue days of a loan increases, the provision allocated for the loans will increase and the increased provisions will increase the costs of the loans to the bank. The fact that a loan is thrown into legal follow-up accounts or becomes a non-performing loan completely is an indication that the problem to be encountered in the loan has reached the highest point. As a matter of fact, when defining the concept of non-performing loans, loans for which the legal follow-up period has started are generally mentioned, but this situation may vary due to the credit policies of banks. Some banks may be based on loans that cannot be collected for 30 days and some banks for 90 days.

This study aims to investigate the effect of exchange rate volatility on the non-performing loan ratio of the Turkish banking sector. In this context, after the introductory section, a brief review of the literature on the subject is provided. Then, information about the data set and methodology used in the study is given. In the last part of the study, the findings of the research are given and the study is finalised. In the literature, it has been observed that non-performing loans are taken in quarterly or annual periods in many studies on the subject. The difference of this study from other studies in the literature is that the variables used in the study are taken on a monthly basis and cover a period of 249 months.

Literature review

When the studies in the literature on non-performing loans are analysed, the general view is that non-performing loans may be an important macroeconomic indicator and may have some effects on the economy in general. In this respect, the relationship between non-performing loans and various macroeconomic indicators (growth, gross domestic product, inflation, interest rates, production index and some stock market indices, unemployment, some exchange rates, etc.) have been analysed and the studies have focused on the macroeconomic determinants of non-performing loans.

In the study conducted by Yücememiş & Sözer (2011), NPL ratios were tried to be estimated monthly with macroeconomic data. In the model constructed, it is observed that the past period performance coincides with the realised value and it is determined that NPLs are affected by the past period performance. At the same time, it is determined that the NPL ratio is affected by the value of TL and industrial production with a one-period lag.

Park & Zhang (2012) examined whether there is an observable relationship between NPL and macroeconomic variables and bank-specific variables in the US banking sector through regression analysis. In the study, unemployment rate, GDP growth and central bank borrowing interest rates were used as macroeconomic indicators, while bank-specific variables such as solvency ratio, return on equity, efficiency ratio, non-interest income and bank size were used. Year-end data of 2670 banks were used in the study, which was divided into two process-dependent phases as the pre-crisis period between 2002-2006 and the crisis phase between 2007-2010. As a result of the study, a statistically significant negative relationship was found between GDP ratio and NPL.

In the study of Mileris (2012), a forecasting model on doubtful and non-performing loans was developed by considering the banking sector of 22 European Union member countries. According to the results, non-performing loans are related to many macroeconomic variables such as GDP, inflation, interest rates, money supply, industrial production index and current account balance. The model developed in the study provided 98.06% accuracy in predicting the percentage of doubtful and non-performing loans in banks.

Castro (2012) conducted a panel data analysis test for Ireland, Italy, Greece, Spain and Portugal between 1997 and 2011. The study concludes that banking credit risk is significantly affected by the macroeconomic environment. It is observed that credit risk increases when GDP growth, stock price indices and house prices decrease and increase; unemployment rate, interest rate and credit growth increase; real exchange rate is positively affected; and there is a significant increase in credit risk during the recent financial crisis.

Kolapo et al. (2012) conducted a study on the quantitative impact of credit risk on bank performance of five commercial banks in Nigeria for the period 2000-2010. As a result of the study, the rate of return on assets (ROA) is negatively affected by non-performing loans ratio and loan loss provisions. The effect of non-performing loans is found to be greater than that of loan loss provisions.

Janvisloo, et al. (2013) constructed a structural VAR model for the period 1997-2012 to determine how macroeconomic shocks affect non-performing loans in the Malaysian economy. The model includes four variables (real GDP, inflation rate, interest rate and non-performing loan rate). The results of the impulse-response analysis show that non-performing loans increase in response to a positive interest rate shock and decrease in response to a positive inflation shock.

Curak et al. (2013), in their study on 69 banks in 10 countries in the Southeast European banking system, investigated the effects of macroeconomic data and a number of banking-related variables on non-performing loans using a panel data test. According to the study, low growth, high inflation and high interest rates in the economy positively affect non-performing loans and are also affected by variables such as credit risk, bank size, bank performance and solvency.

Yağcılar & Demir (2015) examined the determination of the factors affecting the non-performing loan ratios in the Turkish banking sector. In this context, they aimed to determine the macroeconomic and bank-level determinants of non-performing loan ratios, which are the main indicators of risk and performance in commercial banks. Panel data analysis was used in the study. According to the results of the study, while there are negative relationships between loan/deposit ratio, stock market listing, scale, liquidity and return on assets variables and non-performing loans, there are positive relationships between interest rates, growth and capital adequacy ratio and non-performing loans. On the other hand, interest rates applied to loans, inflation and net interest margin variables have no statistically significant effect on non-performing loans.

Anastasiou et al. (2016) examined the banking sector of European countries and analysed the factors affecting non-performing loans using panel data and VAR model. According to their research, non-performing loans increased after 2008 and were found to be under the influence of macroeconomic factors such as unemployment, growth and taxes.

