CAUSAL RELATIONSHIP BETWEEN GREED AND FEAR INDEX AND NON-PERFORMING LOANS: AN EMPIRICAL STUDY ON THE TURKISH BANKING SECTOR

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Abstract

This study aims to investigate the causality relationship between the greed and fear index and non-performing loans in the Turkish banking sector. Time series analyses are used in this study. For this purpose, Zivot and Andrews unit root test was used to determine the stationarity of the series. Then, Granger causality test was applied to determine whether there is a causality relationship between the series and if there is a causality relationship, the direction of the causality relationship. According to the results of the study, there is a unidirectional Granger causality relationship between the non-performing loan ratios of the Turkish banking sector and the greed and fear index. In other words, it is concluded that an increase in the Greed and Fear Index increases the non-performing loan(NPL) ratios of the banking sector.

Keywords: Greed and Fear Index, Non-Performing Loans, VIX, NPL, Granger Causality Test.

JEL Codes: G21, C30

AÇGÖZLÜLÜK VE KORKU ENDEKSİ İLE TAKİPTEKİ KREDİLER ARASINDAKİ İLİŞKİ: TÜRK BANKACILIK SEKTÖRÜ ÜZERİNE AMPRİK BİR ÇALIŞMA

Öz

Bu çalışmada açgözlülük ve korku endeksi ile Türk bankacılık sektörü takipteki krediler arasındaki nedensellik ilişkisinin araştırılması amaçlanmıştır. Bu çalışmada zaman serisi analizlerinden faydalanılmıştır. Bunun için serilerin durağanlığının tespiti için Zivot ve Andrews birim kök testi kullanılmıştır. Sonrasında seriler arasında bir nedensellik ilişkisinin olup olmadığı, nedensellik ilişkisi varsa yönünü tespit edilmesine yönelik olarak Granger nedensellik testi uygulanmıştır. Çalışmanın sonuçlarına göre, Türk bankacılık sektörü takipteki kredi oranları ile açgözlülük ve korku endeksi arasında tek yönlü Granger nedensellik ilişkisi olduğu tespit edilmiştir. Açgözlülük ve korku endeksindeki bir artışın bankacılık sektörü takipteki kredi oranlarını artırdığı sonucuna ulaşılmıştır.

Anahtar Kelimeler: Açgözlülük ve Korku Endeksi, Takipteki Krediler, VIX, NPL, Granger Nedensellik Testi.

JEL Kodları: G21, C30

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INTRODUCTION

The most important reason for the existence of financial markets is the exchange of funds. The parties exchanging funds can be companies and individuals as well as state institutions. Financial institutions, which are one of the most important elements of financial markets, or in narrower terms, banks, are institutions that act as a bridge between savers and those in need of funds. Banks, which have an important role in the economy, meet the needs of individuals and enterprises with a lack of savings and realise fund flow by making available the funds obtained from those with excess savings at a certain cost (interest, commission, dividend, etc.). The development of the financial system also contributes significantly to the development of the national economy. Recent studies reveal that the relationship between financial development and economic development, especially growth, is very strong, especially in developing countries (Yetkiner and Seven, 2016, p.39). Banks, which are the main component of the financial system, make significant contributions to the acceleration of financial development.

Banking is a commercial activity based on mutual trust. In this trust relationship, the bank is both the trustor and the trusted party. In the relationship between the depositor and the bank, the bank is obliged to protect the money entrusted to it and to utilise it in the most productive areas. In this respect, the bank is the trusted party. In the relationship between the bank and the loan customer, the bank lends the money it holds in trust to a person or an organisation and expects the other party to repay this loan in certain terms. In this relationship, the bank's trust in the counterparty is in question. There is a possibility that the requirements of the trust relationship between the bank and the loan customer may not be fulfilled. In this case, credit risk arises. Loans are the most important item in the assets of bank balance sheets (Özel, 2022, p.1149).

In order to sustain their activities and increase their profitability, banks need to ensure the return of the loans they have given. Failure to ensure the repayment of loans may bring about serious risks in the banking sector and consequently in the economy. In Turkey, in order to clarify the conditions for a loan to become a non-performing loan(NPL), the BRSA published a regulation titled "Principles and Procedures on Determining the Qualifications of Loans and Other Receivables to be Provisioned by Banks and the Provisions to be set aside" in the Official Gazette in 2001. According to this regulation, third group, fourth group and fifth group loans are defined as non-performing loans and receivables (Ayaydın, Platin and Barut, 2021, p.170).

