The Effect of Macroeconomic Variables on Non-performing Loan Ratio of Publicly Traded Banks in Turkey

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Abstract: - There are various studies analyzing the correlation between non-performing loan ratios of banks and macroeconomic variables. The main motivation behind these studies is to reveal whether macroeconomic factors have an impact on non-performing loan ratio of banks and to determine lag length in cases in which these factors have an impact. This study examines the effect of macroeconomic variables (commercial loan interest rates and public debt stock/GDP ratios) on the consolidated non-performing loan ratio of banks involved in Borsa Istanbul (BIST) XBANK index in quarterly basis during 2002-2013 period. The result of econometric analysis revealed that changes in non-performing loan ratio can be explained by above mentioned macroeconomic variables.

Key-Words: Non performing Loan Ratio, Interest Rates, Public Debt, GDP

1. Introduction

A financial system that works safely and effectively is necessary in ensuring economic efficiency. The main responsibility of financial intermediaries in financial system is to serve as intermediaries in transferring economic resources or loanable funds into profitable investment areas. However, it is known that this ideal functioning cannot always be ensured in fund transfers. Sometimes systematic (non-operating) and sometimes non-systematic (business-specific) reasons might hinder healthy flow of funds. One of the primary indicators of failure in fund transfer in financial system is the ratio of nonperforming loans.

High ratio of non-performing loans in banking system or rising tendency leads to increase in allowance to be allocated for aforementioned loans and thus, to a decrease in the profitability and capital adequacy ratio of the banks. Considered from the point of economics, increase in non-performing loans, negatively effects economic growth by causing to a decrease in loanable funds.

This study examined the effect of macroeconomic variables (gross public debt stock/GDP and commercial loan interest rates) on the nonperforming loans of banks involved in Borsa İstanbul (BIST) XBANK index. The literature analyzing the impact of macroeconomic variables on nonperforming loan ratio of banks is summarized in the ensuing section. The recent developments regarding Turkish Banking Industry and Nonperforming Loans is explained in section three. The fourth section provides detailed information on the data of the study. The method and the econometric model is given in the fifth section followed by empirical results. And finally the last section consists of concluding remarks.

2. Literature Review

Because the ability of banks to fulfill their obligations and the financial stability of a country depend on the capacity and willingness of the loan customers to pay their debts, non-performing loans of banks, in general, is something that the policy of economics and central banks are closely concerned (Bebczuk 2008).

Banks are fragile against external shocks because they finance debts with low liquidity in their assets with liquid debts (Diamond and Rajan, 2001). Therefore, there is a maturity mismatch between the assets and liabilities of banks. During the cyclical expansion periods of economies, because depositors extend their deposit accounts, there are no problems in flow of funds. An upswing in macroeconomic variables such as foreign exchange rate, interest rates, however, not only increase the funding costs of banks but also narrow down the funding possibilities. And since loan

customers or borrowers cannot renew their existing debts, the non-performing loans ratio of banks rises. When the statistical findings of many researchers are taken into consideration, it is seen that the most important reason behind bank failures is the asset quality and before insolvency, banks, generally, have high amounts of non-performing loan portfolio.

There are various studies where the correlation between the non-performing loan ratio of banks and bank-specific factors are examined. Whilst significant increases are observed in non-performing ratio of bank loans before economic crisis, non-performing loan ratio of banks during the expansion periods of economies, except in cases of excessive loan expansion, keep their low levels. In their study, Kalirai and Scheicher(2001) tested the correlation between the trend in the loan loss provisions of Austrian banks and macroeconomic data of the country. Therefore, bank-specific factors were ignored in the study and the systematic components of credit risk related to cyclical fluctuations, inflation or other external factors were modeled. They employed a simple linear regression to examine the change in loan expenses of banks and possible variables to explain this change. They found that among these variables increase in short-term interest rates, decrease in trustworthiness of business life and worsening in industrial production and capital markets were effective in the loan loss provisions of banks.

In the survey carried out to determine the factors effecting the nonperforming loans in Spanish Banking Sector, Salas and Saurina (2002) concluded that real growth in GDP, bank size, market power and loan expansion effected nonperforming loans.

In their study in which Jimenez and Saurina (2005) examined the effect of rapid growth in loans or loan explosion, they found the empirical evidence that there was strong positive correlation between rapid growth in loans and increase in nonperforming loans.

Gaganis et al. (2010) collected the factors effecting banking stability under four general categories. These factors are: Regulations, Other Banking and financial sector attributes, Institutional Environment, and Macroeconomic Conditions.

Reinhart and Rogoff (2010) examined the relationship between the public debt crisis and bank crisis and revealed that in most cases banking crisis advanced or emerged alike with public debt crisis. Deterioration in public finance forms a threshold in terms of the market rating of credibility for banks

and thus, banks have to continue their operations under the pressure of liquidity. In such cases, banks limit their loan placements and since loan customers cannot renew their debts, the ratio of nonperforming loans shows an increasing trend.

