MODEL FACTORS AFFECTING CREDIT RISK AT VIETNAMESE COMMERCIAL BANKS

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Abstract

Of all the business activities of the bank, credit activity is a traditional business and is the most important business activity, bringing the largest proportion of profits for the bank. Tuy nhiên, nó cũng là hoạt động phức tạp, tiềm ẩn nhiều rủi ro nhất. Credit risk can have a significant impact on other business activities and may damage the reputation and position of the bank. Currently, the issue of bank credit risk has become the concern of many domestic and foreign researchers in various aspects. Many empirical studies have shown that bank credit risk is affected by many different factors. Therefore, the research has conducted a study of 20 Vietnamese commercial banks over a 10-year period from 2009 to 2018 through the use of GMM dynamic table data regression method to test 9 factors affecting credit risk of Vietnamese commercial banks. The testing results show that: out of the nine factors introduced in the original research model, 6 factors are affecting bank credit risk, including: NPL ratio in the past, provisioning rate of credit risk, rate of non-interest income, Increasing number of branches and transaction offices of the bank, inflation rate, GDP growth rate . There are 3 factors including: Operating expense ratio, the credit growth rate, Bank size are not statistically significant. With these research results, the article will be a scientific basis for the State management agencies to have support policies to limit credit risks for Banking industry of Vietnam in the period of international economic integration.

Keywords: credit risk, impact factor, Vietnamese commercial banks**.**

1. Introduction

Commercial banks are enterprises operating in the monetary field, mainly operating as deposit taking and lending activities. In the lending process, many uncertainties may occur. In other words, the bank's business activities are always risky, especially risks in lending activities (credit risks). In Vietnam, loans often account for a large proportion (over 70% of asset value), so Vietnamese commercial banks are "sensitive" to credit risk. Therefore, credit risk is the most important risk of commercial banks in Vietnam, it affects the profitability and safety of commercial banks as well as the stability of the whole banking system. In fact, over the past years, the Vietnamese commercial banking system has implemented many synchronous and implemented measures throughout the system to enhance credit risk restriction and prevention, but for many reasons, in which the main reason leading to the increase in the ratio of bad debts in 2012 to 2015 is that many bad debts will continue to appear in 2016 despite the declining NPL ratio. Especially the weaknesses in the prevention and limit of credit risks have caused the "loss" of staff, the bank's income has been increasingly reduced in 2012 to 2015. Not only that, the competitiveness of Vietnamese commercial banks is also reduced compared to other banks in the region and in the world; Although in the 3 years from 2016 to 2018 after the implementation of the restructuring project, the system of Vietnamese commercial banks has recovered, but there is still a negative balance in a part of public opinion, affecting the ability to meet credit capital for the economy. In order to continue implementing the scheme of restructuring Vietnamese credit institutions under the Prime Minister's decision, at the same time, so that the Vietnamese commercial bank system is highly competitive, dynamic and implement safe and effective business objectives; Researching to find out the causes that affect credit risk, from that, propose solutions to prevent and limit credit risks in business activities of Vietnamese commercial banks is extremely necessary.

2. Overview of research on factors affecting credit risk of commercial banks

When analyzing the factors affecting credit risk, there are many schools offering different groups of factors depending on the measures of credit risk of commercial banks. But most studies suggest that commercial banks' credit risk can be measured through the ratio of bad debts. Typically, Abhiman Das and Saibal Ghosh (2007) when studying State Commercial Banks in India between 1994 and 2005 gave the factors affecting credit risk including micro factors and the macro factors: GDP growth, bank size, real bank credit growth, bank operating costs. And Yurdakul Funda (2014) is only based on macro factors including: inflation rate, interest rate, ISE-100 index,