Abdioğlu & Aytekin (2016) used panel data analysis in their study on determining the factors affecting the non-performing loan ratio. In their study, it is aimed to determine the factors affecting the non-performing loan ratios of deposit banks after the 2001 financial crisis. In this context, private capital domestic deposit banks, public capital deposit banks and foreign capital deposit banks operating in Turkey between 2002-2014 were analysed in detail. As a result of the study, it was determined that the non-performing loan ratio, capital adequacy, solvency and net interest margin ratio in the previous period had a negative effect on non-performing loans.

Banerjee & Murali (2017) investigated the effects of domestic macroeconomic variables and external factors on banks' asset quality in India. In the study, the VAR model method was estimated using quarterly data for the period 1997-2014. The VAR model includes 7 variables (non-performing loans, loan interest rate and deposits, net capital inflow, output gap, wholesale price index, real effective exchange rate). The impulse-response analysis reveals that non-performing loans are negatively affected by shocks to the real exchange rate, foreign capital inflows and output gap.

In their study, Mensah, et al. (2017) analysed the period covering the global crisis period (2007-2009) in the Ghanaian banking sector. In their analyses, they found that micro factors such as the previous year's NPL ratio, credit risk, bank size and loan growth as well as macro variables such as inflation, debt stock, growth and real interest rate have a statistically significant effect on NPLs.

In their study, Poyraz & Arlı (2019) examined the effect of foreign exchange volatility on non-performing loans through the case of Turkey. As a

result of the study using Granger causality test, a long-run relationship between USD and non-performing loans was observed and it was determined that USD affects non-performing loans. Gbp did not have a clear long-run relationship with NPLs, but Gbp was found to be the cause of NPLs. They concluded that Jpy has no long-run relationship with non-performing loans.

Sevinç (2021) investigated the effects of some selected macroeconomic factors on the NPL ratios of the Turkish Banking Sector for the periods between 2005-2019 using the ARDL Bound Test. As a result of the research, it was found that increases in inflation and economic growth have a negative effect on NPL ratios, while increases in exchange rates and unemployment factors have a positive effect on NPL ratios. Moreover, a bidirectional causality relationship was found between NPL ratios and unemployment rates.

Özel & Sayılgan (2021) conducted a study on the structure of non-performing loans in the Turkish banking sector and bank-specific macroeconomic determinants. As a result of the analysis covering the period between 2003-2019, the existence of a long-run cointegrated relationship between NPL ratios and macroeconomic and bank-specific factors was determined. According to the findings of the analysis, positive and statistically significant relationships were found between the NPL ratio and credit growth, exchange rate appreciation, consumer inflation, capital adequacy ratio and deposit/loan ratio variables. On the other hand, no significant relationship was found between industrial production index and NPL ratio.

In their study, Gül & Koy (2023) investigated the determination of macroeconomic indicators that can be associated with non-performing loan ratios (NPL), which is one of the leading indicators of bank assets, taking into account the effective role and position of banks in shaping the economy in Turkey. They used the Momentum Threshold Autoregressive Model (MTAR) method in the study. They concluded that there is a non-linear, asymmetric causality relationship between NPL ratios and inflation rates.

Sezal (2023) investigated the effect of Covid-19 on non-performing loans. In the study covering the pandemic period, time series analyses were used. Whether there is causality between variables, and if there is a causality relationship, determining the direction of causality is tested by Hatemi-j method in the form of binary analysis. According to the test results, a causal relationship was found between the number of cases and non-performing loan variables.

Varlık (2023) investigated the relationship between non-performing loans ratio and macroeconomic variables for the period 01/2003 -04/2019 in Turkey. Structural vector autoregressive model estimation was used in the study. According to the findings of the impulse response analysis, increases in loan growth and real GDP growth slow down the increase in the NPL ratio, while an increase in the loan interest rate accelerates the increase in the NPL ratio. An increase in the NPL ratio, on the other hand, is found to have a negative feedback effect on loan growth and economic growth.

Research Design and Methodology

This study utilizes time series analysis methods. In this context, it investigates the relationship between NPL and Euro and USD indices in Turkey. Time series analyses, which were previously used for economic research, have become increasingly important in financial studies.

Purpose of the study

The study aims to econometrically investigate the relationship between NPL and Euro and USD indices in Turkey and to determine whether there is a relationship between the monthly frequency data between 2003 and 2023.

Data set

The data set of the study consists of NPL and Euro and USD indices for the period 2003-2023. In terms of foreign currencies, the first two of the most widely circulated currencies in the world according to the December 2022 report of the "Society for Worldwide Interbank Financial Telecommunication" (SWIFT) were selected. The time series in question were accessed from BRSA and T.C.M.B Electronic Data Distribution System (EVDS). The logarithm of all variables used in the research was taken. In this way, measurement differences between the series were tried to be minimized.

In Table 1, it is determined that all three series have a normal distribution since the mean and median values in descriptive statistics are close to each other and the JB P-values show that the null hypothesis is not rejected.

