Received: 28 October 2021 | Accepted: 07 November 2021
DOI: 10.52898/ijif.2021.9

ORIGINAL ARTICLE

Determinants of Credit Risk in the Turkish Commercial Banking Sector: New Findings

Kaşif Batu TUNAY
İlyas AKHİSAR

Abstract
The commercial banking sector is the most important part of the financial system and in particular the banking sector in Turkey. The high credit risk exposure of commercial banks is so significant that it can endanger the stability of the banking system. In the study, bank-specific and macroeconomic determinants of credit risks of commercial banks were analyzed. The empirical analysis covers 23 commercial banks operating in the Turkish Banking Sector in the period of 2010-2020. The determinants of credit risk are modeled in line with the findings of international empirical studies. In this context, a dynamic panel data model covering bank-specific and macroeconomic variables was estimated with the help of alternative estimators. The findings show that both bank-specific and macroeconomic variables have strong effects on credit risk.

Keywords
Commercial Banking, Credit Risk, Dynamic Panel Data Models

JEL Classification
C23, C63, G21.

Authors Notes:
Correspondence
Marmara University School of Banking and Insurance, Capital Markets Department,
ORCID ID: 0000-0002-9040-5831.
batu.tunay@marmara.edu.tr,

Kocaeli University Faculty of
Economics and Administrative Sciences,
Business Administration Department,
ORCID ID: 0000-0001-7988-0183.
İlyas.akhisar@kocaeli.edu.tr,

1. INTRODUCTION

The credit risk is one of the most important fundamental risks in the banking sector. For this reason, it is a frequently discussed subject in the banking literature. However, after the 2008 global crisis which showed the potential of credit risk to produce important and widespread crises, it is seen that the studies in this field increased significantly. The studies carried out aim to guide the efforts for the correct and effective management of credit risk.

The increase in the ratio of non-performing loans to total loans indicates that borrowers have repayment problems. When this problem becomes widespread, it is likely that the banking sector will face serious losses. As the deterioration in the credit portfolios of banks is a serious source of systemic risk, they are closely monitored by the supervisory and surveillance authorities. The rapid growth in loan portfolios observed during the economic expansion periods, may pose serious risks when the repayment rates decrease the economy begins to contract. In the applied banking literature, non-performing loans are used as the main indicator of credit risk. The non-performing loan rates are closely monitored by the supervisory and surveillance authorities, and care is taken to keep them within certain limits. This depends on the effective management of loan portfolios by considering modern risk management techniques, as well as taking strict legal measures to limit bank loan operations.

The findings of empirical studies in the international literature have revealed that credit risk has bank-based and macroeconomic determinants. It has been determined that variables such as the size of the banks analyzed on the basis of the sector in which the banks operate, the level of use of the leverage effect, the capital structure, the profitability ratio, the liquidity and the provision levels are important. As for macroeconomics, inflation, growth rate, unemployment, exchange rate and interest rate developments affect credit risk. Developments in the past have shown that credit risk may increase even if the credit management of macroeconomic factors is effective. That's due to the fact that such variables directly or indirectly affect almost all bank-based variables. For example, sharp changes in interest rates will affect not only loans but also many factors such as market share, cost and profitability. For this reason, it is of great importance to analyze the interactions between bank loans and macroeconomic variables on the basis of credit risk in order to take effective measures. As well as determining which macroeconomic variables are more effective on credit risk, it is also extremely important to determine which banks in the sector are more exposed to the macroeconomic credit risk.

Based on the above determinations and evaluations, the main purpose of this study is to explain the determinants of the credit risk. It is also aimed to determine whether the credit risk shows persistence over time. Alternative dynamic panel data estimators were used in the econometric analysis.

2. LITERATURE REVIEW

2.1. International Studies and Findings

Within the framework of a credit risk model, the effects of macroeconomic variables on default rates began to be discussed in the late 1990s. However, after the 2008 global crisis, it is seen that the number of studies in this field has increased rapidly. Jakubik and Schmieder (2008), Ali and Daly (2010), Vogiazas and Nikolaidou (2011), Nkusu (2011), Louzis et al. (2012), Mileris (2012), Castro (2013), Yurdakul (2014), Chaibi and Ftiti (2015), Gosh (2015), Manab et al. (2015), Misman et al. (2015), Zhu et al. (2015) are the authors of some of these studies.

Among the listed studies, Ali and Daly (2010), Jakubik and Schmieder (2008), Vogiazas and Nikolaidou (2011), Mileris (2012), Yurdakul (2014), Manab et al. (2015), Zhu et al. (2015) differ from the others due to the different analysis methods which they use. Other studies analyze the components of the credit risk with linear and dynamic panel data models, using single or multiple country samples. By using the stress tests, Jakubik and Schmieder (2008) determined that the growth rate of GDP in the Czech Republic and Germany and the credit-to-GDP ratio, affect the default rates of corporate loans. In addition, it has been observed that these variables also have an effect on the non-performing loans of households.