foreign exchange rate, GDP growth rate, money supply, unemployment rate. And Ravi Prakash Poudel & Sharma Poudel (2013) studied 31 commercial banks in Nepal in the period 2001-2011, the regression results showed that there are 4 factors affecting the bank's credit risk: Gross domestic product (GDP), inflation rate, money supply, interest rate market, exchange rate fluctuations. Most recently, Nguyen Quoc Anh and Nguyen Huu Thach (2015) used dynamic table data regression (GMM) to study the factors affecting credit risk through the bad debt ratio of 26 commercial banks. Vietnam in the period of 2005 to 2013. The research results show that two groups of factors affecting credit risk: (i) Macro factors include: GDP growth rate, inflation rate, unemployment rate, exchange rate rate, nominal interest rate. (ii) Micro factors include: NPL ratio of banks in the past, ROE, non-interest income, leverage ratio. In addition, Nguyen Thi Hong Vinh (2015) has built two models including factors affecting credit risk of commercial banks through the bad debt ratio of 22 commercial banks in Vietnam during 2007 to 2014. The estimation results show that micro factors including: NPL ratio of banks in the past, profitability, bank size and credit growth all affect the bank's bad debt ratio and are statistically significant; Other factors such as equity, loans/deposits, and short-term loans are not statistically significant. Macro factors include: economic growth is negatively related to the bad debt ratio with statistical significance of 1%, while the inflation rate is not statistically significant.

3. Research models and hypotheses

Through an overview of the factors affecting credit risk of commercial banks in general, the topic is the factors affecting credit risk of Vietnamese commercial banks, therefore, The research model has the following form:

$$\mathbf{Y_t = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \varepsilon t}$$

In which:

Yi: dependent variable (Credit risk measured in bad debt ratio of year t)

β0, β1 β2 ... β9: regression constant

X1; X2 ... X9: Independent variables are as follows:

Table 1. Independent variables encrypted

Variable name		Encode
Micro	X1: NPL ratio of banks in the past	L1.TLNX
	X2: Credit growth rate	TTTD
	X3: Provisioning rate of credit risk	DPRRTD
	X4: Bank size	QMNH
	X5: Operating expense ratio of the bank	CFHD
	X6: The rate of non-interest income of the bank	TNNL
	X7: Increasing number of branches and transaction offices of the bank	TTCN
Macro	X8: GDP growth rate	TTGDP
	X9: Inflation rate	LP

Source: The research and synthesis of the author

From the above research model, the author offers the following research hypotheses:

Hypothesis	Content	Expected
H1	NPL ratio of banks in the past with a one-year delay has a positive impact on the current NPL ratio of the bank	+
H2	Credit growth rate has a negative impact on the bank's credit risk	-
H3	Provisioning rate of credit risk has a positive impact on the bank's credit risk	+
H4	Bank size has a positive impact on the bank's credit risk	+
H5	Operating expense ratio of the bank has a positive impact on the bank's credit risk	+
H6	The rate of non-interest income of the bank has a negative impact on the bank's credit risk	-
H7	Increasing number of branches and transaction offices of the bank has a positive impact on the bank's credit risk	+
H8	GDP growth rate has a negative impact on the bank's credit risk	-
H9	Inflation rate has a positive impact on the bank's credit risk	+

Source: Synthesis of the author

4. Research method and data analysis process

The estimation methods that are most used in empirical studies with table data are FEM fixed impact model and REM random impact model. After analyzing the FEM and REM impact

models, Hausman will be tested to evaluate and select FEM or REM models. However, the FEM and REM estimates have the disadvantages that the variance of error of change is very difficult to overcome and there are endogenous variables in the research model. To overcome the ineffectiveness of FEM and REM estimates, previous studies conducted pre-test for defects of the research models and then used GMM to analyze the direction of impact.

With the goal of studying the factors affecting the bad debt ratio of banks by the array data set for 10 years from 2009 to2018 of 20 Vietnamese commercial banks, the author uses Stata software 14.0 for analysis. The data analysis is performed in the following order:

Step1: Testing the multi-collinear phenomenon, if there is the multi-collinearity phenomenon of the variables, it is separated into a separate model to test.

Step 2: Estimate the impact of the fixed model (FEM) and the random model (REM) for each study model to select the appropriate FEM or REM impact estimates to be used for the next analysis.