In case of partial or complete non-payment of the loans given by the banks despite the maturity of 90 days, the loans fall into NPL. While the ratio of NPL to total loans shows the solvency of individuals in the economy, it also shows the asset quality and risk level of banks. As a result of the increase in NPL ratios,

investment opportunities and interest income of banks decrease and this situation may lead to liquidity problems and bankruptcy in the banking sector (Tanınmış and Sözer, 2010, p.90).

Banks allocate provisions at certain ratios for NPL and recognise them as expenses, thus affecting their profitability. Pursuant to Article 5 of the "Regulation on Determination of the Qualifications of Loans and Other Receivables and the Procedures and Principles to be set aside for these Loans and Other Receivables", "all types of loans outside the first and second groups according to their collection ability are non-performing loans for banks, in other words, non-performing loans" (Official Gazette, p. 26333: Article 5). According to Article 3 of the Regulation amending this Regulation, it is stated that special provisions should be set aside at least 20% as of the date a loan is included in the 3rd group, 50% as of the date it is included in the 4th group, and 100% as of the date it is included in the 5th group (Official Gazette, p. 27119: art.3). However, non-performing loans are subject to different methods depending on how long the repayment period of the loan is delayed. In this framework, what is expected from risk management is to determine the capital required for the risks of banks and the amount of non-performing or potential non-performing loans and to effectively determine the amount of provisions to be set aside. Moreover, in the event of an increase in NPL in a significant part of the banking system, the financial stability of the entire sector is threatened. Banks' reluctance to accept additional credit risk has adverse effects on the real economy in terms of financial resources.

On the other hand, during the COVID-19 pandemic period, flexibility was granted in the payment delays of bank customers due to the pandemic, and the period for transferring loans with delays to follow-up accounts was increased from 90 days to 180 days to be valid until 31.12.2020. In addition, the requirement to classify loans whose principal and/or interest payments are delayed for more than thirty days within the one-year monitoring period, or which are subject to restructuring once again within this period, in the third group has been removed. The regulation does not discriminate between loans, and the period of transfer to the legal follow-up account has been extended for all kinds of loans utilised by all corporate and individual bank customers. With this regulation, it is aimed to postpone in the short term the threat of forced enforcement in case of deterioration of the financing conditions of institutions and individuals due to the covid-19 outbreak.

In recent years, uncollectible receivables of banks have gained importance. This is because the increase in non-performing loans is seen as an important indicator before the risks that may arise in the banking system. During the 2008 global financial crisis, an important factor that attracted attention was the proportional increase in NPL in banks' balance sheets. These increases in the NPL of the banking sector expose banks to significant credit risks. In addition, the increase in NPL reduces the ability of banks to

provide new loans and to fund companies, and thus may have adverse effects on the general economic outlook. This situation has been stated by authors such as (Barr, Seifor and Siems, 1994, p.425; Reinhart and Rogoff, 2011, p.1700) as an important symptom indicating that the increase in NPL may be the beginning of a banking crisis. Sorge (2004, p.1), Marcelo, Rodriguez, and Trucharte (2008, p.77) and Buncic and Melecky (2012, p.6) state that non-performing loans can be used to test the fragility of the financial system.

The fear and greed index (VIX) is an index used to measure the effects of investors' feelings of fear and greed on the markets (TradingView, 2024). In particular, it can be considered as a graphic indicator of investors' emotional reactions to market volatility. This index is usually calculated for stock markets in the United States. The VIX index was first created by Whaley (1993) and started to be evaluated by the CBOE as one of the important measures of market volatility (Başarır, 2019, p.178). The VIX index is calculated by the CBOE (Chicago Board of Option Exchange). The VIX fear index is based on the S&P 500 index and is calculated based on the difference between the call and put option prices of the stocks in the index. A high VIX index indicates that volatility in the market will increase. A low difference between option prices indicates the expectation that volatility in the market will decrease."(Çağlar, Bektaş and Babuşcu, 2019, p.99). In this respect, a VIX index value exceeding 30 indicates that market volatility and uncertainty are high, while a value below 20 indicates that risk and uncertainty are low. All decision makers in financial markets look at the VIX index to measure market stress before making decisions (Ulusoy and Kendirli 2019, p.1128). When VIX returns are higher, market participants are more likely to follow lower-risk investment strategies.

Due to its impact on the overall economy, recent studies have analysed the factors affecting the NPL ratio and these factors are divided into two as internal and external factors (Makri, Tsagkanos, Bellas and Athanasios, 2014, p.194). By identifying the determinants of the NPL ratio, policy instruments that should be applied in the effective management of credit risk can be determined more easily. Recent studies on non-performing loans have focused on the factors affecting the NPL in the banking sector and which variables affect them in which direction. Therefore, this study aims to determine the relationship between the VIX index and NPL and its direction. In the following sections of the study, firstly, a literature review of the previous studies on the subject is presented. Then, the data set and methodology used in the study are mentioned. Finally, the study is concluded with the findings and conclusion of the research.