Ali and Daly (2010) tried to develop a country-level understanding of credit risk modeling in the context of Basel II capital adequacy standards. In this context, they questioned the interaction between the cyclical implications of aggregate defaults and the banks' capital stocks in an economy. For this purpose, they

developed a macroeconomic credit model and performed a scenario analysis. They made a comparative analysis based on the examples of Australia, which was not affected by the global crisis, and the USA, where the crisis was experienced with all its severity. Based on the finding that negative macroeconomic shocks are effective in both countries, they investigated which macro variables have the greater potential to cause such shocks. Their findings indicate that GDP, short-term interest rates and total public debt are the most influential variables on loan default rates.

Vogiazas and Nikolaidou (2011) and Yurdakul (2014) showed that macroeconomic variables are effective on credit risk by using various time series analysis methods. Analyzing the Romanian banking system, Vogiazas and Nikolaidou (2011) determined that variables such as investment expenditures, inflation, unemployment, the ratio of external debt to GDP and M2 money supply affect credit risk. Yurdakul (2014), on the other hand, examined the long-term effects of macroeconomic variables such as inflation rate, interest rate, stock index, exchange rate, growth rate, money supply, unemployment rate on non-performing loans. In these studies, it has been determined that increases in variables such as the growth rate and stock index, which generally represent the expansion in the volume of an economic activity, reduce the credit risk. On the other hand, it was observed that increases in other variables lead to an increase in the credit risk. In addition, in Yurdaul's study, it was determined that credit risk showed a significant historical dependency.

Mileris (2012) examined a large sample covering 22 European Union countries and used analysis methods such as logistic regression, factor analysis and probit model. He determined that the credit risk in these countries is seriously affected by macroeconomic changes. Manab et al. (2015) analyzed credit risk with a data set of companies whose shares are traded in Malaysia. Credit risk has been analyzed on the basis of efficiency and productivity, and it has been observed that liquidity ratio, efficiency ratio and profitability ratio are important risk components. Zhu et al. (2015) analyzed commercial banks operating in China and examined the relationship between their efficiency and productivity and non-performing loans. It was observed that the increase in non-performing loans decreased the efficiency of banks.

Nkusu (2011), Louzis et al. (2012), Castro (2013), Chaibi and Ftiti (2015), Gosh (2015), Misman et al. (2015) analyzes based on linear and dynamic panel data methods. Except for Louzis et al. (2012) who examined the Greek banking system, Gosh (2015) which analyzes the credit risk on the basis of states in the USA, and Misman et al. (2015) which analyzes the credit risks of Islamic banks in Malaysia, the others are studies that cover many countries. The most important common feature of these studies is that they prove that credit risk is affected by macroeconomic variables through different samples. However, of course, the macroeconomic variables that affect the credit risk differ due to the different structural characteristics of the countries that make up the samples. Nevertheless, some important common observations can be made. The development of the volume of economic activity reduces the credit risk, and the credit risk increases rapidly after the possibility of economic contraction appears. Therefore, developments such as growth, increase in stock prices and moderate increase in inflation rates, decrease in unemployment, interest rates, budget deficits and public debts (domestic and foreign) will contribute to the decrease in credit risk. Developments in the opposite direction will increase the credit risk.

Among them, Louzis et al. (2012) and Chaibi and Ftiti's (2015) studies differ from others in terms of their findings. Both studies consider both bank-specific and macroeconomic components of credit risk. Louzis et al. (2012) handled each loan group separately as consumer loans (consumer loans), commercial loans (commercial loans) and housing loans (mortgages). It has been shown that credit risk in the Greek banking system is affected by GDP, unemployment, interest rates and public debt, as well as the quality of management on a bank basis. It has been determined that the effects of macroeconomic variables in different loan categories vary numerically. Among others, it was determined that housing loans gave the lowest response to macroeconomic variables. These last two findings are particularly important as they show that credit risk should be analyzed on the basis of different loan types.

The study of Chaibi and Ftiti (2015), which analyzes the components of credit risk through France and bank-based German financial systems is interesting. The study is based on the assumption that macroeconomic and bank-specific variables are effective on credit quality and that these effects vary in different bank systems. Loan loss provisions, inefficiency, leverage, non-interest income, size and ROE are taken into account as bank-specific variables. As macroeconomic variables, inflation, GDP growth, interest rates, unemployment, and exchange rates are taken into account. It has been determined that the ones other than inflation affect the credit risk in both countries. It has been determined that credit risk

is more sensitive to bank-specific components in France, which is a market-based financial system. This is an extremely important finding as it shows that the credit risk components change in different systems.

It has been frequently discussed in the literature that Islamic banks were less affected by crises than traditional commercial banks in the post-crisis period, and therefore could be an alternative to the current system. Islamic banks that do interest-free banking are also open to default risk. Misman et al. (2015) study shows that bank-specific factors strongly influence credit risk in Islamic banks. Factors such as financing quality, capital ratio, and the ownership structure of the bank were also found to be important in terms of the credit risk of these banks. The importance of these findings is that they show us that alternative banking applications are open to credit risk and that credit-based crises are likely to occur in almost every bank system.