Step 3: Based on the estimation of the FEM or REM model suitable for the study, the author conducted a test of the autocorrelation phenomenon and variance of error of change with each research model.

Step 4: GMM estimation to overcome the FEM or REM estimation defect of the variance of error of change and endogenous variables in the research model.

5. Research results

5.1. Analysis results of research samples

Table 2. Descriptive statistics of research sample

Variable	Mean	Std. Deviation	Minimum	Maximum
TLNX	2.258479	1.490324	0.00	11.4
TTTD	26.81465	25.18816	-30.7114	124.5746
DPRRTD	1.46358	0.8424564	0.1538294	8.524312
QMNH	215294.6	255041.2	5841	1258256
CFHD	1.613627	0.5125152	0.2213935	3.202497
TNNL	20.0692	14.28425	-17.45530	78.57623
TTCN	2.83	9.032627	-53	53
TTGDP	6.035	0.60	5.03	6.9
LP	8.31	0.5980548	2.06	16.9

Source: Author calculated from Stata software 14.0

NPL ratio is the dependent variable in this study. Looking at table 2, the mean of TLNX is 2,25%, the standard deviation is 1,49% with minimum is 0.00% and maximum is 11,4% of commercial banks in 10 years from 2009 to 2018. Credit growth (TTTD) is the second independent variable in the model. The statistical results show that the credit growth of banks in 10 years from 2009 to 2018 has mean of 26,8%, with minimum is 30,71% and maximum is 124,57% with a standard deviation of 25,19%.

Bank size (QMNH) is the fourth independent variable in the model. The size between banks has high difference with the standard deviation of 255041.2, the mean of banks is VND 215294.6 billion, minimum is VND 5841 billion and maximum is VND 1258256 billion according to the 10-year statistics from 2009 to 2018.

Provisioning rate of credit risk (DPRRTD) is the third independent variable in the model. According to statistics, DPRRTD of commercial banks in 10 years from 2009 to 2018 has mean of 1,46% with minimum is 0,16% and maximum is 8,52%.

Operating expense ratio (CFHD) in 10 years from 2009 to 2018 is the fifth independent variable in the model. Statistical results show that CFHD has mean of 1,61%, with minimum is 0,22% and maximum is 3,20%.

The ratio of non-interest income (TNNL) of banks in 10 years from 2009 to 2018 has a big difference between the banks with minimum is 17,45% and maximum is 78,57% with mean of 20,07%.

Increasing number of branches and transaction offices of the bank (TTCN) is the 7th independent variable in the model. The branch growth of banks in the 10 years from 2009 to 2018 has mean of 2,83 branches, with minimum is 53 branches and maximum is 53 branches.

The GDP growth rate (TTGDP) is an independent macroeconomic variable. According to statistics, the average GDP growth rate for 10 years from 2009 to 2018 was 6,035% with the lowest growth rate of 5,03% and the highest growth rate of 6,9% with standard deviation is 0,60%.

The last macro independent variable in the model is the inflation rate (LP). The inflation rate in 10 years from 2009 to 2018 has mean of 8,31% with minimum is 2,06% and maximum is 16,9%.

5.2. Results of correlation analysis between the variables

To analyze the data in Stata 14.0, you must first convert the QMNH variable to the Logarite QMNH variable according to the command in Stata: genlog_QMNH = log (QMNH) and assign the name tag to this variable SIZE

Table 3. Correlation coefficient matrix between variables

	L1.TLNX	TTTD	DPRRTD	SIZE	CFHD	TNNL	TTCN	TTGDP	LP
L1.TLNX	10.000								
TTTD	-0.0553	10.000							
DPRRTD	**0.3174**	-0.2373	10.000						
SIZE	-0.0373	-0.2846	0.3163	10.000					
CFHD	0.0457	-0.2385	0.0987	-0.0509	10.000				
TNNL	-0.0570	0.1631	0.0746	0.1025	-0.2171	10.000			
TTCN	0.0629	0.0541	0.0496	0.0654	-0.0348	0.0867	10.000		
TTGDP	-0.1718	-0.0500	-0.0152	0.1991	-0.1458	0.0514	0.0021	10.000	
LP	-0.0651	0.0275	-0.0266	-0.1950	-0.1163	-0.1261	0.0578	-0.0904	10.000