LITERATURE

There are many studies on non-performing loans, credit risk, asset quality and credit quality in the literature. While some studies focus exclusively on data for a specific country, other studies focus on comparing specific countries or analysing countries that are members of certain international associations such as the member states of the European Union. Although the data analysed in these studies are generally macroeconomic data, it is also observed that the effects of some factors specific to banks on asset quality and NPL are also investigated.

The literature is analysed in two sections: NPL and the VIX index. Firstly, when the literature on NPL is analysed, the general view is that non-performing loans will have an impact on the economy in general and on the real sector. In the study by Espinoza and Prasad (2010), it is aimed to explain NPLs and their macroeconomic effects in the banking system (80 banks) in the GCC-Gulf Arab Cooperation Council Region. In the study where panel data method is applied, quarterly data for the period 1995-2008 are used. The dependent variable of the study is NPL representing non-performing loans. The independent variables of the study are GDP growth rate and interest rate representing macroeconomic factors. As a result of the study, it is concluded that decreasing economic growth and interest rate increase NPLs.

Adebola, Yusoff and Dahalan (2011) aimed to explain the determinants of non-performing loans in Islamic banks in Malaysia. ARDL method was applied and quarterly data for the period 2007:Q1-2009:Q4 were used. As a result of the study, it is found that industrial production index has a positive but insignificant effect on non-performing loans, interest rate has a positive effect in the long run, while inflation has a negative effect and is not significant in the short run.

Messai and Jouini (2013) analysed 85 banks in Italy, Greece and Spain covering the period between 2004 and 2008 and concluded that the NPL ratio is affected by macro variables such as GDP growth, unemployment rate, real interest rate as well as bank-specific characteristics such as return on assets and loan loss provisions to total loans.

Skarica (2014), in his analysis covering the years 2007-2012 on banks operating in the developing countries of Europe, found that macro factors such as GDP growth, inflation and unemployment have an effect on non-performing loans, while bank and country-specific factors have no statistically significant effect on the non-performing loan ratio.

Makri et al. (2014), using the data of banks in the Euro area between 2000 and 2008, found that macro variables such as government borrowing level, unemployment, GDP growth and bank-specific variables

such as capital adequacy, prior period non-performing loan ratio and return on equity have a statistically significant effect on the non-performing loan ratio.

Beck, jakubik and Piloıu (2015) aimed to explain the macroeconomic factors that cause non-performing loans in the banking sector in 75 countries. In the study, dynamic panel data and GMM method were applied and annual data for the period 2000-2010 were used. As a result of the study, it was found that real GDP growth, stock price, exchange rate and loan interest rate affect the non-performing loans.

Anastasiou, Louri and Tsionas (2016) aimed to explain the determinants of non-performing loans in the banking sector in 15 countries in the EURO area. Quarterly data for the period 1990:Q1-2015:Q2 were used in the study, which applied panel data and GMM method. As a result of the study, it is found that GDP growth and inflation rate have a negative but insignificant effect on non-performing loans, while unemployment rate and tax rate have a strong positive effect.

Ayaydın, et al. (2021) examined the bank-specific, financial and macroeconomic determinants of non-performing loans using static and dynamic panel data analysis methods. The study shows that banks give riskier loans with low capital, which leads to an increase in non-performing loans.

Radivojević, Cvıjanović, Sekulic, Pavlovic, Jovic, and Maksimović (2019) aimed to explain the determinants of non-performing loans in developing Latin American countries (except Colombia, for which data are not available). In the study, the panel data analysis method was applied and annual data for the period 2000-2015 were used. As a result of the study, it was found that the inflation rate, unemployment rate and the microeconomic variables included in the study do not have a statistically significant effect on NPL, whereas GDP and final consumption expenditures have a negative effect on non-performing loans.

Poyraz and Arlı (2019) used Johansen cointegration test and Granger causality test in their study examining the effect of foreign exchange volatility on non-performing loans in Turkey. According to the results of the study, a long-run relationship was observed between USD and non-performing loans, and it was determined that USD affects non-performing loans. No clear long-run relationship between GBP and NPLs was found, but GBP was found to be the cause of NPLs. JPY, on the other hand, has no long-run relationship with non-performing loans.