2.2. Findings of National Studies

It is observed that applied studies on credit risk are increasing gradually in Turkey. Ayanoğlu and Ertürk (2007), Kavcıoğlu (2011), Budak and Erpolat (2012), Koçyiğit and Demir (2014), Tunay (2011 and 2015), Genç and Şaşmaz (2016), Akhisar and Tunay (2017), Çetinkaya (2019), Kabataş and Karamustafa (2019), Yüksek (2019), Tunay et al. (2021) are some of the studies conducted in this area. From the studies listed, it approaches credit risk from different dimensions. For example, the studies of Ayanoğlu and Ertürk (2007) and Koçyiğit and Demir (2014) deal with the credit risk measurement and management approach outlined in the Basel II consensus. Kavcıoğlu (2011) evaluated alternative credit risk management techniques in terms of their strengths and weaknesses in practice. Other studies are on modeling and forecasting of credit risk with various econometric analysis methods.

Ayanoğlu and Ertürk (2007) discussed contemporary credit risk management within the framework of Basel II, based on traditional and contemporary risk management approaches. In this context, they analyzed the credit risks of companies listed on the İMKB using the factor analysis method. It has been determined that the liquidity ratios of the companies are the most effective factor on the credit risk, followed by the ratios reflecting the asset turnover rate and resource structure. On the other hand, Koçyiğit and Demir (2014) examined the change in credit risk of a large-scale bank on a quarterly basis. They have determined that the credit risk of the bank they are analyzing with is measured and directed in accordance with the standards stipulated by Basel II. This is an important finding, at least in terms of showing that large banks manage their credit risks within the framework of Basel II.

For an effective credit risk measurement, it is necessary to develop measurement models that will reflect possible problems with a proactive point of view. In this context, the studies of Budak and Erpolat (2012) and Tunay (2012) are important. Budak and Erpolat discussed a model based on predicting the payment behavior (payment or non-payment) of banks' loan customers. As a result of the analyzes based on artificial neural networks and logistic regression techniques, they concluded that artificial neural networks are more successful in predicting the regular payment habits of loan customers. Tunay (2012), on the other hand, analyzed the default risk using the Kalman filter. In the created state-space model, the credit risk was taken as the unobservable variable and it was estimated using the Kalman filter based on the observable variable, the credit spread. The results show that the Kalman filter is quite successful in predicting the credit risk. The applied studies are important in showing that credit risk can be predicted with appropriate techniques.

Although the number is not high, some studies conducted in industrialized countries point to risk increases due to the fact that banks give more space to the loans of certain sectors in their loan portfolios. Tunay (2015) analyzed the concentration of sectoral loans opened by commercial banks in Turkey in the 2002-2014 period and its effect on the credit risks of these banks. As a result of the analyzes made with linear panel data models, it was determined that there is a strong relationship between credit risk and sectoral concentration. In order to increase their profitability ratios, it has been observed that the risk of banks that give more credit to certain sectors in their loan portfolios has increased significantly. In this respect, it has been observed that foreign banks, which increase their share in the sector as the strength goes on, behave more aggressively and take higher risks compared to national banks.

In relatively new empirical studies, quite consistent results have been obtained. Genç and Şaşmaz (2016), with their time series analysis, determined that non-performing bank loans are affected by GDP, BIST-100 index, loan interest rates and real exchange rate. Accordingly, the BIST-100 index negatively

affects non-performing loans, while real exchange rate positively affects non-performing loans. Akhisar and Tunay (2017) showed that both bank-specific and macroeconomic variables have strong effects on credit risk. They observed that especially the contraction in the volume of economic activity and macro instability increased the credit risk.

Yüksek (2019) found that bank-specific factors have strong effects on credit risk. Accordingly, variables such as capital adequacy, special provisions, non-interest income, liquidity risk, and return on assets affect credit risk. The findings of Çetinkaya (2019) are also consistent with those of Yüksek (2019). Çetinkaya (2019) determining that credit risk is mostly affected by bank-specific variables such as return on assets and equity, bank size, and net interest margin. Among the macroeconomic variables, it was determined that the GDP had the highest effect on the credit risk. Kabataş and Karamustafa (2019) analyzed the factors affecting the NPL ratio of consumer loans in banks. Their results showed that growth, unemployment and capital adequacy negatively affect the NPL ratio. On the other hand, variables such as inflation, interest rate, real exchange rate, return on assets and the ratio of loans to deposits have not been found to have a significant effect on credit risk. Tunay et al. (2021) analyzed how and to what extent credit risk is affected by macroeconomic variables. Their findings showed that credit risk is strongly affected by changes in inflation, growth, exchange rates and interest rates. Nominal interest rates and growth rate affect credit risk negatively and other variables positively.