Source: Synthesis of the author

Correlation analysis shows whether the variables in the research model have a correlation. The correlation coefficient has a value of -1 to 1. If the correlation coefficient is 0 or approximate to zero, the two variables are considered to have no correlation, but if the correlation coefficient is 1, there is an absolute correlation. The results shown in Table 3 show that the correlation coefficients between the variables are nonzero, the largest correlation value is 0.3174. Thus, among the variables in the research model, the correlation with correlation coefficients is low. However, if the correlation coefficient is greater than 0.7, the collinearity phenomenon is more likely to occur.

5.3. Test results of multi-collinear phenomena

In the next step, the author conducts the multi-collinearity test, the results of data analysis give the following table results:

Table 4. Test of the multi-collinearity of the variables

Biến	VIF	1/VIF
SIZE	83.35	0.011394
TTGDP	71.27	0.017031
CFHD	9.47	0.095372
DPRRTD	5.24	0.186796
L1.TLNX	3.67	0.271045
TNNL	3.24	0.304837
LP	2.98	0.335259
TTTD	2.38	0.420919
TTCN	1.15	0.890420
VIF average value	20.42	

Source: Synthesis of the author

Multi-collinearity test of variables with VIF <10, the variables do not have multi-collinear phenomena. Table 4 of the multi-collinearity test results of the variables shows that the coefficients of SIZE and TTGDP variables are > 10. Therefore, the variables SIZE and TTGDP have multi-collinear phenomena, so separating the variables SIZE and TTGDP from the research model, then running the results again, shows that the remaining variables have VIF <10. Therefore, there are three models of research regression that need to be tested:

Model 1: $TLNX_{i,t} = \beta_1 TLNX_{t-1} + \beta_2 TTTD_t + \beta_3 DPRRTD_t + \beta_4 TTCN_t + \beta_5 CFHD_t + \beta_6 TNNL + \beta_7 LP + \varepsilon_{I,t}$

Model 2: $TLNX_{i,t} = \chi SIZE_t + \mu_{I,t}$

Model 3: $TLNX_{i,t} = \delta_1 TTGDP + \lambda_{i,t}$

5.4. Estimated results

5.4.1. Testing the first model

Model 1:

$$\mathbf{TLNX_{i,t} = \beta_1 TLNX_{t-1} + \beta_2 TTTD_t + \beta_3 DPRRTD_t + \beta_4 TTCN_t + \beta_5 CFHD_t + \beta_6 TNNL + \beta_7 LP + \varepsilon_{I,t}}$$

To test the impact of factors on the table data model, the author first estimated the fixed impact model FEM.

- **Estimated FEM**

Table 5. Results of FEM testing

TLNX	Regression coefficient	Standard error	t	P > t	95% confidence intervals	
L1.TLNX	0.4024639	0.0684631	5.85	0.000	0.2672282	0.5376603
TTTD	-0.0067812	0.0041663	-1.61	**0.108**	-0.0150456	0.0014638
DPRRTD	0.3665772	0.1475926	2.45	0.014	0.0749743	0.6580302
CFHD	0.7186719	0.2305307	3.12	0.002	0.2634576	1.174.454
TNNL	0.027485	0.0086510	3.18	0.002	0.0106103	0.0442528
TTCN	0.015054	0.0100273	1.55	**0.124**	-0.004601	0.035108
LP	0.0617552	0.0187275	3.32	0.001	0.0248382	0.0986585
Constant	-1.147064	0.5389144	-2.13	0.035	-2.215740	-0.0824932

Source: Authors' calculations

FEM model estimate results for Prob> F = 0.0000; The variables are statistically significant except for TTTD and TTCN with P > 10% are not statistically significant.