In the study of Louzis et. al (2011) in which they analyzed 9 big banks in Greece during 2003Q1-2009Q3, they concluded that real growth rate in GDP, loans and unemployment rates were the macroeconomic variables explaining the increase in nonperforming loans. The study includes the panel data of 9 big Greek banks during 2003-2009 period in order to evaluate the factors effecting the growth in nonperforming loans in Greek banking system. Loan distribution was made on consumer loans, working capital loans and mortgage basis. While real growth in GDP and unemployment, loan interest rates, which are among macroeconomic variables play an important role in the growth of nonperforming loans, performance and management quality risk management practices representing bank-specific variables were found to be related to the change in nonperforming loans.

Using time series modeling, Vogiazas and Nikolaidou (2011) investigated the macroeconomic determinants of non-performing loans in the Romanian banking sector between December 2001 and November 2010. And the macroeconomic determinants effecting non-performing loans in Romanian banking system were identified as monetary aggregates, interest rates, financial markets, and bank-specific variables. Both the booming period and the periods of financial crisis were covered. Considering the significant presence of the Greek banks in Romania, variables that proxy the Greek crisis were introduced. Thus, whether the Greek crisis had an impact on Romanian banking system was examined. The findings in the study indicate that macroeconomic variables, particularly the construction and investment expenditure, the inflation and the unemployment rate, and the ratio of country's external debt to GDP and M2 jointly with Greek crisis-specific variables influenced the credit risk of the Romanian banking system.

Saba et al. (2012), in their study in which they considered Real GDP per Capita, Inflation, and Total Loans during 1985-2010 as independent variables and Nonperforming Loan Ratio as dependent variable, concluded that all the selected independent variables had significant impact on the dependent variable.

In their study, Badar and Javid (2013), assessed long and short run dynamics between

nonperforming loans and macroeconomic variables (inflation, exchange rate, interest rate, gross domestic product and money supply) covering the period from January 2002 till December 2011 of commercial banks in Pakistan. Employing Johansen and Juselius Multivariate Cointegration Test, a long run relationship was found among variables in the study. Using Granger causality test it was found that inflation and exchange rate were the causes of non-performing loans however, vector error correction model provided that there was weak short run relationship between Nonperforming loans with inflation and exchange rate.

In the survey covering banks operating in Central, Eastern and Southeast European countries, Jakubik and Reininger (2013) found that the leading economic variable that effects non-performing ratios of banks was economic growth and that there was a negative correlation between non-performing loan ratios and economic growth. Panel data analysis was carried out in the study which also involved Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Russia, Slovakia and Ukraine. In addition, other factors explaining the change in nonperforming loan ratios of banks were change in exchange rates and the high degree of lending in foreign currencies. The survey also quantitatively revealed that excessive loan growth and high degree of lending in foreign currencies would pose a risk in terms of the asset quality of the bank. In the study carried out using a novel panel data set, Beck et al. (2013) studied macroeconomic determinants of nonperforming loans across 75 countries. According to their dynamic panel estimates, real GDP growth, share prices, the exchange rate, and the lending interest rate were found to significantly affect nonperforming loan ratios. Similar to the findings of Jakubik and Reininger (2013), they found that depending on the lending rate in foreign currencies among all loans, the depreciation in local currency had a significant negative impact on the asset quality of banks.

Within the scope of the quarterly data belonging to 1998Q2-2012Q3 Şahbaz and İnkaya (2014) analyzed the correlation between non-performing loans and macroeconomic variables (domestic loan volume of banking sector, real GDP growth, total personal consumption expenditures and individual fixed capital expenditures) using Granger causality test and VAR method. As a result of cointegration analysis, a long-term relationship was found between nonperforming loans and macroeconomic

variables and Granger causality tests revealed that these relationships were bilateral.

3.Turkish Banking Sector And Non-performing Loans

With global integration, continuously shrinking economies with the downsizing trend in world's trade volume in the period before 1980s gave way to rapidly growing and developing commercial and financial markets. As of the end of 1970s, global integration experienced in real economy and financial services brought along a process in which such macroeconomic variables as foreign exchange rate and interest rates were left for crawling pegs. However, leaving foreign exchange rates and interest rates for crawling pegs caused to an increase in the volatility in the prices of these variables and the necessity of managing these risks in the new period emerged. The increasing product diversity particularly in financial services in the new era and thus, rapidly growing trading volume made it necessary to make new legal regulations.

However, making only legal regulations was not enough. It required authorities with administrative and financial autonomy independent from political authority that will enable the implementation of legal arrangements in a safe, transparent and objective manner or regulatory and supervisory authorities.