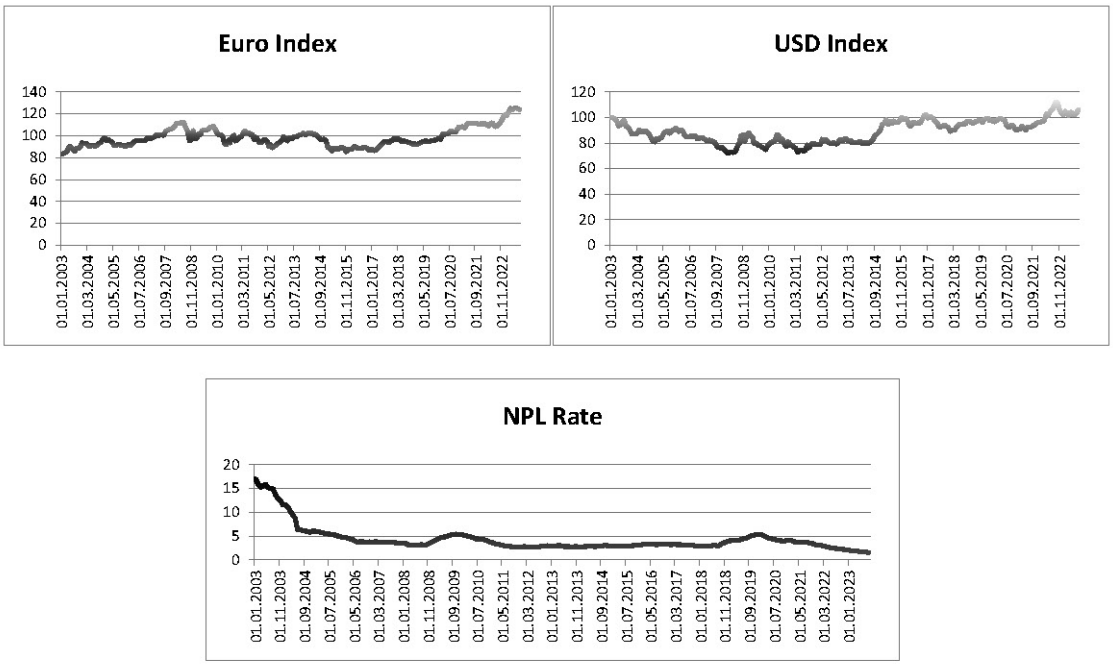

Figure 1 – Time series graphs

Table 1 – Descriptive statistics

	LOGNPL	LOGEUR	LOGUSD
Average	1.334.823	4.585.840	4.483.632
Median	1.220.830	4.568.195	4.492.561
Maximum	2.834.976	4.831.987	4.719.570
Minimum	0.425268	4.424.128	4.273.884
Standard deviation	0.433650	0.085214	0.100084
Distortion	1.454.188	0.675987	-0.067094
kurtosis	5.854.078	3.153.050	2.048.170
Jarque-Bera	1.722.708	1.920.679	9.586.367
Possibility	0.000000	0.000067	0.008286
Observations	249	249	249

Method

The study utilizes time series analysis to test the relationship between the Turkish banking system NPL variable and the Eur and USD indices. In order to determine the relationship between the variables, the stationarity of the variables should be determined first. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are applied to the data. Since the series are stationary at different levels, ARDL (Autoregressive Distributed Lag Bound Test) test, one of the cointegration tests, was applied. The ARDL method, which helps to model the dynamic interactions between the current and past data of the dependent and independent variables, contributes to the understanding of the long-run relationships between variables. Afterwards, whether there is causality between the variables, and if there is a causality relationship, the determination of the direction of causality is mutually tested with the "Granger Causality" method. Analyses in the research were conducted with the help of the E-Views 9.0 program.

ADF and PP unit root tests

The Extended Dickey-Fuller unit root test is frequently used in research to determine whether the

series contains unit roots. This unit root test can be characterized as a different version of the ADF unit root test based on the AR(1) process. However, in time series, εt (error/residual terms) loses its clean series property if there is a higher order correlation in the series. To solve this problem, the ADF test utilizes the AR(p) process rather than the AR(1) process and includes "p" lagged difference terms in the equation (Dickey & Fuller, 1979). Thus, ADF equations without constant term and trend (none), with constant term (intercept) and with constant term and trend (intercept&trend) respectively:

$$\Delta y_t = \delta y_{t-1} + \sum_{i-1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_i \quad (1)$$

$$\Delta y_t = \mu + \delta y_{t-1} + \sum_{i-1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_i \quad (2)$$

$$\Delta y_t = \mu + \beta t + \delta y_{t-1} + \sum_{i-1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_i \quad (3)$$

is expressed as follows. In equations 1, 2, and 3, μ corresponds to the constant term, t to the trend, p to the number of lags, and εt to the error term series. For all three ADF equations, the null hypothesis is formulated in the same way and states that the series contains a unit root. Therefore, the null hypothesis states the existence of a non-stationary series (Gujarati, 2015, p.328). The hypotheses for the existence of a unit root for these models are as follows:

H_0: δ=0 (The series is non-stationary)
H_1: δ<0(φ1<1) (The series is stationary)

The ADF test is based on the basic assumptions that error terms are independent and constant variance. Moreover, the DF test does not provide adequate results in series with structural breaks. PP attempts to generalize the DF test by smoothing its assumptions about error terms (Demirel, 2015, p.28). In this transformation, the nonparametric method was utilized (İnce, 2015, p.30).