Platin and Ayaydın (2022) empirically examined the relationship between loan growth, credit quality and social capital of all commercial banks operating in Turkey on the basis of 81 provinces in the twelve-year period between 2007-2018. As a result of the study, they concluded that the relationship between

provincial social capital level, loan growth and non-performing loans is negative and significant. The results of the study show that the level of social capital is important and determinant for banks' loan growth and credit risk.

In his study, Özel (2022) analysed the factors affecting non-performing loans in the Turkish banking sector with VAR (Vector Autoregressive) Model, Granger causality test and impulse-response analyses. As a result of the study, it is concluded that the changes in the industrial production index is the most important variable in explaining the changes in non-performing loans compared to other variables and that there is an inverse relationship with the changes in non-performing loans.

In their study, Teke İlhan and Gökçe (2024) investigated the effect of the change in non-performing loans on lending behaviour in the Turkish banking system. In the econometric model, bank-specific variables (ROA, ROE) and country-specific variables (GDP, consumer loan interest rate) were used. Econometric estimations were performed using a panel data set with 400 observations, where the time dimension is 40 and the cross-sectional dimension is 10. The study suggests that there is a negative relationship between the increase in the non-performing loan ratio and the willingness to lend in Turkey. Accordingly, it is concluded that the increase in non-performing loans weakens banks' willingness to lend.

There are many studies in the literature that examine the relationship between financial markets and the VIX index. These studies and their results can be expressed as follows. Sadeghzadeh (2018) analysed the sensitivity of the Borsa Istanbul 100 (BIST 100) Index to the Consumer Confidence Index and the VIX Index in Turkey. BIST 100 Index closing values, Consumer Confidence Index data and VIX Index for the period between 2004 and 2018 were included in the study. In the study, long and short-run analyses were conducted with the DOLS method and the causality relationships between the series were tested with the Granger (1969) method. According to the results of the analyses, in the long run, increases in the VIX Index decreased the stock market index values, while increases in the consumer confidence index decreased the stock market index values. When we look at the short-term effects, it is concluded that the fear index and the confidence index affect the BIST 100.

Badshah, Bekiros, Lucey and Uddin, (2018) analysed whether the relationship between VIX and emerging market volatilities is asymmetric. The results of the analysis show that there is a strong positive relationship between changes in the VIX and emerging market volatilities and that the links tend to be as strong as the extreme quantiles for the upper parts of the conditional distributions. Other test results revealed that the relationship is highly asymmetric.

Çağlar, Bektaş and Babuşcu (2019) examined the relationship between the VIX Fear Index, growth, exchange rates and CDS premium. In this direction, volatility index data for Turkey covering the period between January 2008 and December 2018, data on the USD currency equivalent of the Euro currency, industrial production index for growth and CDS premium data were used. Extended Dickey Fuller Unit Root Test and Granger Causality Test are applied. As a result, it is determined that the volatility index is the Granger cause of the industrial production index. There is a unidirectional causality relationship between these two variables. No causality link was found between other variables.

Zhu, Liu, Wang, Wei, and Wei (2019) compared Equity Market Volatility (EMV) and VIX in terms of predicting the volatility of US stock indices. The results of the analysis revealed that although VIX is also effective, policy-related EMV works better than VIX and other EMV trackers.

Özdemir (2020) compared the effect of the VIX index on the return volatilities of the BIST 30 stock index and the futures contract based on the BIST 30 stock index. In the study, "EGARCH models were first estimated to determine the asymmetry in the volatility of BIST30 index and BIST30 futures returns using daily data from 9 June 2012 to 31 October 2019. As a result of the estimated EGARCH models, the existence of the leverage effect in both return series was determined and it was concluded that bad news in the financial market has a greater effect on return volatility than good news. Then, in order to measure the effect of the VIX index on the volatility of returns, EGARCH models were constructed by including the VIX index in the volatility model. As a result of the inclusion of the VIX index in the model, it was determined that the leverage effect strengthened in both return series. When the effect of the VIX index on volatility persistence is examined, it is determined that the volatility persistence of the BIST30 index return remains at the same level, while the volatility persistence of the BIST 30 futures return decreases."

In their study, Çonkır, Meriç and Esen (2021) investigated the effect of investor sentiment on the related indices with VAR model and Granger Causality analysis using monthly data of BIST-30, IPC, NIFTY-50, MOEX, JKII and VIX Fear index between 2015-2019. According to the results of the analysis, a unilateral causality relationship was found from the VIX index to the BIST-30 index. On the other hand, no causality relationship was found between VIX index and IPC, NIFTY-50, MOEX, JKII indices.