Particularly during the period between 1990-2000, although there existed a legal regulation in the field of banking and financial services, because the autonomous authority to implement this legal regulation was not established, or in other words, because there was a divided structure (on–site supervision authority belonged to Under secretariat of Treasury, supervision belonged to the Central Bank) in which Under secretariat of Treasury was primary authority in preparing and implementing the Banking Law (Former Law no 3182) and relevant other regulations, those bank owners establishing fair relationships with the political authority paved the way for themselves to use loanable funds as a loan for their own companies without considering public interest. In addition, as the interest rates of TL assets primarily including Domestic Government Bonds was at desirable levels, due to the high level of public borrowing requirement in the period, the risk appetite of the banks increased. Banks carried high foreign exchange position in their balance sheets by means of placing the deposits they borrowed in foreign currency. This high-risk taking tendency put heavy burden on economy with the economic crisis in 1994, when there was a big depreciation in Turkish

lira. Together with other structural problems, the economic crisis created severe effects and 11 banks were retained between the years 1994-1999 (BDDK, Banking Regulation and Supervision Agency of Turkey). And finally with the political crisis in November 2000 and devaluation in February 2001 both the Turkish economy and the banking system in Turkey experienced the worst economic crisis in the history of the Republic.
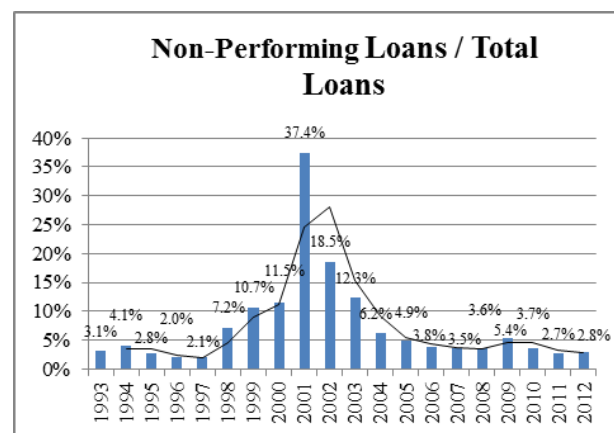
As it is seen in Figure-1, there are gradual increases in the ratio of nonperforming loans to total loans before the economic crisis 2001 in Turkish banking sector. The period between the years 1999-2001 was the period when the banks with poor financial structure were transferred to Saving Deposit Insurance Fund. A total number of 18 banks were transferred to Saving Deposit Insurance Fund during the period. 6 of these banks were transferred in 1999, 4 of them were transferred in 2000 and 8 of them were transferred in 2001. Besides, there was a consolidation in the sector in the aforementioned period and the number of banks was reduced. Particularly, the fact that ratio of nonperforming loans realized as 37% in 2001 was substantially effected by the problematic loans of banks transferred to Saving Deposit Insurance Fund. In this respect, it is possible to say that the trend in non-performing loans ratio of banking sector can be one of empirical predictors of economic crisis.

The reasons behind the increase in the ratio of nonperforming loans in Turkish Banking sector before the economic crisis in 2001 are completely different from the global financial crisis in 2008. Before the crisis in 2001, banking activities were carried out in an economic environment with structural problems and high vulnerability. The regulatory institutions were not independent from the political authority to carry out the auditing of the sector effectively. When considered in terms of the whole sector, there was vulnerability in the management of unsystematic risks.

Foundation of Banking Regulation and Supervision Agency in 1999 based on the Banking Law no 4389 and swinging into action in August 2000 has been the first important step of the structural changes to be made afterwards. Thus, the aim was to form an efficient central regulation and supervision authority which can take independent decisions free from the pressure of the political authority.

In addition to economic and financial crisis, the lack of legal regulations is another factor causing to an increase in the ratio of non-performing loans (Ricardo and Davis, 2001).

Following the crisis in 2001, the financial crisis that broke out in the United States of America in 2008 and later expanded to the whole world had a limited impact on the banking system in Turkey.

Source: www.tbb.org.tr

Figure-1. The Development of Non-performing Loans/Total Loans in Turkish Banking Sector

As is seen in Table-2, whilst the ratio of nonperforming loans to total loans in 2008 was 3,6%, it rose slightly in 2009 and realized as 5,4%. However, in 2010 the same ratio realized as 3,7% and fell to the level before the financial crisis. Today, in order to prevent rapid increase in the ratio of non-performing loans during a time of economic crisis banks aim to structure their loan portfolio well and to improve their asset quality (Başak T., Yücememiş İ. 2011).

4.Research Data

This study examined the correlation between the ratio of nonperforming loans to total loans of banks involved in Borsa İstanbul (BIST), XBANK index and macroeconomic variables (the ratio of public debt stock to GDP and commercial loan interest rate) between 2002/04-2013/03.