As in the ADF test, the PP test is applied in three different ways: without constant, with constant, and with constant and trend (Samut, 2016, p.40).

$$\Delta y_t = a y_{t-1} + x_t^1 \delta + \varepsilon_t \quad (4)$$

is of the form. In equation 4, a= ρ -1, "xt " is the set of deterministic components (constant term or constant term and trend) and "εt " is the set of error (residual) terms. In the PP test, the main and alternative hypotheses are formulated as "H_0: α = 0 and H_1: α < 0" and the main hypothesis states that the series contains a unit root (Çağlayan and Saçalı, 2006, p.125).

H_0: If δ = 0, there is a unit root.
H_1: If δ<0, there is no unit root.

Cointegration and ARDL bounds test

Cointegration means that linear combinations of multiple non-stationary time series are stationary and these series have an equilibrium relationship in the long run (Tarı, 2014, p.415). Although there are different cointegration tests developed in the literature such as Engle-Granger (1987), Johansen (1988) & Phillips-Ouliaris (1990), in order to apply these cointegration tests, the series of all variables must be stationary in their first differences, i.e. I(1). However, the ARDL bounds test approach eliminates this constraint and allows cointegration analysis in all combinations where the variables are I(0) and I(1) (Pesaran, Shin & Smith, 2001, pp.289-290). In other words, cointegration relationships between time series with different stationarity levels can be realized with the ARDL bounds test approach. In addition, the dependent variable must be I(1) in the ARDL bounds test approach.

The bounds test, which is based on the estimation of the unrestricted error correction model, is applied in two stages: the first one is to establish the long-run relationship between the variables and the second one is to determine the cointegration relationship between the variables. The ARDL Border Test equation with two variables to be performed in order to reveal the cointegration relationship is as follows:

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{m} \beta_{1i} Y_{t-i} + \sum_{i=1}^{m} \beta_{2i} X_{t-i} + \beta_{3i} Y_{t-1} + \beta_4 X_{t-1} + \varepsilon_t \quad (5)$$

In the equation; is the dependent variable, Xt is the independent variable, is the error term, m is the optimum lag length and m is the minimum value of the information criteria. The hypotheses regarding the existence of cointegration in the ARDL bounds test model are as follows:

H_0: $\beta_3 = \beta_4 = 0$ (There is no cointegration)
H_1: $\exists \delta_i < 0, i = 3,4$ (There is cointegration).

In the ARDL bounds test approach, the long-run relationship coefficients of the variables are examined after the cointegration relationship for the variables is revealed. In addition, the existence of short-run deviations from the long-run relationship can also be examined with the help of the error correction model. The equation for the long-run relationship is as follows:

$$Y_t = \beta_0 + \sum_{i=1}^{m} \beta_{1i} Y_{t-i} + \sum_{i=0}^{n} \beta_{2i} X_{t-i} + \varepsilon_t \quad (6)$$

In the equation, Yt is the dependent variable, Xt is the independent variable, is the constant term, is the error term, and n and m are the optimal lag lengths.

Granger causality analysis

Granger causality means that the independent variable X in the regression has a causal relationship with the dependent variable Y. For this to happen, two basic conditions must be met. The first one is that the dependent variable X mediates the prediction of the independent variable Y. The second assumption is that Y will not be effective in predicting X. In causality tests, the direction of the tests is important, that is, it is important in determining whether the variables are dependent or independent. The direction of causality is important in understanding whether the relationships between two or more variables are unidirectional, bidirectional or no relationship at all (Granger, 1969, pp. 424-438; Kennedy, 2006, pp. 81-82; Gujarati, 2009, pp. 620-623). Granger causality test enables causality analysis between dependent and independent variables in the "short run".

$$y_t = a_1 + \sum_{i-1}^{n} \beta_i x_{t-i} + \sum_{j=1}^{m} Y_j y_{t-j} + e_{1t} \quad (7)$$

$$x_t = a_2 + \sum_{i-1}^{n} \theta_i x_{t-i} + \sum_{j=1}^{m} \delta_j y_{t-j} + e_{2t} \quad (8)$$

If hypothesis H_0 is rejected, it means that X has a Granger causality relationship with Y. In a Granger causality test, there can be both a direction from X to Y and a direction from Y to X. It is denoted as X↔Y. If both H_0 hypotheses are rejected, it is possible to say that there is a bidirectional causality between X and Y variables. In order to conduct a Granger causality test between X and Y series, the covariance of both variables should be stationary and stochastic. The hypotheses of the Granger causality test are as follows:

H_0: There is no causality between NPL ratios and Euro and USD indices.
H_1: There is a causal relationship between NPL ratios and Euro and USD indices.