In this study, Can and Dönmez (2021) "examine the effect of the VIX Index on public expenditures and public revenues in Turkey. In this context, the VIX Index and the data on public expenditures and public revenues in Turkey for the period 1999-2021 are analysed. The series are analysed with Augmented Dickey Fuller (ADF) and Lumsdaine-Papell unit root tests and it is found that the series contain unit roots. Bootstrap Granger causality test was used to test the causality relationship between the VIX Index and public

expenditures and public revenues in Turkey and a causality relationship was found from the VIX Index to public expenditures."

Sevinç (2021) investigated how macroeconomic factors affect the non-performing loan ratio. According to the estimation results of the ARDL Model estimated with quarterly data covering the period 2005Q1-2019Q3, economic growth and inflation decreased the non-performing loan ratio, while unemployment and exchange rate increased the non-performing loan ratio. According to the findings of the Toda-Yamamoto causality test, it is determined that there is a causality relationship from all variables to non-performing loans, and there is a bidirectional causality relationship with the unemployment rate.

Sertkaya (2022) investigated the effect of gold, oil and wheat prices, which are among the strategic commodity products, on the VIX fear index. In the study, where the VIX index is the dependent variable and weekly data between 2015:01 and 2022:02 are used, the short and long-run relationship between the variables is analysed with the ARDL bounds test approach. Accordingly, it was found that there is a cointegration relationship between the VIX index and strategic commodity variables in the long run. Gold price has a statistically significant and positive effect on the VIX fear index. Brent oil has a statistically significant and negative effect on the VIX index.

Bonaparte, Chatrath and Christie (2023) examined the effectiveness of the VIX as an indicator of 30-day forward S&P 500 volatility. The results of the analysis revealed that the effectiveness of VIX as a predictor of 30-day forward S&P 500 volatility is between 20% and 25% depending on the sampling period.

Kazak (2023) analysed the impact of the VIX index on conventional and Islamic equity markets. The study analyses the causality relationship between the variables subject to evaluation by using a cumulative frequency causality test (Fourier Toda-Yamamoto-FTY) that enriches the Toda-Yamamoto procedure with the Fourier function. The analyses conducted with data covering the period of 2019/January-2023/May show that the VIX index has a unilateral causality effect on conventional and Islamic equity markets, and at the same time, there is a reciprocal causality relationship between both markets.

There are many factors that affect financial markets directly or indirectly. Fear and greed index is one of them. The importance of this concept for financial markets is also valuable in this context. Financial markets generally fluctuate with the changes in the psychological behaviour of investors. Decision makers can sometimes become overly fearful and greedy, which can cause prices to break sharply. The fear and greed index therefore provides clues about market trends by measuring the emotional positions of investors. Especially decision makers can make more meaningful decisions in this way. In the literature review, no

study on the fear and greed index with non-performing loans was found. It is thought that this study will contribute to the literature.

DATA AND METHODOLOGY

Method and Purpose of the Research

This study aims to investigate the causality relationship between the Greed and Fear Index (VIX) and the non-performing loan ratio (NPL) of the Turkish banking sector. In the application part of the study, in the equations established between VIX and NPL, the variables are mutually constructed as dependent and independent. "Time series analyses were used to examine the relationship between the variables. In order to determine the stationarity levels of the variables, Zivot and Andrews (1992) unit root tests, taking into account structural breaks, were applied to the data." Subsequently, Granger Causality test was utilised to determine whether there is causality between the variables, and if there is a causality relationship, to determine its directions.

Data Set of the Research

VIX and Turkish banking sector NPL ratios are used in the equations constructed in the research. The data set consists of monthly frequency data (105 observations) between 01.01.2015 and 01.09.2023. The reason for choosing this date range is to clearly see the impact of a number of economic and political developments that have recently affected the Turkish economy (coup attempt in 2016, currency attack crisis in 2018 and Covid-19 pandemic that has affected the whole world since the beginning of 2020).

Table 1: Descriptions of the data set

Variables	Explanations of Variables	Time Interval	Data Period	Source
NPL	Non-performing Loan Ratio	01.01.2015 - 01.09.2023	Monthly	bddk.org.tr investing.com
VIX	Greed and Fear Index			

Figure 1: Time series graphs of variables

Greed and Fear Index (VIX)