Table-1.Research Data

Variable	Explanation	Reference	Period	Access Date
Npl	Non performing loans/Total loans	tbb.org.tr, tkbb.org.tr	2002/04-2013/03	30.06.14
Intrates	Commercial Loan Interest Rates	tcmb.gov.tr	2002/04-2013/03	30.06.14
Debtgdp	Public Debt Stock/GDP	tuik.gov.tr, tcmb.gov.tr	2002/04-2013/03	30.06.14

The Commercial Loan Interest Rates and GDP Current Prices are extracted from Central Bank of

Turkey, Electronic Data Delivery System. In order to calculate Public Debt Stock/GDP ratio, the Public Debt Stock (Gross) numbers downloaded from Turkish Statistical Institute (TURKSTAT) were used in the analysis.

In time series analysis, the frequency of observations or the longer periods play a significant role in getting sound results. However, Commercial Loan Interest Rates are announced on a weekly basis, since GDP and Public Debt Stock statistics are announced quarterly, the number of observations within a year is taken as four in the analysis.

Table-2. List of Banks Involved In BIST XBANK Index

Stock Code	Description	Index Code	Date(Dd.Mm.Yyyy)
AKBNK	AKBANK	XBANK	21.05.2014
ALBRK	ALBARAKA TÜRK KATILIM BANKASI	XBANK	21.05.2014
ALNTF	ALTERNATIFBANK	XBANK	21.05.2014
ASYAB	BANKASYA KATILIM BANKASI	XBANK	21.05.2014
DENIZ	DENİZBANK	XBANK	21.05.2014
FINBN	FINANSBANK	XBANK	21.05.2014
GARAN	GARANTİ	XBANK	21.05.2014
HALKB	HALKBANK	XBANK	21.05.2014
ISCTR	İŞ BANKASI	XBANK	21.05.2014
KLNMA	KALKINMA BANKASI	XBANK	21.05.2014
SKBNK	ŞEKERBANK	XBANK	21.05.2014
TEBNK	T.EKONOMİ BANKASI	XBANK	21.05.2014
TEKST	TEKSTİLBANK	XBANK	21.05.2014
TSKB	T.SINAİ KALKINMA BANKASI	XBANK	21.05.2014
VAKBN	VAKIFBANK	XBANK	21.05.2014
YKBNK	YAPI KREDİ BANKASI	XBANK	21.05.2014

Above is a list of banks involved in XBANK Index of Borsa Istanbul Common Stock Market (http://borsaistanbul.com/veriler/verileralt/hisse-senetleri-piyasasi-verileri,, 21.05.2014). As of 31.12.2012 banks involved in XBANK Index represent 76,1% of the asset size of Banking System. Among the Banks which are not involved in XBANK index in terms of the asset size of Banking system as of 31.12.2012, T.C Ziraat Bank, whose shares have not been offered to public has the highest proportion with 12,54%. Considered from the point of loans (extended funds) banks involved in XBANK index as of 31.12.2012 form 78% of the loan balance of the Banking System (Including Participation Banking).

5. Research Method

The study examines whether there is a correlation between the development in macroeconomic variables and change in non-performing loans ratio of Turkish Banking Sector in short and long run. In order to find out whether each variable is stationary or not, Augmented Dickey-Fuller (1979) Test will be carried out. To determine if there is a long-term relationship between the series, Johansen Cointegration Analysis will be carried out. If the long-term relationship between series is validated, Granger Causality Test will be implemented to identify whether the dependent variable is explained by independent variables.

Regression analysis will be carried out to find out the impact of intrates and debtgdp series together on npl series and to determine the direction of this impact. In econometric analysis, Eviews7 Package Programme is used.

6. Empirical Results

6.1. Unit Root Test

It is necessary that the variables to be used in the analysis must be stationary.Because if the time series are not stationary, they include stochastic or deterministic trends. In such a case, spurious regression condition might arise in the regression model where time series are used. In order to find out whether the series in the regression equation are stationary or not, Augmented Dickey-Fuller (ADF) Unit Root Test has been implemented. The results of Unit Root Test revealed that all three series used in the analysis are not stationary. Therefore, the first difference of the series has been taken in order to ensure stationarity. ADF Unit Root Test results are obtained through the intercept equation below which does not include trend.

$$\Delta y_t = \beta_1 + \theta y_{t-1} + \alpha_i \sum_{i=0}^{n} \Delta y_{t-i} + e_t \qquad (1)$$

After logarithm and differential processes has been implemented for all the variables used in the analysis, y in the equation(1) is replaced with the transformed form of variables and thus, their unit root values have been taken. Where Δ in the equation represents difference operator,n represents lag length, e represents error term. If the coefficient of the lagged version of the variable is $\theta = 0$, it is concluded that the variable does not have unit root. ADF test results for all the variables are given below.