Results and Discussion

In this section of the study, the results of the tests applied and the findings obtained in order to reveal the relationship between the Turkish banking system NPL dependent variable and Euro and USD indices are presented.

ADF and PP unit root test results

Before proceeding to cointegration analysis, it is necessary to check whether the series contain unit root, that is, whether they are stationary. For this purpose, ADF and PP tests were conducted. The purpose of these tests is to prevent spurious regression. The results of ADF and PP unit root tests are presented in Table 3 below.

According to the test results applied to check the stationarity of the series used in the research, it was determined that some variables were non-stationary, that is, they contained unit roots. The series were made stationary by taking the first differences of the variables containing unit root.

Table 2 – ADF and PP unit root test results

			ADF			PP		
			logEUR	***logNPL***	***logUSD***	***logEUR***	***logNPL***	***logUSD***
LEVEL	With Constant	t-Statistic	-1,4351	-2,7945	-1,5071	-1,4785	-2,7957	-1,6869
		Prob.	0,5648	0,0605	0,5285	0,5430	0,0603	0,4367
			-	*	-	-	*	-
	With Constant & Trend	t-Statistic	-1,7379	-3,0764	-2,9114	-1,7938	-2,8428	-3,0163
		Prob	0,7315	0,1143	0,1607	0,7051	0,1835	0,1298
			-	-	-	-	-	-
	Without Constant & Trend	t-Statistic	1,1789	-2,2962	0,1401	1,2313	-2,8195	0,1287
		Prob	0,9387	0,0212	0,7258	0,9443	0,0049	0,7223
			-	**	-	-	***	-
FIRST DIFFERENCE	With Constant	t-Statistic	-16,1836	-4,8739	-15,4074	-16,1947	-11,7367	-15,4354
		Prob	0,0000	0,0001	0,0000	0,0000	0,0000	0,0000
			***	***	***	***	***	***
	With Constant & Trend	t-Statistic	-16,1617	-4,8935	-15,5139	-16,1728	-11,7726	-15,5318
		Prob	0,0000	0,0004	0,0000	0,0000	0,0000	0,0000
			***	***	***	***	***	***
	Without Constant & Trend	t-Statistic	-16,1217	-4,6206	-15,4370	-16,1181	-11,3737	-15,4639
		Prob	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
			***	***	***	***	***	***
Significance Level	1%	-3,4566						
	5%	-2,8729						
	10%	-2,5729						

Note: (*) denotes rejection of the null hypothesis that there is a unit root in the series at 10%, (**) 5% and (***) 1% significance level.

ARDL bounds test results

In time series analysis, whether the variables are related to each other in the long run is investigated by cointegration tests. Normally, for these tests to be applied, the series should be stationary. However, if non-stationary series form a stationary process when they come together, a long-run relationship between variables can be determined. In order to conduct the ARDL test, the maximum lag lengths of the data must first be determined. The results of this test are as follows:

As a result of setting the maximum lag length as 4, the results of the ARDL Border Test applied to the NPL and Euro and USD indices series are as follows:

Table 3 – Maximum lag lengths

Lag	LogL	LR	FPE	AIC	SC	HQ
0	4.013.197	NA	7.36e-06	-3.305558	-3.262178	-3.288081
1	1.782.662	2.716.831	8.34e-11	-14.69429	-14.52077*	-14.62438
2	1.798.983	3.169.317	7.84e-11	-14.75504	-14.45139	-14.63271*
3	1.807.355	1.604.983	7.89e-11	-14.74983	-1.431604	-14.57507
4	1.820.720	2.528.902	**7.61e-11***	**-14.78606***	-14.22213	-14.55887
5	1.823.589	5.356.957	8.01e-11	-14.73518	-14.04111	-14.45555
6	1.826.585	5.518.482	8.42e-11	-14.68535	-13.86115	-14.35329
7	1.835.170	1.560.267	8.45e-11	-14.68191	-13.72756	-14.29742
8	1.845.992	19.39883*	8.33e-11	-14.69703	-13.61255	-14.26011

Note * denotes the lowest critical value indicating the maximum lag length.

Table 4 – ARDL bounds test results

Model	K	M	F Statistics	Significance Level	Lower Limit	Upper Limit
				1%	4,13	5,00
ARDL (4,0,0)	4	12	4,085288	5%	3,10	3,87
				10%	2,63	3,35

Note: Critical values for lower and upper bounds are taken from Table CI(ii) in (Pesaran et al., 2001, p.300).

As can be seen in Table 5, the F-statistic value is above the upper bound at the 5% level. According to this result, there is a cointegration relationship between the NPL ratios of the Turkish banking system and the Euro and USD indices. Since there is a cointegration relationship between the series, it is appropriate to use the ARDL model for long and short-run estimations.