3. ECONOMETRIC ANALYSIS AND FINDINGS

3.1. Analysis Method

Findings of international empirical studies identifiying the determinants of credit risk have shown that bank-based and macroeconomic variables are effective on credit risk. When the results of many different studies are examined, it has been observed that some variables explain credit risk more strongly than others. Explaining the credit risk through the bank-specific variables such as loan loss provisions (lls), capital adequacy or leverage ratio (lev), liquidity ratio (liq), non-interest income (nii), return on equity (roe) and the relative size of the bank's (the ratio of bank i's assets to the sector's total assets / rs). As for macroeconomic variables; inflation (inf), GDP growth rate (grw), unemployment rate (unem), foreign exchange rate (fx), and the average deposit rate (int) was found significant. Again, in many of the empirical studies, it has also been observed that credit risk exhibits a strong historical dependence or persistence and therefore needs to be modeled dynamically. In other words, the set of explanatory variables should include their own delays. In the light of all these determinations, credit risk can be modeled as follows:

$$\begin{aligned} crdr_{i,t} &= \alpha + \lambda crdr_{i,t-1} + \beta_1 lls_{i,t} + \beta_2 lev_{i,t} + \beta_3 liq_{i,t} \\ &+ \beta_4 nii_{it} + \beta_5 roe_{i,t} + \beta_6 rs_{i,t} + \gamma_1 inf_t + \gamma_2 grw_t \\ &+ \gamma_3 unem_t + \gamma_4 fx_t + \gamma_5 \mathrm{int}_t + \varepsilon_{i,t} \end{aligned}$$

$$\begin{aligned} crdr_{i,t} &= \alpha + \lambda crdr_{i,t-1} + \beta_1 lls_{i,t} + \beta_2 lev_{i,t} + \beta_3 liq_{i,t} \\ &+ \beta_4 nii_{i,t} + \beta_5 roe_{i,t} + \beta_6 rs_{i,t} + \gamma_1 inf_t + \gamma_2 grw_t \\ &+ \gamma_3 unem_t + \gamma_4 fx_t + \gamma_5 \mathrm{int}_t + \varepsilon_{i,t} \end{aligned}$$

In equation (1), subscript *i* represents the banks in the sample and *t* represents the examined time period. Respectively α, λ, β_j $(j=1,\ldots,6)$, γ_k $(k=1,\ldots,5)$ are the model parameters. $\varepsilon_{i,t}$ is the error term assumed to be normally distributed with zero mean.

Credit risk will increase as the bank's business size or trading grows, as the bank outsources more and as its profitability increases. Therefore, the relative size of the bank is expected to be positively correlated with leverage and return on equity (ROE). Since the liquidity of the bank may change periodically, the relationship between credit risk and these variables may be positive or negative periodically. Credit provisions will be increased by the bank's management as credit risk increases. Therefore, provisions and credit risk are expected to have a negative relationship. However, due to the Basel II and III accords and other legal

requirements, high provisions have become mandatory for all banks, and the relationship between credit risk and provisions has been differentiated. For this reason, the direction of the relationship between the two variables is open to the effects of periodic changes depending on the decisions of the legal authorities. In other words, this relationship, which is expected to be positive, may also be negative periodically.

Banks' loan volumes are in a strong positive relationship with the volume of an economic activity. In this respect, since the growth in GDP and the increase in inflation within certain limits and the decrease in unemployment indicate that the economy has revived and the volume of general economic activity has expanded, the credit volume will also increase. In such expansion periods, non-performing loans decrease and credit risk falls. Therefore, credit risk is expected to be negatively related to inflation and growth and positively related to unemployment. Apart from the moderate exchange rate and interest rate changes during growth periods, credit risk will be positively affected by excessive increases in interest rates and exchange rates.

Due to the dynamic nature of the model to be analyzed, it was preferred to use the dynamic panel data method in the estimation process. In the literature, the estimation approach based on the two-stage generalized method of moments (GMM) developed by Arellano and Bond (1991) is frequently used in similar analyzes. However, it is seen that system dynamic panel data models developed by Arellano and Bover (1995) and Blundell and Bond (1998) are used in more recent studies in the fields of banking and insurance. System dynamic models are also based on the two-stage GMM estimator, but by their nature they have superior estimation properties than the first generation dynamic models.

System dynamic models are considered ideal for datasets that contain a large number of cross-sections but have a relatively short time dimension. While the familiar Arellano-Bond (1991) method produces biasing results in such datasets, system dynamic models eliminate this bias problem and give robust results. In order to ensure that consistent estimations are made with this method, it is necessary to prove that there is no second-order autocorrelation in the error terms and that the instrument variables are valid (instruments validity). For this, the Arellano-Bond test, which tests the null hypothesis that there is no second-order sequential correlation, and then the Hansen test to test the validity of the instrumental variables should be applied (Roodman, 2006, 2008). In the study, diagnostic tests will be carried out with the mentioned tests. The estimation process in dynamic models is based on one-stage or two-stage GMM estimators. In this respect, in dynamic models, in addition to the variables in the model, there is also a set of instrumental variables. The instrumental variables can consist of lags of the dependent variable and lags of difference, explanatory variables, and dummy variables.

3.2. Data set

The bank-specific data used in the study were obtained from the official website of the Banks Association of Turkey, and the macroeconomic indicators were obtained from the official website of the Central Bank of Republic of Turkey. Annual data covering the period of 2010-2020 of 23 commercial banks operating in the Turkish Banking Sector were used and a sample containing 1771 observations was created, except for macroeconomic variables. When macroeconomic variables are added, the total number of observations is 3036. The names of the commercial banks in the sample are presented in Table 1, and the variables used in the analyzes and their explanations are presented in Table 2.