Table 3-Augmented Dickey Fuller Unit Root Test Results

Variables	T-statistics	Variables	T-statistics
lognpl	-1.94545	Δlognpl	-4.239197*
logintrates	-2.401094	Δlogintrates	-3.416501**
logdebtgdp	-2.417648	Δlogdebtgdp	-5.026905*

*The * indicates significance at %1 and ** at %5*

6.2. Short Term Causality Analysis

Following unit root test, the next step has been to look into whether Δlognpl series is explained by Δlogintrates series or whether Δlogintrates is the cause of Δlognpl. First of all, considering all errors to be White Noise, *m*, the lag length with the least AIC (Akaike Information Criterion) and SIC (Schwartz Information Criterion) has been found. After the most appropriate lag length has been identified as 2, VAR (Vector Autoregression) Model Equation has been formed as given below.

$$Y_t = \alpha_0 + \sum_{i=1}^{2} \alpha_i \, Y_{t-i} + \sum_{i=1}^{2} \beta_i \, X_{t-i} + e_t \qquad (2)$$

Wald Test has been implemented to find out whether the variables in the equation individually effect dependent variable. In this respect to verify if the coefficients of Δlogintrates series are equal to zero or not, Wald Test has been implemented. The results of the Wald Test are given in the table below.

Table 4-Wald Test Statistics 1

Test Statistic	Value	Df	Prob*
Chi-square	7.655011	2	0.0218
Coefficients of Δlogintrates	**Value**		**Std. Err.**
C(3)	0.916471		0.386275
C(4)	-0.570693		0.405700

*H_0=The coefficients of the independent variable are equal to zero
(p value>%5)
H_1=The coefficients of the independent variable are not equal to zero
(p value<%5)*

For the first independent variable Δlogintrates series, H_0 hypothesis has been rejected at 95% confidence level according to the results of Wald Test. Δlogintrates series at 95% confidence level has been a cause of Δlognpl series.

In order to find out whether the second independent variable Δlogdebtgdp series is the cause of Δlognpl series, the lag length with the smallest AIC and SIC value has benn found as 1. VAR Model Equation for Δlogdebtgdp and Δlognpls given below.

$$Y_t = \alpha_0 + \alpha_1 Y_{t-i} + \beta_1 X_{t-1} + e_t \qquad (3)$$

Wald test has been implemented for testing hypothesis. Results of Wald test are given below.

Table 5-Wald Test Statistics 2

Test Statistic	Value	df	Prob*
Chi-square	7.974321	1	0.0047
Coefficients of Δlogdebtgdp	**Value**		**Std. Err.**
C(2)	1.180112		0.417904

*H_0=The coefficients of the independent variable are equal to zero
(p value>%5)
H_1=The coefficients of the independent variable are not equal to   zero
(p value<%5)*

For the second independent variable Δlogdebtgdp series, H_0 hypothesis has been rejected at 95% significance level according to the results of Wald Test. Δlogdebtgdp series at 95% significance level has been a cause of Δlognplseries.

6.3.VAR Analysis

After the causality relationship of independent variable with dependent variables each has been identified, VAR analysis has been carried out to form convenient multi-variant regression analysis. In this analysis dependent variable is called endogenous variable whilst independent variable is called exogenous variable. All series used in the analysis are supposed to be stationary. According to the smallest AIC value (Table 5), the most convenient lag length for VAR model has been found as 2.

Table-6.VAR Lag Order Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	43.58	NA	0.007	-2.08	-1.95	-2.03
1	45.89	4.13	0.006	-2.14	-1.97	-2.08
2	48.26	4.14*	0.006*	-2.21*	-1.00*	-2.14*
3	48.30	0.06	0.006	-2.16	-1.91	-2.07
4	48.85	0.90	0.006	-2.14	-1.84	-2.03

* indicates lag order selected by the criterion

After VAR model has been formed as given below, according to the second lag, autocorrelation relating to the model, changing variance problem and whether the errors are white noise has been tested.

$$\Delta lognpl_t = \sum_{i=1}^{2} \alpha_t \, \Delta lognpl_{t-i} + \sum_{i=1}^{2} \beta_t \, \Delta logintrates_{t-i} + \sum_{i=1}^{2} \gamma_t \, \Delta logdebtgdp_{t-i} + e_t \qquad (4)$$

To test whether there is autocorrelation problem in the model, Autocorrelation LM Test has been implemented. Since the p-values obtained for 10 lag interval is more than 5%, there is no autocorrelation problem in the model. The errors are white noise.