- **Estimated REM**

Next, the author conducts an estimate of the REM model. The estimation results are reflected in the following table:

Table 6. Results of REM model tests

TLNX	Regression coefficient	Standard error	t	P	95% confidence intervals	
L1.TLNX	0.4880831	0.0625334	7.84	0.000	0.3660724	0.6102325
TTTD	-0.0037764	0.0037715	-1.00	**0.314**	-0.0110619	0.0037942
DPRRTD	0.289275	0.116937	2.48	0.013	0.0607278	0.5194177

CFHD	0.5025626	0.1846892	2.72	0.007	0.1405739	0.8645484
TNNL	0.0182436	0.0067692	2.70	0.007	0.0049863	0.0318614
TTCN	0.012355	0.0095754	1.29	**0.192**	-0.0064025	0.0311427
LP	0.0573329	0.0186432	3.08	0.002	0.0207308	0.0936761
Constant	-0.7607536	0.462791	-1.64	0.100	-166.720	0.146540

Source: Authors' calculations

The estimation results of the REM model show that all factors influence the bad debt ratio except for TTTD and TTCN with P > 10% is not statistically significant.

- **Select the appropriate estimate:**

In order to choose the FEM model or REM model is appropriate, the next step the author conducted Hausman test. The results of the FEM model and the REM model comparison are as follows:

Table 7. Results of estimating factors

TLNX	Fixed impact (b)	Random impact (B)	Different (b-B)	S.E.
L1. TLNX	0.4024449	0.4880535	-0.0856087	0.0284817
TTTD	-0.0067711	-0.0037365	-0.0030345	0.0018393
DPRRTD	0.3665274	0.289872	0.0766554	0.0900666
CFHD	0.7189709	0.5025641	0.2164068	0.1380317
TNNL	0.027155	0.0182739	0.0088812	0.0053836
TTCN	0.015304	0.012385	0.002919	0.0029348
LP	0.0617958	0.0573337	0.0044621	0.0015558

Source: Authors' calculations

Hypothesis test Ho: There is no difference

Result: Chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 21.93; Prob>chi2 = 0.0026

The Hausman test result for Prob> chi2 = 0.0026 shows that P <5% should refute the hypothesis Ho means that the difference between REM model and FEM model is consistent with

the data of the analysis table of this study. Thus, with equation 1, the FEM model is suitable for analysis.

Next, the author examines the multi-collinear phenomena, the autocorrelation and the variance of changes in the estimates.

Testing the phenomenon of multi-collinearity with the VIF command: The results show that the coefficients of the variables in the first equation are < 10, the variables do not have multi-collinear phenomena.

Testing of variance of error of change: In order to test the variance of error of change, we execute the command xttest 3, the results of data verification are as follows:

Modified Wald test in FEM model

Hypothesis Ho: no variance of error of change

Result: chi2(20) = 1639.97; Prob > chi2 = 0.0000

The result of testing the variance of error of change has P <5%, so it rejects the Ho hypothesis and accepts hypothesis H1. The conclusion is that FEM estimates have a variance of error of change.

Testing of autocorrelation of research data: Using the xtserial command, the following results are obtained: Wooldridge test for autocorrelation in table data.

Hypothesis Ho: There is no autocorrelation

Result: F (1,19) = 41.601; Prob > F = 0.0000

The test result has P <5%, so it can reject the Ho hypothesis and accept hypothesis H1 or the research data has the autocorrelation phenomenon. Therefore need to overcome the phenomenon of self correlation. To fix the autocorrelation phenomenon we execute the command Xtregar. The testing results are as follows:

Table 7. Results of the autocorrelation test of FEM model

TLNX	Correlation coefficients	Standard error	t	P	95% confidence intervals	
L1.TLNX	**0.352851**	0.0776139	4.55	0.000	0.1993337	0.5063683
TTTD	-0.0022337	0.0059879	-0.37	0.710	-0.0140775	0.0096101
DPRRTD	**0.3241014**	0.1618677	2.00	0.047	0.0039334	0.6442694