Table 1.
Commercial Banks in the Sample

Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	Arap Türk Bankası A.Ş.
Türkiye Halk Bankası A.Ş.	Burgan Bank A.Ş.
Türkiye Vakıflar Bankası T.A.O.	Citibank A.Ş.
Akbank T.A.Ş.	Denizbank A.Ş.
Anadolubank A.Ş.	HSBC Bank A.Ş.
Fibabanka A.Ş.	ICBC Turkey Bank A.Ş.
Şekerbank T.A.Ş.	ING Bank A.Ş.
Turkish Bank A.Ş.	Odea Bank A.Ş.
Türk Ekonomi Bankası A.Ş.	QNB Finansbank A.Ş.
Türkiye İş Bankası A.Ş.	Turkland Bank A.Ş.
Yapı ve Kredi Bankası A.Ş.	Türkiye Garanti Bankası A.Ş.
Alternatifbank A.Ş.	

Table 2.
Variables Used in the Study and Their Definitions

Symbol	Variable	Definition	Source
crdr	Credit risk	Non-performing Loans / Total Credits	B.A.T.
llp	Loan loss prov.	Loan Loss Provisions / Non-performing Loans	" "
lev	Leverage	Equity / Total Assets	" "
liq	Liquidity ratio	Liquid Assets / Total Assets	" "
nii	Non-interest income	Non-interest Income / Total Assets	" "
roe	Return on equity	Net Profit / Equity	" "
rs	Relative size	Total Assets of i bank / Total Assets of Sector	" "
inf	Inflation rate	Annual percent change of CPI (2003=100)	C.B.T.
grw	Growth	Annual percent change of GDP (1998, constant prices)	" "
unem	Unemployment	Annual unemployment rate	" "
fx	Foreign exchange rate	US Dollar buying rate	" "
int	Interest rate	Average deposit rate	" "

B.A.T. – The Banks Association of Turkey, C.B.T. – The Central Bank of Turkey.

3.3. Results

In the first stage of the analysis, the structure of the variables was analyzed. In this framework, descriptive statistics and correlation coefficients were calculated, respectively. The descriptive statistics of the variables are presented in Table 3 and the correlation coefficients in Table 4. With the help of the correlation coefficients matrix, the interrelationships between the variables were evaluated. When these are examined; although credit risk is higher with bank-specific variables, it has been observed that it exhibits strong relationships with almost all variables. Apart from this, strong relations between macro variables such as bank-based variables were determined.

Table 3.
Descriptive Statistics

	Mean	Std. Dev.	Min	Max
crdr	4.6480	4.9496	0.0000	48.5879
llp	1.1214	0.9444	-2.8979	9.2451
lev	17.0036	3.8902	0.0000	36.4188
liq	26.9048	12.1918	0.0000	66.6435
nii	1.2826	0.7664	-0.9899	3.5976
roe	9.1172	14.5264	-176.6806	35.3044
rs	4.0825	4.6963	0.0000	16.6433
inf	10.0591	3.1262	6.4700	16.3300
grw	1.5818	0.2870	1.1700	2.0300
unem	11.1636	1.2748	9.8000	13.3000
fx	3.2664	1.7500	1.5000	7.0100
int	16.7373	3.8227	12.8100	25.4100

The second stage of the analysis is the estimation of the model numbered (1). In this context, both the Arellano and Bond (1991) estimator and the two-stage system estimator based on the work of Arellano and Bover (1995) and Blundell and Bond (1998) were used. The estimation results are presented in Table 5. In the estimation process, first the reference model including all the variables was estimated, and then the meaningless variables were step by step eliminated to reach the refined model. In Table 5, the estimations of both the reference model and the refined model are seen together. According to the Wald test results, the general significance of the models is high, and the Sargan test results show that the set of instrumental variables selected in the models is appropriate. However, the results of the Arrellano-Bond test indicate that there is a problem of autocorrelation, especially in the residuals of the estimates made with the system estimator. Accordingly, the findings obtained with the system estimator should not be given much credit.

Leaving aside the statistical significance of the estimates, it is seen that the credit risk is strongly affected by both bank-specific variables and macroeconomic indicators. In addition, credit risk also shows a strong historical dependence, since its own lag is significant. It has been observed that there is a positive relationship between loan loss provisions, liquidity and profitability and credit risk among the bank-specific variables. Leverage rate and non-interest income, on the other hand, affect credit risk negatively. There is no definite finding on whether the size of the bank is related to the credit risk or not.

It is not surprising that these two variables have a positive significant relationship, as the loan loss provisions are increased due to credit risk. Similarly, as the profitability of banks that take higher credit risk increases, it is expected that ROE and credit risk will interact positively. The positive relationship between credit risk and liquidity is not clear. Since the liquidity positions of banks and their credit processes are not related, the difference between these two variables can only be established in terms of liquidity risk. These two risks may interact positively, as the liquidity risk, as well as the credit risk, will increase in banks that follow more risky managerial strategies. On the other hand, since net interest incomes may decrease in banks with increased credit risk, a negative interaction between these variables can be expected. The interaction between leverage and credit risk is somewhat more complex. Normally risky management strategies increase the use of leverage, as does credit risk. However, due to increasing capital adequacy practices in recent years, the use of leverage has decreased and the relationship between these two variables has also changed.