Table-7.VAR Residual LM Test

Lags	LM-Statistics	Prob*
1	7.346769	0.6011
2	4.674537	0.8617
3	13.42012	0.1445
4	8.842517	0.4519
5	7.160107	0.6205
6	11.69142	0.2313
7	8.420422	0.4924
8	6.446748	0.6945
9	13.01453	0.1620
10	10.42845	0.3169

*H_0=There are no autocorrelation in each lag (p value> %5)
H_1=There is an autocorrelation in each lag (p value< %5)

White Heteroskedasticity Test has been implemented for the variance problem. It was suggested by Halbert White in 1980. The result of White Test showed that there is no variance problem between error terms. There is no heteroscedasticity in the model at 95% confidence level.

Kurtosis and skewness states has been tested to find out whether normality distribution is ensured for the error terms. Jarque-Bera test has been carried out to see whether sample data have the skewness and kurtosis matching a normal distribution. The test is named after Carlos Jarque and Anil K. Bera econometricians who first developed the test. Jarque and Bera test is based on LM (Lagrange Multiplier) principle.

Table-8.VAR Residual Heteroskedasticity Tests: No Cross Terms

Joint Test:

Chi-square	df	Prob.*
68.55686	72	0.5932

Individual components:

Dependent	R^2	F(12,28)	Prob.	Chi-sq(12)	Prob.*
res1*res1	0.0808	0.2051	0.997	3.313	0.992
res2*res2	0.3076	1.0369	0.444	12.614	0.397
res3*res3	0.3154	1.0753	0.415	12.934	0.373
res2*res1	0.1499	0.4115	0.946	6.1476	0.908
res3*res1	0.3477	1.2438	0.304	14.256	0.284
res3*res2	0.1157	0.3055	0.982	4.747	0.965

*H_0=There is a changing variance state between error terms
(p value< %5)
H_1=There is not a changing variance state between error terms
(p value> %5)

Test statistics has been obtained from the kurtosis and skewness transformations of variables. Null hypothesis is a joint hypothesis: A null hypothesis is one in which expected skewness is 0

and expected kurtosis is 3. Normality test results showed that normal distribution has been ensured at 95% confidence level.

Table-9. VAR Residual Normality Tests

Component	Skewness	Chi-sq	df	Prob.*
1	0.094748	0.061344	1	0.8044
2	0.097153	0.064498	1	0.7995
3	0.131003	0.117272	1	0.7320
Joint		*0.243114*	*3*	*0.9703*
Component	**Skewness**	**Chi-sq**	**df**	**Prob.***
1	2.744928	0.111147	1	0.7388
2	3.527990	0.476238	1	0.4901
3	3.791532	1.070309	1	0.3009
Joint		*1.657694*	*3*	*0.6464*

Component	Jarque-Bera	df	Prob.*
1	0.172491	2	0.9174
2	0.540736	2	0.7631
3	1.187581	2	0.5522
Joint	*1.900808*	*6*	*0.9286*

*H_0=Residuals are multivariate normal   (p value>%5)
H_1= Residuals aren't multivariate normal (p value<%5)

Test results showed that VAR model equation statistically and financially ensures all hypotheses and thus, it is a valid model.

To what extent do the variables in the analysis explain each other is known by Variance Decomposition Analysis. To summarize the results given below, it is possible to say that Δlognpl series is explained 100% by itself in the first period while it is explained 73,05% by itself, 14,61% by Δlogintrates and 12,33% by Δlogdebtgdp at the end of the second period. At the end of five periods, it is explained 60,90% by itself, 26,79% by Δlogintrates and 12,30% by Δlogdebtgdp.

Table-10.Variance Decomposition of Δlognpl

Period	S.E.	Δlognpl	Δlogintrates	Δlogdebtgdp
1	0.07253	100.000	0.000000	0.000000
2	0.08719	73.0571	14.61097	12.33193
3	0.09438	66.4680	20.67270	12.85930
4	0.09776	62.5199	24.92970	12.55033
5	0.09906	60.9046	26.79221	12.30314

Cholesky Ordering: dlognpl dlogintrates dlogdebtgdp

6.4. Cointegration Analysis and Vector Error Correction Model

Johansen Cointegration Test developed by Soren Johansen (1991) is chosen because it enables to identify more than one cointegration relationship between time series. Whether there is a cointegration relationship between the variables or not is determined using Johansen Cointegration Analysis. This analysis has been carried out to examine the long-term relationships between the series. In the analysis, the eigen-values of the series

must be used. Cointegration is measured with the help of eigen-values so the time series used in analysis should not be subject to a differential process. However stationarity must be ensured at the same level for all the series involved in the analysis.
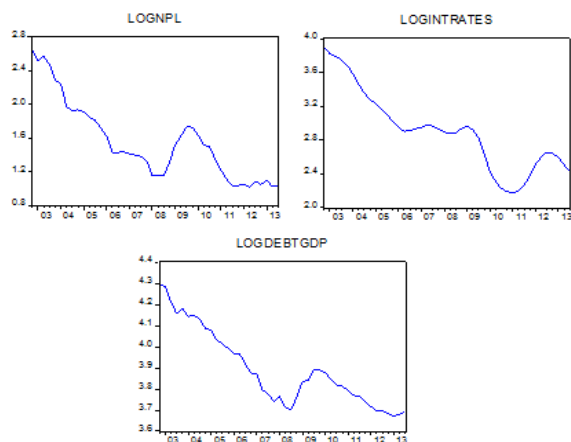