CFHD	**0.8189183**	0.2834049	2.89	0.005	0.2583543	1.379.482
TNNL	0.0346913	0.0100453	3.45	0.001	0.014822	0.0545606
TTCN	0.011825	0.0105052	1.13	0.262	-0.0089538	0.0326038
LP	0.058973	0.0206502	2.86	0.005	0.0181277	0.0998183
Constant	-1.299.981	0.5934809	-2.19	0.030	-2.473863	-0.1260984

Source: Authors' calculations

The analytical results show that there are independent variables with P <10% except for the variables TTTD, TTCN. The research results show that factors such as “NPL ratio in the past with a one-year delay; Provisioning rate of credit risk; Operating expense ratio; The rate of non-interest income; Inflation rate” has a positive impact with “the current NPL ratio of the bank”. In which factor “Operating expense ratio” has the strongest impact with a correlation coefficient of 0.819, The next one is the factor "NPL ratio in the past with a one-year delay" with a correlation coefficient of 0.353 and finally, the factor " Provisioning rate of credit risk" with a correlation coefficient of 0.324.

- **GMM estimates:**

The estimation of GMM overcoming the defects of FEM and REM estimates is the variance of error of change, the autocorrelation of variables in the research model. In addition, there are also endogenous variables in the study. Endogenous variables are the phenomenon of explanatory variables in a state that is not completely independent from the explanatory variables, but has a two-way effect on the explanatory variables. Estimating GMM will overcome the variables in the study with endogenous variables that estimate FEM, REM is not effective. The endogenous variables in this study are operating expense ratio (CFHD) and credit growth (TTTD). In fact, the increase in the ratio of bad debts will increase the cost of dealing with bad debts or increase the ratio of operating expenses (CFHD) and the banks will tighten credit so credit growth will be reduced. Therefore, factors of CFHD, TTTD are endogenous variables of the model. The GMM estimation is performed with the xtabond2 statement through 2 steps, the estimated results are as follows:

Table 8. Estimated results by GMM method

Factors	**NPL ratio ($TLNX_{t)}$**		**NPL ratio ($TLNX_{t)}$ twostep**	
	Correlation coefficients	P-value	Correlation coefficients	P-value
L1.TLNX	0.4499267	0.001	0.3914464	0.000

TTTD	0.000657	0.934	-0.0036219	0.248
DPRRTD	1.226.221	0.066	112.214	0.001
CFHD	0.8153047	0.276	0.4029399	0.269
TNNL	0.0177544	0.426	0.0169259	0.000
TTCN	0.0252058	0.529	0.0632193	0.016
LP	0.0600024	0.062	0.0384414	0.010
	Wald chi2 (7) = 34.75 Prob > chi2 = 0.000 Arellano-Bond test for AR(2) in first differences: z = 1.81 Pr > z = 0.070 Sargan testchi2 (1) = 1.47 Prob > chi2 = 0.225		Wald chi2(7) = 2172.61 Prob > chi2 = 0.000 Arellano-Bond test for AR(2) in first differences: z = 1.12 Pr > z = 0.262 Sargan testchi2(10) = 28.55 Prob > chi2 = 0.001	

Source: Authors' calculations

According to the table of GMM estimation results shows the factors “NPL ratio in the past with a one-year delay, provisioning rate of credit risk, the rate of non-interest income, Increasing number of branches, Inflation rate” has impact with “the current NPL ratio of the bank”. The remaining factors include: “Credit growth rate, Operating expense ratio” do not show a statistically significant relationship with “the current NPL ratio of the bank”.

5.4.2. Testing the second model

Model 2: $\mathbf{TLNX}_{i,t} = \chi \mathbf{SIZE}_t + \mu_{I,t}$

Carrying out the test similar to the first model, the author first tested the FEM model and the REM model, then tested Hausman to select the appropriate impact estimation model.