Table 4.
Correlation Coefficients Matrix

	crdr	llp	lev	liq	nii	roe	rs	inf	grw	unem	fx	int
crdr	1.0000											
llp	0.5771	1.0000										
lev	0.0076	-0.0903	1.0000									
liq	-0.0969	-0.3469	0.4355	1.0000								
nii	0.0872	0.1492	0.1379	0.1525	1.0000							
roe	-0.5997	-0.5039	0.0627	0.0675	0.1899	1.0000						
rs	-0.1834	-0.0335	-0.1739	-0.1769	0.0077	0.2886	1.0000					
inf	0.3256	0.3589	0.2910	-0.3189	-0.0334	-0.0806	-0.0107	1.0000				
grw	0.0963	0.0190	0.0655	-0.1116	-0.0643	0.0348	-0.0032	0.3290	1.0000			
unem	0.3301	0.3132	0.2575	-0.3040	0.0831	-0.1011	-0.0105	0.7502	-0.0036	1.0000		
fx	0.3141	0.2700	0.2717	-0.3412	-0.0854	-0.0998	-0.0110	0.7921	0.2291	0.7758	1.0000	
int	0.2422	0.3598	0.1799	-0.1931	0.0062	-0.1180	-0.0067	0.7681	0.0960	0.5193	0.4100	1.0000

Table 5.
Estimation Results of Dynamic Panel Data Model

	Arrellano - Bond Estimator						System Estimator					
	Coeff.	z Test		Coeff.	z Test		Coeff.	z Test		Coeff.	z Test	
crdr(-1)	0.6414	8.050	***	0.6527	9.93	***	0.6248	7.330	***	0.5594	47.930	***
llp	2.3723	6.090	***	2.4449	8.56	***	2.3841	6.680	***	2.2097	32.110	***
lev	-0.1251	-5.870	***	-0.1078	-4.63	***	-0.1521	-4.570	***	-0.1353	-6.560	***
liq	0.0682	6.820	***	0.0627	6.77	***	0.0664	3.750	***	0.0716	6.670	***
nii	-0.5890	-3.290	***	-0.5471	-6.66	***	-0.2431	-0.890				
roe	0.0869	2.680	***	0.0939	4.32	***	0.0644	2.030	**			
rs	-0.1333	-0.560					-1.1112	-2.170	**	-0.3156	-1.490	*
inf	-0.1711	-1.610	*	-0.2505	-3.32	***	-0.1839	-2.240	**	-0.1291	-2.350	**
grw	0.2533	1.210		0.3371	1.54	*	0.4666	1.670	*	0.7939	6.350	***
unem	0.0139	0.100					-0.0094	-0.080				
fx	0.2692	1.430		0.3810	4.16	***	0.2144	1.290		0.3239	4.150	***
int	0.2249	3.620	***	0.2528	8.55	***	0.2462	6.860	***	0.2112	10.430	***
constant	-4.2713	-3.310	***	-5.0920	-6.92	***	0.6395	0.300		-3.2193	-3.030	***
Arrellano Bond Test:												
AR(1)	-1.4857	*		-1.4863	*		-1.2094			-1.1617		
AR(2)	1.0077			0.9653			1.0000			1.0517		
Sargan Test:												
Chi^2	10.1643			9.3669			6.1724			7.2042		
Wald Test:												
Chi^2	6263.84	***		8509.51	***		15262.94	***		17522.04	***	

(***), (**) and (*) indicate that the test statistics are significant at the 1%, 5% and 10% levels, respectively.

The results show that most of the macroeconomic indicators have strong effects on credit risk. Unemployment was not found to have a significant relationship with credit risk. In particular, inflation and interest rates were found to be significant in all forecasts. However, the interactions of these variables with credit risk are different. Interest rates, as expected, positively affect credit risk. Nevertheless, contrary to expectations, it has been determined that the inflation rate affects the credit risk negatively. This can be attributed to the effect of inflation on purchasing power. High inflation rates favor loan borrowers as they cause debt to fall in real terms until maturity and encourages repayment of loans. Therefore, inflation may negatively affect credit risk.

It has been observed that exchange rates and growth rate increase the credit risk. Exchange rate increases can make it difficult to repay commercial loan debts by both increasing input costs in production and pushing economic units to reduce their expenditures. On the other hand, the increase in the growth rate will encourage the increase in loans, and the credit risk will increase in parallel with the increasing loans.