Figure-2. Cointegration Graphs in Eigen Values of the Variables

According to the results of Johansen Cointegration Test, in order to accept the existence of cointegration equation, Trace and Max-Eigen Statistical values should be higher than the critical value at 5% significance level. Test results revealed that there is only one cointegration equation.

Table-11. Johansen Cointegration Test Trace & Maximum Eigenvalue Statistics

Hypothesis	Eigen value	Trace Statistics	Critical Values %5	Prob
r =0	0.328756	29.34992	29.79707	0.0462
r<=1	0.166300	12.60781	15.49471	0.1300
r<=2*	0.111574	4.968762	3.841466	0,0258

Hypothesis	Eigen value	Max-EigenStatistics	Critical Values %5	Prob
r =0	0.328756	16.74212	21.13162	0.1845
r<=1	0.166300	7.639043	14.26460	0.4166
r<=2*	0.111574	4.968762	3.841466	0.0258

*Vectors *lognpl, logintrates, logdebtgdp*

One cointegration equation has been obtained based on the results of Johansen Cointegration Test. In the equation the coefficient of Δlogintrates series is negative whilst the coefficient of Δlogdebtgdp series is positive. According to test results, it is verified that in the long-term Δlogintrates series effects Δlognpl negatively and Δlogdebtgdp positively.

Table-12.Coefficients of Cointegration Equation

Variables	Coefficients	Standart Error
Δlognpl	0.022496	0,05135
Δlogintrates	-0.060245	0.02049
Δlogdebtgdp	0.037455	0.01870

After it is validated that there is a cointegration relationship between the variables, Vector Error Correction Model equation has been formed. Vector Error Correction Model is the equation in which the assessment of cointegration vector and maximum likelihood ratio is done. Vector Error Correction Model is given in the table below. As it is seen in Table-13, the coefficient of Δlogintrates series is negative and the coefficient of Δlogdebtgdp series is positive.

Table-13.Vector Error Correction Model

Error Correction	Δlognpl	Δlogintrates	Δlogdebtgdp
CointEq1	0.022496	-0.060245	0.037455
	(0.05135)	(0.02049)	(0.01870)
	[0.43810]	[-2.94000]	[2.00250]

Standard errors in ( ) & t-statistics in [ ]

While Δlogintrates series effects Δlognpl negatively in the long term, it effects Δlogdebtgdp positively. In the period, the interest rates in Turkish banking sector shows a declining trend causes to excessive loan growth by rising loan demands. Depending on the excessive loan growth in the long term, there are increases in the ratio of non-performing loans in the sector. The increase of public debt stock/GDP ratio leads to decrease in loanable funds in loan market. In such a case, the possibility for loan customers to renew their loans runs low and the non-performing loans ratio of banks increases.

Table-14.VEC Residual Serial Correlation LM Test

Lags	LM-Statistics	Prob*
1	14.78366	0.0971
2	3.680662	0.9311
3	11.47267	0.2447
4	11.51351	0.2421
5	8.281943	0.5060
6	7.002493	0.6369
7	11.77508	0.2263
8	12.34841	0.1944
9	12.46266	0.1885
10	8.369713	0.4974

*H_0=There is no autocorrelation in each lag (p value> %5)
H_1=There is an autocorrelation in each lag (p value< %5)

According to VEC Residual Serial Correlation LM Test results, considering lag interval between error terms in VEC Model equation as 10, it was found that there is no autocorrelation.

Table-15.Variance Decomposition of Δlognpl

Period	S.E.	Δlognpl	Δlogintrates	Δlogdebtgdp
1	0.074802	100.0000	0.000000	0.000000
2	0.093057	72.00057	15.96937	12.03005
3	0.105039	62.52428	24.13655	13.33917
4	0.117507	54.42299	29.26037	16.31664
5	0.128192	48.85788	33.00039	18.14174

Cholesky Ordering: dlognpl dlogintrates dlogdebtgdp.

According to the Variance Decomposition of Δlognpl results while Δlognpl series is explained 100% by itself in the first period, it is explained 72% by itself, 15.96% by Δlogintrates and 12.03% by Δlogdebtgdp at the end of the second period. At the end of five periods, it is explained 48.85% by itself, 33.00% by Δlogintrates and 18.14% by Δlogdebtgdp.