Table 5 – ARDL (4,0,0) model long-run coefficient estimates

Variables	Coefficient	Std. Deviation	t-Statistic	Probability
LOGEUR	-2.931635	1.281126	-2.288326	0.0230
LOGUSD	-1.057848	1.054507	-1.003168	0.3168
C	19.317662	7.875567	2.452860	0.0149

As can be seen in Table 6, only the Euro data is statistically significant in the long run. The data is significant at the 5% level. The coefficient of the Euro index is -2.93. Accordingly, a 1% increase in the Euro index results in a 2.93% decrease in NPL ratios. Therefore, there is a negative and strong long-run relationship between the Euro index and NPL ratios.

Table 6 – ARDL error correction model

Değişkenler	Coefficient	Std. Deviation	t-Statistic	Probability
D(LOGEUR)	0.021110	0.194197	0.108705	0.9135
D(LOGUSD)	-0.071020	0.179567	-0.395507	0.6928
CointEq(-1)	-0.021661	0.005323	-4.069.413	0.0001

The existence of a short-run relationship between variables should be determined by the coefficient of the error correction model (ECT). For this model to work, the ECT coefficient must be between 0 and -1 and statistically significant. Table 7 results show the short-run data and error correction model for the ARDL (4,0,0) model." When the short-run estimation results are analyzed, the coefficient of the error correction term "Y1" corresponds to "CointEq(-1)" in this table. This coefficient is expected to be negative (-) and the probability value is expected to be less than 0.05. As can be seen in Table 7, the coefficient of the error correction term is -0.021661 and the probability value is 0.0001. The fact that the coefficient of the error correction term is negative and statistically significant provides additional evidence that the variables are cointegrated. A probability value less than 0.05 indicates that this coefficient is significant, while a negative (-) coefficient means that an imbalance in the model will be corrected. The data show that the Euro and USD index values do not affect NPL ratios in the short run.

Granger causality analysis results

The direction and lag structure of the causality relationship between variables are analyzed by Granger Causality Test. This test aims to determine whether there is a unidirectional or bidirectional relationship between the variables in the model. While determining the causality between the series, the lag length (k) of the series is found according to the "Akaike Information Criterion (AIC)" and the maximum degree of integration (dmax) is found according to the unit root tests. Then, "Wald Statistic" was applied to the lagged values of this model (k) and it was determined whether there is a causality relationship between the variables.

Table 7 – Granger causality test results

Independent Variable	*Dependent Variable*	*K*	*F-Statistic*	*Prob.*	*Relationship*
LOGEUR	LOGNPL	4	412.607	0.0173	**There is a relationship**
LOGNPL	LOGEUR	4	0.16163	0.8509	No relationship
LOGUSD	LOGNPL	4	0.16351	0.8493	No relationship
LOGNPL	LOGUSD	4	204.017	0.1322	No relationship
LOGUSD	LOGEUR	4	362.557	0.0281	**There is a relationship**
LOGEUR	LOGUSD	4	268.485	0.0703	No relationship

Table 7 shows the results of the Granger causality test. According to the results of this test, there is a unidirectional Granger causality relationship from NPL ratios to the Euro index. A similar unidirectional causality relationship was also found from the Euro index to the USD index. For the relationship between these variables, the H_0 hypothesis is rejected while the H_1 hypothesis is accepted. Since no relationship was found for other comparisons, hypothesis H0 was accepted while hypothesis H_1 was rejected.

Conclusion

The banking sector non-performing loan ratio is considered as an indicator of financial stability. An increase in this ratio may lead to a liquidity shortage or even a crisis in the banking sector as it causes a decline in banks' profits and an increase in the provisions they set aside. Therefore, the question of what factors determine the NPL ratio gains importance. In addition to factors specific to the banking sector, macroeconomic factors can significantly change the NPL ratio by affecting the debt repayment capacity of borrowers. On the other hand, macroeconomic variables can also be affected by the NPL ratio. An increase in the NPL ratio may create negative feedback on domestic credits and economic growth.

Although the Turkish banking sector is positively differentiated from banks in major world economies in terms of asset management quality, it is important to closely monitor some critical parameters in order to maintain the success of our banking sector in asset quality. International studies reveal that there are negative or positive correlations between some bank-specific variables and certain macroeconomic indicators and NPL ratios. In this context, the determination of the relationship between these variables and their direction may not only contribute to the inferences to accurately predict NPL ratios at controllable levels, but also shed light on the policies to be implemented by bank managers and legislative authorities to maintain asset quality in the sector.

In this study, the volatility in foreign exchange, which is thought to have an impact on non-performing loans, is analyzed. In this context, non-performing loans from the banking sector balance sheet on a monthly basis for the period 01/2003-09/2023 and Euro and USD indices on a monthly basis for the same period were the subject of the study. Time series analysis methods were used in the study. Firstly, ADF and PP tests are used to examine whether there is a unit root or not, and then cointegration and causality relationship between the series are tried to be revealed. Based on this, ARDL bounds test and Granger causality tests were conducted. According to the results, there is a cointegration relationship between the NPL ratios of the Turkish banking system and the Euro and USD indices. In the long run, a 1% increase in the Euro index is associated with a 2.93% decrease in NPL ratios.