Non-Performing Loan Ratio (NPL)
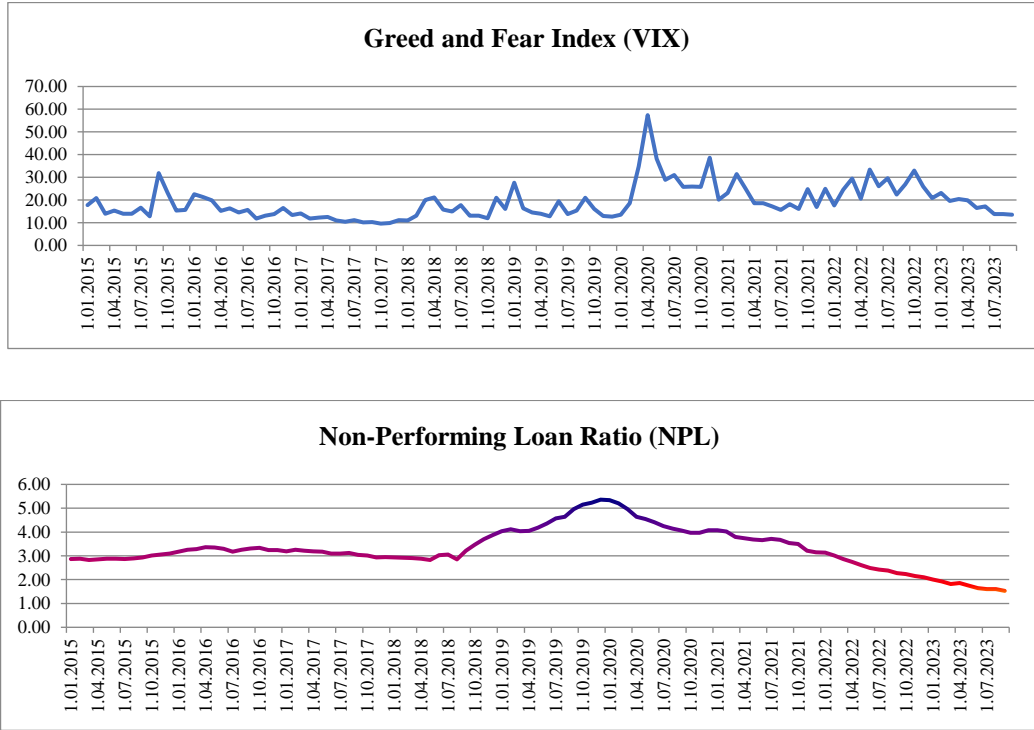
Figure 1 shows the time series graphs of the variables related to the study. Looking at the time series graphs for the periods analysed, it is seen that the VIX index showed small fluctuations, entered an upward trend during the pandemic period, and then followed a downward trend again.

Likewise, when we look at the NPL variable, it is seen that it has been in an upward trend since 2015 due to the deterioration in the economy, and the excessive increase in exchange rates due to the political crisis with the United States of America with the arrest of Pastor Brunson in 2018 led to an economic crisis. Turkey's economy, which already had a fragile structure, was hit by the Covid-19 pandemic in 2020, which affected Turkey as well as the rest of the world, leading to a further increase in non-performing loans. As can be seen in the chart, a downward trend has been observed in NPL ratios as the impact of the pandemic has diminished.

Summary statistical information about the variables analysed within the scope of the research is given in Table 2:

Table 2: Summary Statistical Information

	VIX	NPL
Mean	19.06581	3.308762
Median	16.63000	3.190000
Maximum	57.38000	5.360000
Minimum	9.590000	1.530000
Std. Dev.	7.608268	0.860843
Skewness	1.778756	0.287584
Kurtosis	8.080776	3.037746
Jarque-Bera	168.3071	1.453567
Probability	0.000000	0.483462
Sum	2001.910	347.4200
Sum Sq. Dev.	6020.117	77.06934
Observations	105	105

Hypotheses of the Study

H0: There is no causal relationship between NPL and VIX variables.

H1: There is a causal relationship between NPL and VIX variables.

Zivot-Andrews Unit Root Test

The unit root test developed by Perron (1989) allows one structural break and the date of the structural break is exogenously determined. Zivot and Andrews (1992) criticised the exogenous determination of the structural break in the unit root test proposed by Perron (1989) and proposed a test procedure in which the structural break can be determined endogenously. Zivot and Andrews (1992) stated that the choice of the break date in the Perron (1989) unit root test is based on the prior observation of the data and therefore there may be problems with pre-testing. The following equations are used in the Zivot-Andrews (ZA) unit root test (Zivot and Andrews, 1992: 254):

$$\text{Model A: } y_t = \mu^A + \theta^A DU_t(\lambda) + \beta^A t + \alpha^A y_{t-1} + \sum_{j=1}^{k} C_j^A \, \Delta y_{t-j} + e_t \tag{1}$$

$$\text{Model B: } y_t = \mu^B + \gamma^B DT *_t (\lambda) + \beta^B t + \alpha^B y_{t-1} + \sum_{j=1}^{k} C_j^B \, \Delta y_{t-j} + e_t \tag{2}$$

$$Model\ C:\ y_t = \mu^C + \theta^C DU_t\ (\lambda)\ \gamma^C\ DT*_t\ (\lambda) + \beta^C t + \alpha^C y_{t-1} + \sum_{j=1}^{k} C^C_j\ \Delta y_{t-j} + e_t \qquad (3)$$