The obtained findings are quite different from the results of previous experimental studies in this field. For example, Akhisar and Tunay's (2017) study found that all variables except non-interest income and growth affect credit risk. However, the findings of this study show that net interest incomes affect credit risk negatively and growth positively. On the other hand, no significant relationship was found between credit risk, bank size and unemployment rate. The difference between the findings of the two studies can be attributed to the change in dynamics, especially economic conditions, affecting the banking sector over time. Factors such as the gradual deterioration of macro balances after 2017, the decrease in the number of banks in the system due to mergers and withdrawals from the sector changed the variables affecting credit risk and their interaction levels. What hasn't changed is that credit risk still has a strong persistence. New findings indicate that exchange rates and interest rates have strong positive effects on credit risk.

4. CONCLUSION

In this study, bank-specific and macroeconomic variables that determine the credit risk of commercial banks in Turkey were investigated. In the experimental analysis, data compiled from 23 commercial

banks in the 2010-2020 period were used and predictions were made with dynamic panel data models. Alternative estimators were used in the estimation process, and in this context, Arellano-Bond and system estimators were preferred. Although the system estimator is a more effective analysis method, it has not passed the diagnostic tests; It was determined that the results obtained with the Arellano-Bond estimator were more robust.

The results of the analysis showed that bank-based variables and macroeconomic variables explain credit risk in general. This is consistent with most of the previous studies in the literature. However, the main difference from previous works is gathered in two points. The first of these is that some of the variables found to be significant are different from those in previous studies. The second is the differences in the interactions of the variables found to be significant. In other words, some variables have been found to affect credit risk positively in previous studies, but in our study, it was seen that there were some negative interactions. Of course, the reverse is also true. These changes were attributed to the volatility in the economy and the banking sector, along with the change in the sample period. Recently, the number of commercial banks in the sample has decreased due to reasons such as mergers and acquisitions and withdrawals from the sector. In addition, the deterioration in economic conditions after 2017 pushed banks to operate in a more difficult environment, causing the risks they were exposed to and the factors affecting them to be changed.

Our findings show that loan loss provisions, liquidity and profitability positively affect credit risk. Capital adequacy or leverage ratio and non-interest incomes affect credit risk negatively. There is no definite finding on whether the size of the bank is related to the credit risk or not. On the other hand, it has been observed that most of the macroeconomic indicators have strong effects on credit risk. It was determined that only unemployment was not significantly associated with credit risk. Inflation and interest rates strongly explain credit risk in all estimates, albeit in different directions. As expected, interest rates affect credit risk positively, while inflation affects it negatively. This was attributed to the effect of inflation on purchasing power. Due to the increasing inflation rates in the sample period, the real value of the loan debts decreases until the maturity date. This development, which is in favor of borrowers, encourages the repayment of loans and has a negative impact on credit risk. It has also been observed that exchange rates and growth rate increase the credit risk. These results are attributed to the interaction of credit risk with economic activity and the exchange rates that affect it.

To sum up, our findings differ somewhat from the findings of previous studies. The main reason for this is that the analyzes were made in a process where the economic and financial balances gradually deteriorated, albeit with similar variables. This is important in terms of showing the sensitivity of credit risk to the economic situation.

REFERENCES

Akhisar, İlyas ve Tunay, K. Batu. (2017). “Türk Ticari Bankacılık Sektöründe Kredi Riskinin Belirleyicileri Temelinde Banka Sıralaması”, Gazi Üniversitesi, Bankacılık ve Finansal Araştırmalar Dergisi, 4(1), 1-20.

Ali, Asghar, and Daly, Kevin. (2010), “Macroeconomic Determinants of Credit Risk: Recent Evidence from a Cross Country Study”, International Review of Financial Analysis, 19, 165-171.

Arellano, Manuel ve Bond, Stephen. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Unemployment Equations, Review of Economic Studies, 58, 277-297.

Arellano, Manuel. ve Bover, Olympia. (1995). Another Look at the Instrumental Variable Estimation of Error-Components Models, Journal of Econometrics, 68(1), 29-51.

Ayanoğlu, Yıldız, ve Ertürk, Burak. (2007), “Modern Kredi Riski Yönetiminde Derecelendirmenin Yeri ve İMKB’de Kayıtlı Şirketler Üzerine Bir Uygulama”, Gazi Üniversitesi İ.İ.B.F. Dergisi, 9(2), 75-90.

Blundell, Richard. ve Bond, Stephen. (1998). Initial Conditions and Moment Restrictions in Dynamic Panel Data Models, Journal of Econometrics, 87(1), 115-143.

Budak, Hüseyin, ve Semra, Erpolat. (2012), “Kredi Riski Tahmininde Yapay Sinir Ağları ve Lojistik Regresyon Analizi Karşılaştırması”, Online Academic Journal of Information Technology, 3(9), 23-30.

Castro, Vitor. (2013), “Macroeconomic Determinants of the Credit Risk in the Banking System: The Case of the GIPSI”, Economic Modeling, 672-683.

Chaibi, Hasna, and Ftiti, Zied. (2015), “Credit Risk Determinants: Evidence from A Cross-country Study”, Research in International Business and Finance, 33, 1-16.

Çetinkaya, Harun. (2019). “Bankacılık Sektöründe Kredi Riskinin Temel Belirleyicilerine Yönelik Ampirik Bir Çalışma”, İktisat Politikası Araştırmaları Dergisi, 6(2), 121-134.