In other words, there is a negative and strong long-run relationship between the Euro index and NPL ratios. There is no relationship between the USD index and NPL ratios. On the other hand, Euro and USD index values do not affect NPL ratios in the short run. According to the Granger causality test results, there is a unidirectional Granger causality relationship from NPL ratios to the Euro index. A similar unidirectional causality relationship was also found from the Euro index to the USD index.

Preventing loans from becoming problematic is as important as the management of problematic loans. For this purpose, banks should have an effective credit risk management. Regulations for the banking sector should aim to mitigate the effects of exchange rate fluctuations on the banking sector on the one hand and the feedback effects of credit risk on the economy on the other. In this respect, in order to reduce the vulnerability of the banking sector in the face of sudden shocks in exchange rates, priority should be given to surveillance and supervision to ensure the maintenance of credit quality. Macroprudential regulations should aim at preventing excessive risk-taking behaviour of banks and maintaining high credit standards. Moreover, FX-denominated loans to unprotected borrowers should be prevented and the sensitivity of bank balance sheets to exchange rate fluctuations should be reduced.

In future studies, the panel data analysis technique can be used to extend the study by using bank-based and additional currencies (such as Sterling, Swiss Franc, Japanese Yen). On the other hand, a different study can be conducted by analyzing bank-specific endogenous and exogenous factors affecting non-performing loans.

References

Abdioğlu, N. ve Aytekin, S. (2016). Takipteki kredi oranını etkileyen faktörlerin belirlenmesi: mevduat bankaları üzerinde bir dinamik panel veri uygulaması. İşletme Araştırmaları Dergisi, *8*(1), 538-555.

Anastasiou, D., Louri, H. & Tsionas, M. E. (2016). Non-performing loans in the euro area: are core-periphery banking markets fragmanted? *Bank of Greece Working Paper*, (219), 1-49.

Banerjee, S. ve Murali, D. (2017). Stress test of banks in India across ownerships: a var approach. *Studies in Economics and Finance, 34*(4): 527-554.

Bankacılık Düzenleme Kurulu ve Denetleme (BDDK). Aylık Bülten.

Black, J., Nigar H. & Gareth M. (2009). *Dictionary of Economics*.Third Edition, USA.

Çağlayan, E. ve Saçaklı, İ. (2006). Satın alma gücü paritesinin geçerliliğinin sıfır frekansta spektrum tahmincisine dayanan birim kök testleri ile incelenmesi. *Atatürk* Üniversitesi İktisadi *ve* İdari *Bilimler Dergisi, 20* (1), 121-137.

Castro, V. (2012). Macroeconomic determinants of the credit risk in the banking system: the case of the GIPSI. *Economic Modelling, Documentos De Trabalho Working Paper Series*, 672-683.

Curak, M., Pepur, S. & Poposki, K. (2013). Determinants of non-performing loans – evidence from southeasterneuropean banking systems. *Banks and Bank Systems Journal, 8*(1), 45-53.

Demirel, A. K. (2015). *Asimetrik nedensellik testi ve ihracat-ekonomik büyüme ilişkisi* üzerine *bir uygulama.*(Yüksek Lisans Tezi). İnönü Üniversitesi Sosyal Bilimler Enstitüsü, Malatya.

Dickey, D. A. & Wayne A. F. (1979). Distribution of the estimators for autoregressive time series with a unitroot. *Journal Of TheAmerican Statistical Association, 74*(366), 427-431.

Engle, R. F. & Granger, C. W. J. (1987). Co-integration and error correction: representation, estimation and testing. *Econometrica, 55*(2), 251-276.

Gujaratı, D. N. (2004). *Basic Econometrics.* TataMcGraw-HillEducation.

Gül, S. ve Koy, A. (2023). NPL ve makroekonomik göstergeler arasındaki ilişkinin MTAR modeli ile eşbütünleşme ve nedensellik analizi. *Ekonomi ve Finansal Araştırmalar Dergisi, 5*(1), 1-18. https://doi.org/10.56668/jefr.1229535

İnce, T. (2015). *AB'ye* üyelik *sürecinde Türkiye'nin maastricht kriterlerine yakınsama analiz*. (Yüksek Lisans Tezi). İstanbul Üniversitesi Sosyal Bilimler Enstitüsü Ekonometri Anabilim Dalı, İstanbul

Janvisloo, M.A., Muhammed, J. & Hassan, T. (2013). Macroeconomics shocks and stability in Malaysian banking system; a structural VAR model. *American Journal of Economics, 3*(5C), 22-28.

Johansen, S. (1988). Statistical analysis of cointegrating vectors. *Journal of Economic Dynamics and Control, 12*(2-3), 231-254.

Kolapo, T. F., Ayeni, R. K. & Oke, M. O. (2012). Credit risk and commercial banks' performance in Nigeria: a panel model approach. *Australian Journal of Business and Management Research, 2*(2), 31-38.