6.6. Granger Causality Analysis

Granger causality analysis is a statistical hypothesis test for determining whether one time series is useful in predicting another. Granger Causality Analysis is testing whether the coefficients of independent variable in each lag is equal to zero. If it is validated that the coefficients of the independent variable are not zero at a certain significance level, it is possible to talk about a causality relationship.

Table-16. VEC Granger Causality/Block Exogeneity Wald Tests

dependent variable: Δlognpl	Chi-sq	df	Prob.*
Δlogintrates	6.273934	1	0.0123
Δlogdebtgdp	10.32659	1	0.0013
All	**15.23000**	**2**	**0.0005**
dependent variable: Δlogintrates	Chi-sq	df	Prob.*
Δlognpl	3.999220	1	0.0455
Δlogdebtgdp	2.388803	1	0.1222
All	**8.399319**	**2**	**0.0150**
dependent variable: Δlogdebtgdp	Chi-sq	df	Prob.*
Δlognpl	1.734292	1	0.1879
Δlogintrates	1.73E-08	1	0.9999
All	**1.951190**	**2**	**0.3770**

*H_0=Independent Variable isn't Granger Cause of Dependent Variable (p value> %5)
H_1=Independent Variable is Granger Cause of Dependent Variable (p value< %5)

Granger causality test results have revealed a bilateral causality relationship between Δlognpl and Δlogintrates and a one-way causality relationship, towards Δlognpl, between Δlognpl and Δlogdebtgdp.
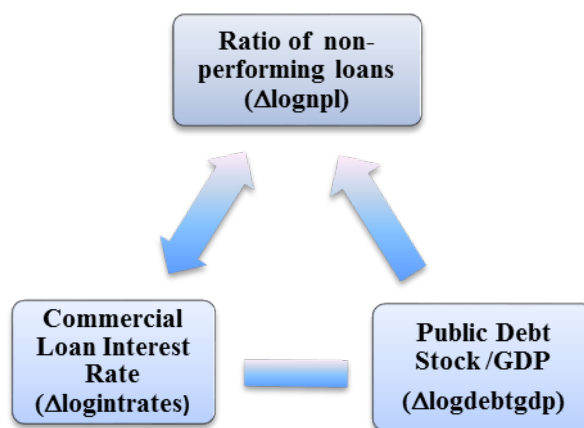

Figure-3.Granger Causality Diagram

7. Conclusion

This study examines the effect of macroeconomic variables (public debt stock/GDP ratio and commercial loan rates) on the nonperforming loans of 13 banks (comprising 78% of the sector in terms of loan balance) involved in Borsa İstanbul (BIST) XBANK Index. The study covers the period of 2002Q4 and 2013Q3; and for the variables to have a normal distribution, their logarithmic transformation is applied. Later since the variables are not stationary at level, the stationarity of variables is ensured after taking their first difference. Using Wald Test, it is found that commercial loan interest rate and public debt stock/GDP ratio has a short-term causality relationship with the ratio of non-performing loans.

VAR analysis has been implemented to model the impact of commercial loan interest rates and public debt stock/GDP ratios jointly on the ratio of nonperforming loans. After VAR Model equation is formed, whether the model has autocorrelation, heteroscedasticity and white noise problem has been checked through Autocorrelation LM Test and White Heteroskedasticity Test.

Because it is required to validate the existence of cointegration relationship between the variables in order to form VECM Model, Johansen Cointegration Test has been implemented. The test

results have revealed a cointegration equation. After cointegration relationship is identified, VECM model is formed. To identify if a long-term causality exists between the variables, Granger Causality Test is performed. The test results have revealed that change in both commercial loan interest rates and Public Debt Stock/GDP ratios are Granger cause of the change in the ratio of nonperforming loans in banks and that the causality relationship between change in nonperforming loan ratio and the change in commercial loan interest rate is bilateral..

In VECM equation, while the change in commercial loan interest rates effects the ratio of non-performing loans negatively in the long run, it has a positive impact on public debt stock /GDP ratio.

Decrease in the commercial loan interest rates in the long term causes excessive loan growth and thus, increases the nonperforming loan ratio. This result supports the finding of Jimenez and Saurina (2005) that loan boom increases the ratio of non-performing loans though with quite lagged.

Increase in public debt stock/GDP ratio in the long-term increases the ratio of non-performing loans. Similar to this result, Reinhart and Rogoff (2010) stated in their study that the increase in the public borrowing requirement would cause to a decrease in loanable funds in loan market and thus, banks are obliged to limit their loan placements. It is concluded that this increases the ratio of non-performing loans because loan customers cannot renew their loan debts.

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