Model A refers to the model with break in constant, Model B refers to the model with break in trend and Model C refers to the model with break in constant and trend.

$$DU_t = \begin{cases} 1 \\ 0 \end{cases} \qquad t > TB \ \text{ while in other cases}$$

$$DT_t = \begin{cases} t - TB \\ 0 \end{cases} \qquad t > T\lambda \ \text{ while in other cases}$$

In the estimation of the break point, T-2 number of regressions are estimated using the EKK (Least Squares) method. The date in the model where the smallest t-statistic is obtained for the δ coefficient is determined as the break point. If the t-statistic calculated for δ is smaller than the critical value, the null hypothesis that the series is non-stationary without structural break is rejected. In this case, it is concluded that the series is stationary with structural break.

Granger Causality Analysis

The Granger causality relationship means that the independent variable X in the regression has a causal relationship with the dependent variable Y. For this to be the case, 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. This is called unidirectional causality. In causality tests, the direction of the tests is important, that is, it is very important in determining whether the variables are dependent or independent. The direction of causality is very 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 allows the causality analysis between dependent and independent variables in the "short run" period.

$$y_t = a_1 + \sum_{i-1}^{n} \beta_i x_{t-i} + \sum_{j=1}^{m} Y_j\ y_{t-j} + e_{1t} \qquad (4)$$

$$x_t = a_2 + \sum_{i-1}^{n} \Theta_i x_{t-i} + \sum_{j=1}^{m} \delta_j\ y_{t-j} + e_{2t} \qquad (5)$$

If Ho hypothesis is rejected, it means that X has a Granger causality relationship with Y. In the Granger causality test, there can be both a direction from X to Y and a direction from Y to X. This is called bidirectional causality. It is denoted as X↔Y. If both H0 hypotheses are rejected, it is possible to say that there is a bidirectional causality between X and Y variables. In order to conduct Granger causality test between X and Y series, the covariance of both variables should be stationary and stochastic.

RESEARCH FINDINGS

In this section of the study, the tests applied and the results of the findings obtained in order to reveal the relationship between NPL ratios and the VIX index are presented.

Zivot-Andrews Unit Root Test Results

In this study, "the C model was taken into account to determine the breaks of the series in the constant and trend in the Zivot-Andrews test. Model A refers to the model with break in constant, Model B refers to the model with break in trend and Model C refers to the model with break in constant and trend. The ZivotAndrews unit root test was applied again by taking the first difference of the non-stationary series in the level. The findings obtained are shown in Table 3.

Table 3: Zivot-Andrews unit root test results

Zivot-Andrews Model(C)						
Variables	**Level Test Statistic**	**Level Break Date**	**Critical Value**	**1. Difference Test Statistic**	**1. Difference Break Date**	**Critical Value**
VIX	-6,2939*	02/2020	-4,93	-	-	-
NPL	-5,0209*	09/2018	-4,93	-	-	-
*: Significant at 5% level.						

In the Zivot-Andrews unit root test, the acceptance of the null hypothesis "The series is non-stationary" against the alternative hypothesis "The series is stationary with structural break" at 5% significance level indicates that the non-stationarity of the series is not caused by structural break and structural breaks do not affect the classical unit root tests. According to the unit root test results, it is concluded that VIX and NPL variables are stationary at level.

Granger Causality Test Result

"Granger causality test is very sensitive to the number of lags and the direction of causality may change depending on the number of lagged terms. For this reason, the Granger causality test can be performed for different lags or the lag length can be determined separately for the independent variables in the model." In the literature, lag lengths are generally considered to be 12 or 24 in studies using monthly data and 4, 8 or 12 in studies using seasonal data (Takım, 2010, p. 327).

After the determination of stationary variables at the level, the stage of determining the most appropriate lag length for Granger causality analysis was started. The results obtained are presented in Table 4.