Genç, Erhan ve Şaşmaz, Mahmut Ü. (2016). “Takipteki Banka Kredilerinin Makroekonomik Belirleyicileri: Ticari Krediler Örneği”, Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 36, 119-129.

Gosh, Amit. (2015), "Banking-industry Spesific and Regional Economic Determinants of Non-performing Loans: Evidence from US States", Journal of Financial Stability, 20, 93-104.

Jakubik, Petr, and Schmieder, Christian. (2008), "Stress Testing Credit Risk: Comparison of the Czech Republic and Germany", BIS Financial Stability Institute Paper, September.

Kabataş, Yaşar ve Karamustafa, Cemal. (2019). "Tüketici Kredilerinde Takipteki Kredi Oranlarının Makroekonomik ve Bankalara Özgü Belirleyicileri: Türkiye Örneği", Marmara Sosyal Araştırmalar Dergisi, 15, 1-17.

Kavcıoğlu, Şahap. (2011), "Ticari Bankacılıkta Kredi Riskinin ve Kredi Riski Ölçüm Modellerinin Değerlendirilmesi", Finansal Araştırmalar ve Çalışmalar Dergisi, 3(5), 11-19.

Koçyiğit, Seyhan Ç., ve Demir, Aysel. (2014), "Türk Bankacılık Sektöründe Kredi Riski ve Yönetimine İlişkin Bir Uygulama: Türkiye Garanti Bankası Örneği", Journal of Business Research Turk, 6(3), 222-246.

Louzis, Dimitrios P., Vouldis, Angelos T., and Metaxas, Vasilios L. (2012), Macroeconomic and Bank-specific Determinants of Non-performing Loans in Greece: A Comparative Study of Mortgage, Business and Consumer Loan Portfolios", Journal of Banking and Finance, 36, 1012-1027.

Manab, Norlida A., Theng, N. Yen, and Md-Rus, Rohani. (2015), "The Determinants of Credit Risk in Malaysia", Procedia – Social and Behavioral Science, 172, 301-308.

Mileris, Ricardas. (2012), "Macroeconomic Determinants of Loan Portfolio Credit Risk in Banks", Engineering Economics, 23(5), 496-504.

Misman, Faridah N., Bhatti, Ishaq, Lou, Weifang, Samsudin, Syansyul, and Abd Rahman, N. Hadaliza. (2015), "Islamic Banks Credit Risk: A Panel Study", Procedia – Economics and Finance, 31, 75-82.

Nkusu, Mwanza. (2011), "Nonperforming Loans and Macrofinancial Vulnerabilities in Advanced Economies", IMF Working Paper, No. WP/11/161, July.

Roodman, David. (2006). "How to Do xtabond2: An Introduction to "Difference" and "System" GMM in Stata", Center for Global Development Working Paper, No:103, December.

Roodman, David. (2008). "A Note on the Theme of Too Many Instruments", Center for Global Development Working Paper, No: 125, May.

Tunay, K. Batu. (2012), "Banka Kredi Portföylerinin Yönetiminde Ödememe Riski Analizi: Kalman Filtresine Dayanan Alternatif Bir Yöntem Önerisi", Finansal Araştırmalar ve Çalışmalar Dergisi, 3(6),56-63.

Tunay, K. Batu. (2015), "Kredi Portföylerinde Sektörel Yoğunlaşma ve Risk İlişkisi: Türk Ticari Bankacılık Sektörü Üzerine Bir Analiz", BDDK Bankacılık ve Finansal Piyasalar Dergisi, 9(1), 127-147.

Tunay, Necla, Özataç, Nesrin, Hamedian, Bahmanyar, Tunay, K. Batu. (2021). "Interaction of Credit Risk and Macroeconomic Variables in Turkey: A Dynamic Empirical Analysis", 5th International Conference on Banking and Finance Perspectives, Eastern Mediterranean University and University of Bedfordshire Business School, April, North Cyprus.

Vogiazas, Sofoklis D., and Nikolaidou, Eftychia. (2011), "Investigating the Determinants of Nonperforming Loans in the Romanian Banking System: An Empirical Study with Reference to Greek Crisis", Economics Research International, 2011, 1-13.

Yurdakul, Funda. (2014), "Macroeconomic Modeling of Credit Risk for Banks", Procedia – Social and Behavioral Science, 109, 784-793.

Yüksek, Aydın. (2019). "Türk Bankacılık Sektöründe Kredi Riskinin İçsel Belirleyicileri", SOBİDER Sosyal Bilimler Dergisi, 6(35), 195-210.

Zhu, Ning, Wang, Bing, and Wu, Yanrui. (2015), "Productivity, Efficiency, and Non-performing Loans in the Chinese Banking Industry", The Social Science Journal, 52, 468-480.

How to cite this article: Tunay, K. B. & Akhisar, İ. (2021). Determinants of Credit Risk in the Turkish Commercial Banking Sector: New Findings. *International Journal of Insurance and Finance, 1*(2), 39-49. https://doi.org/10.52898/ijif.2021.9