Koyuncu, C. ve Saka, B. (2011). Takipteki kredilerin özel sektöre verilen krediler ve yatırımlar üzerindeki etkisi. *Dumlupınar* Üniversitesi *Sosyal Bilimler Dergisi,* (31), 113-124.

Mensah, F. A., Marbuah, G. & Marbuah, D. A.A (2017). Reexamining the determinants of non-performing loans in Ghana's banking ındustry: Role of the 2007–2009 financial crisis. *Journal of African Business, 18(*3), 357- 379.

Mileris, R. (2012). Macroeconomic determinants of loan portfolio credit risk in banks. *Engineering Economics, 23*(5), 496-504.

Özel, Ö. ve Sayılgan, G. (2021). Türkiye bankacılık sektörü takipteki krediler görünümü, takibe dönüşüm oranı ve bazı hesaplama önerileri. *Bankacılar Dergisi*, (119),77-104.

Park, J.H. & Lei, Z. (2013). Macroeconomic and bank-specific determinants of the U.S. non-performing loans: before and during the recent crisis. Research Project Submıtted in Partial Fulfillment of the Requırements for the Degree of Master of Scıence in Finance Beedie School of Business.

Pesaran, M. H., Shin, Y. & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationship. *Journal of Applied Econometrics, 16*(3), 289-326

Phillips, P. C. B. & Ouliaris, S. (1990). Asymptotic properties of residual based tests for cointegration. *Econometrica, 58*(1), 165-193.

Phillips, P. C. B. ve Perron, P. (1988). Testing for a unit root in time series regression. *Econometrica, 75*(2), 335-346.

Poyraz, E. ve Arlı, O. E. (2019). Dövizdeki volatilitenin takipteki krediler üzerine etkisi: Türkiye örneği. *Muhasebe ve Finansman Dergisi*, (84), 133-148. https://doi.org/10.25095/mufad.625767

Resmi Gazete (2006). Bankalarca Kredilerin ve Diğer Alacakların Niteliklerinin Belirlenmesi ve Bunlar İçin Ayrılacak Karşılıklara İlişkin Usul ve Esaslar Hakkında Yönetmelik.

Samut, S. (2016). *Döviz kuru ve parite oynaklığının dış ticaret sektörü* üzerindeki *etkileri: Türkiye* örneği. (Yüksek Lisans Tezi). Karadeniz Teknik Üniversitesi Sosyal Bilimler Enstitüsü Ekonometri Anabilim Dalı, Trabzon.

Selimler, H. ve Kale, S. (2018). Banka ve finansal kurumların krediler ve sorunlu krediler açısından karşılaştırılması. *Marmara* Üniversitesi İktisadi *ve* İdari *Bilimler Dergisi, 40*(2), 274-295.

Sevinç, D. (2021). Türkiye'de takipteki banka kredileri ile makroekonomik faktörler arasındaki ilişki. *Mehmet Akif Ersoy* Üniversitesi İktisadi *ve* İdari *Bilimler Fakültesi Dergisi, 8*(2): 609-629.

Sezal, L. (2023). Covid-19'un takipteki kredilere etkisinin araştırılması: Ekonometrik bir analiz. İktisadi İdari *ve Siyasal Araştırmalar Dergisi, 8(*20), 54-68.

Society for Worldwide Interbank Financial Telecommunication (SWIFT)

Şahbaz, N. ve İnkaya, A. (2014). Türk bankacılık sektöründe sorunlu krediler ve makro ekonomik etkileri. *Optimum Ekonomi ve Yönetim Bilimleri Dergisi, 1*(1), 69-82.

Tanınmış, Y.B. ve Sözer, İ. (2011). Bankalarda takipteki krediler: Türk bankacılık sektöründe takipteki kredilerin tahminine yönelik bir model uygulaması. *Finansal Araştırmalar ve* Çalışmalar *Dergisi, 3*(5), 43-56.

Tarı, R. (2014). *Ekonometri.* (14.Baskı).Umuttepe Yayınları.

T.C. Elektronik Veri Dağıtım Sistemi (EVDS). Rapor Sayfası, Erişim Tarihi: 01.10.2023.

Varlık, C. (2023). Non-performing loans and macro-financial linkages: a SVAR model for Türkiye. *Journal of Economics and Administrative Sciences, 24*(1): 141-158.

Yağcılar, G. G., ve Demir, S. (2015). Türk bankacılık sektöründe takipteki kredi oranları üzerinde etkili olan faktörlerin belirlenmesi. *Uluslararası Alanya* İşletme *Fakültesi Dergisi, 7*(1), 221-229.

Yücememiş, B. T. ve Sözer, İ. (2011). Bankalarda takipteki krediler: Türk bankacılık sektöründe takipteki kredilerin tahminine yönelik bir model uygulaması. *Finansal Araştırmalar* ve Çalışmalar *Dergisi, 3*(5), 43-56.

***Information about the author**:*

Levent Sezal – Dr., Assistant Professor, Kahramanmaras Sutcu Imam University, Vocational School of Social Sciences, (Kahramanmaras, Turkiye, e-mail: leventsezal@ksu.edu.tr)