Results Hausman has Prob > Chi2 = 0.6464 with P> 5%, so it is acceptable that the Ho hypothesis or REM model is suitable.

With REM estimation, the author conducted multi-collinearity testing and the autocorrelation phenomenon in the second model.

Multicollinearity test with VIF statement, research results show that the SIZE variable has a coefficient of 1.00 <10 so there is no multicollinearity phenomenon. Using the xtserial command to perform Wooldridge test for autocorrelation in the model, we get the following results:

Wooldridge test for autocorrelation in table data

Hypothesis Ho: There is no autocorrelation

Result: F (1,19) = 107.685; Prob > F = 0.0000

With P <5%, the Ho hypothesis should be rejected and accepting H1 hypothesis means that there is a self-correlation in the research model. To fix the autocorrelation phenomenon we execute the command Xtregar. The following result:

Table 9. Autocorrelation test results of the second model

TLNX	Correlation coefficients	Standard error	t	P	95% confidence intervals
SIZE	-0.0929154	0.1215158	-0.76	**0.426**	-0.3310819 0.1452512
Constant	3.341.467	1.423.877	2.35	0.019	0.5507184 6.132216

Source: Authors' calculations

The results show that the SIZE variable with P = 0.426> 5% is not statistically significant, or not enough to confirm the impact of the SIZE bank factor on the current NPL ratio of the bank (TLNX).

5.4.3. Testing the third model

Model 3: $\mathbf{TLNX}_{i,t} = \delta_1 \mathbf{TTGDP} + \lambda_{i,t}$

For the third model, the author proceeds similarly to the first and second models. The author first tests FEM and REM models and then tests Hausman to choose the appropriate models. Hausman results give: Prob> Chi2 = 1.0000 so REM estimates are appropriate.

The study conducted multi-collinearity test, the result of testing the VIF coefficient of TTGDP variable <10, variables without multi-collinear phenomenon. Next, the author tests the autocorrelation of variables in the research model with Xtserial statement, the results are as follows:

Wooldridge test for autocorrelation in table data

Hypothesis Ho: There is no autocorrelation

Result: F (1,19) = 98.621; Prob > F = 0.0000

For P <5%, the Ho hypothesis should be rejected and the H1 hypothesis should be accepted. Research results show that there is a correlation in the research model. To fix the autocorrelation phenomenon we execute the command Xtregar. The following results:

Table 10. Autocorrelation test results of the third model

TLNX	Correlation coefficients	Standard error	t	P	95% confidence intervals	
TTGDP	**-0.2817503**	0.1420501	-1.98	0.047	-0.5601339	-0.0033079
Constant	3.98059	0.8791896	4.53	0.000	2.25741	5.70377

Source: Authors' calculations

The results of the autocorrelation test in the above table show that the TTGDP factor has a negative impact on the current NPL ratio of the bank with an coefficient of -0.282.

Table 11. Test results of three models

Variables	Model 1	Model 2	Model 3
L1.TLNX	**0.371*** **		
TTTD	-0.00362		
DPRRTD	**1.142*** **		
CFHD	0.403		
TNNL	**0.0149*** **		
TTCN	**0.0652** **		
LP	**0.0342** **		
Constant	-1.457		
SIZE		-0.0929	
Constant		3.341***	
TTGDP			**-0.282*** **
Constant			3.682***

Source: Extracted from Stata 14.0

(Standard errors in parentheses: ***p < 1%, **p < 5%, *p < 10%)

The analytical results in Table 11 show that:

The first regression equation has the form:

$$\mathbf{TLNX_{i,t} = 0.371* TLNX_{t-1} + 1.142*DPRRTD_t + 0.0149*TNNL +}$$

$$\mathbf{0.0342* LP + 0.0652*TTCN - 1.457}$$

The second regression equation has the form: $\mathbf{TLNX_{i,t} = - 0.282* TTGDP + 3.682}$