Table 4: Lag length test results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4.612.247	NA	4.819.585	9.551.026	9.604.112	9.572.491
1	-2.299.341	4.482.747	0.444371	4.864.620	5.023.881	4.929.017
2	-2.168.330	24.85145*	0.368394*	4.676970*	4.942404*	4.784299*
3	-2.155.117	2.451.935	0.389438	4.732.201	5.103.808	4.882.461
4	-2.124.894	5.483.846	0.397593	4.752.358	5.230.140	4.945.550
5	-2.118.955	1.053.070	0.426899	4.822.588	5.406.543	5.058.710
6	-2.110.748	1.421.487	0.456407	4.888.139	5.578.268	5.167.194
7	-2.083.601	4.589.729	0.469489	4.914.641	5.710.944	5.236.627
8	-2.060.295	3.844.266	0.487054	4.949.062	5.851.538	5.313.979

In the table above, where the lag length test results are shown, five different information criteria are tested. In the literature, AIC (Akaike Information Criterion) and SC (Schwarz Information Criterion) tests are generally preferred. In order to be consistent with the literature, the most appropriate lag length is chosen according to Akaike Information Criterion in this study. Looking at the AIC values in the table, it is seen that the minimum lag takes the value of -4.676970 with a lag length of 2. In support of the AIC results, it is seen that the minimum lag length is determined as 2 according to SC FPE and HQ tests. After determining the optimal lag length, the VAR (Vector Autoregressive) model with 2 lags was established.

Table 5: Granger causality test results

Independent Variable	Dependent Variable	K	Chi-Square Test Statistic	Chi-Square P-value	Relationship and Direction
NPL	VIX	3	2,8240	0,0429	there is a relationship
VIX	NPL	3	0,2667	0,8492	no relationship

Table 5 shows the Granger Causality Relationship. When the NPL ratios and the VIX index are analysed, the probability value is less than 0.05, indicating that there is a causality relationship. There is a unidirectional Granger causality relationship between VIX index and NPL ratios. In other words, it is

concluded that an increase in the VIX index increases the NPL ratio. In this case, H0 hypothesis is rejected and H1 hypothesis is accepted.

CONCLUSION

The most important indicator used to measure the asset quality of financial institutions in the financial system is the extent to which loans can be collected or, in other words, the extent to which they are non-performing. Credit efficiency is possible not only through the contribution of the financial system to economic dynamics, but also through ensuring the repayment of loans, which is a prerequisite for the healthy functioning of financial markets. Failures in loan repayments not only affect the lending financial institution, but also create risks for the economy as a whole. Loans, which are the most important element of the asset structure of banks, and therefore credit risk, which has the highest weight among the risk components, is an issue that requires special attention to its management; for this reason, it is closely monitored by both bank managements and public authorities. The way to ensure the vitality of credits depends on the effective management of economic instruments to increase the solvency of individuals and institutions. It is possible to find many national or international studies in the literature on the factors affecting the loss of vitality of loans and their becoming non-performing, in other words, the factors affecting their becoming non-performing. While these studies focus on the macroeconomic determinants of non-performing loans, some studies also examine bank-specific factors (such as capital adequacy, profitability variables).

This study aims to investigate the causality relationship between the Greed and Fear Index and the non-performing loan ratio of the Turkish banking sector. Firstly, the stationarity of the series was investigated. For this purpose, Zivot-Andrews unit root test was applied. After the stationarity of the series was determined, Granger causality test was applied. When the Turkish banking sector non-performing loan ratios and Greed and Fear Index are analysed, the probability value is less than 0.05, indicating that there is a causality relationship. There is a unidirectional Granger causality relationship between Greed and Fear Index and NPL ratios. In other words, it is concluded that an increase in the Greed and Fear Index increases the NPL ratios of the banking sector. In this case, H0 hypothesis is rejected and H1 hypothesis is accepted. An increase in the Greed and Fear Index indicates that the risk in financial markets is increasing and volatility is high, while a decrease in the Greed and Fear Index indicates that there is a more optimistic atmosphere in financial markets and volatility is low. By using the data of the Greed and Fear Index, decision makers will help to protect themselves from the major risks they may face.

In future studies, the factors affecting non-performing loans by bank groups (deposit, development and investment banks, etc.) and/or loan types (consumer loans, commercial loans, investment loans, etc.)

can be analysed and their effects can be investigated. On the other hand, the study covers the last ten years of the Turkish economy, which constitutes the limitation of the study. Türkiye's crises in 2001 and 2008 can be further expanded by adding to the period of the study. Moreover, the effects of bank-specific factors such as interest income-expense margins, changes in capital adequacy ratios and liquidity expansions on non-performing loans can be investigated through different methods. In addition, another important point is what can be done to increase the resilience of loans to macroeconomic shocks before they turn into non-performing loans and thus reduce non-performing loans.

AUTHOR STATEMENT

The first author contributed 70% to the study. The second author contributed 30% to the study. Researchers have not declared any conflict of interest.

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