6. Conclusion

Analyzing the table data collected from 20 commercial banks in 10 years from 2009 to 2018, the analytical results summarized in Table 11 show: factors "NPL ratio in the past with a one-year delay ($TLNX_{t-1}$); Provisioning rate of credit risk (DPRRTD); The rate of non-interest income (TNNL); Increasing number of branches and transaction offices (TTCN); Inflation rate (LP); GDP growth rate (TTGDP)" have a significant impact on "the current NPL ratio of the bank". Among these factors, there are factors "GDP growth rate" have an opposite impact on "the current NPL ratio of the bank". The positive impact factor, which has the strongest influence on the bad debt ratio of the bank, is the factor "Provisioning rate of credit risk" with the coefficient of 1,142; The next is the factor "NPL ratio in the past with a one-year delay" with the coefficient of 0.371. The remaining variables in the research model are "Credit growth rate (TTTD); Operating expense ratio (CFHD); Bank size (SIZE)" is not statistically significant so they are disqualified.

With the above analysis results, the initial hypotheses presented in the study have 6 hypotheses that are statistically significant and accepted and 3 hypotheses that are not statistically significant.

Table 12. Summary of test results of research hypotheses

Hypotheses		**Coefficient**	**Conclusion**
H1	NPL ratio of banks in the past with a one-year delay has a positive impact on the current NPL ratio of the bank	0.371	Accept
H2	Credit growth rate has a negative impact on the bank's credit risk	-0.00362	No statistical significance
H3	Provisioning rate of credit risk has a positive impact on the bank's credit risk	1.142	Accept

H4	Bank size has a positive impact on the bank's credit risk	-0.0929	No statistical significance
H5	Operating expense ratio of the bank has a positive impact on the bank's credit risk	0.403	No statistical significance
H6	The rate of non-interest income of the bank has a negative impact on the bank's credit risk	0.0149	Accept
H7	Increasing number of branches and transaction offices of the bank has a positive impact on the bank's credit risk	0.0652	Accept
H8	GDP growth rate has a negative impact on the bank's credit risk	- 0.282	Accept
H9	Inflation rate has a positive impact on the bank's credit risk	0.0342	Accept

Source: Synthesis of the author

In summary, the research results based on the regression equation show that out of 9 factors given in the original research model, 6 factors are impacts on bank credit risk including: NPL ratio of banks in the past; Provisioning rate of credit risk; The rate of non-interest income; Increasing number of branches and transaction offices of the bank; Inflation rate; GDP growth rate. There are 3 factors: Operating expense ratio of the bank; Credit growth rate; Bank size are not statistically significant.

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APPENDIX

LIST OF 20 COMMERCIAL BANKS IN VIETNAM

Order	Trading name	Bank name
1	NCB	National Citizen bank
2	NamABank	Nam A Commercial Joint Stock Bank
3	HDBank	Ho Chi Minh City Development Joint Stock Commercial Bank
4	Eximbank	Viet nam Export Import Joint Stock Commercial Bank
5	VPBank	Vietnam Joint Stock Commercial Bank for Private Enterprise
6	SCB	Sai Gon Joint Stock Commercial Bank
7	VIB	Vietnam International Joint Stock Commercial Bank
8	OCB	Orient Joint Stock Commercial Bank
9	SHB	Saigon-Hanoi Joint Stock Commercial Bank

10	MSB	The Maritime Joint Stock Commercial Bank
11	MB	Military Joint Stock Commercial Bank
12	Techcombank	Viet Nam Technological and Commercial Joint Stock Bank
13	Sacombank	Saigon Thuong Tin Joint Stock Commercial Bank
14	LPB	LienViet Commercial Joint Stock Bank– Lienviet Post Bank
15	ABB	An Binh Joint Stock Commercial Bank
16	ACB	Asia Joint Stock Commercial Bank
17	BIDV	Joint Stock Commercial Bank for Investment and Development of Vietnam
18	VCB	Joint Stock Commercial Bank for Foreign Trade of Vietnam
19	Vietinbank	Vietnam Joint Stock Commercial Bank of Industry and Trade
20	Agribank	Vietnam Bank for Agriculture and Rural Development