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Assessing the Credit Risk of Commercial Banks in Vietnam

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Bad debt has reached alarming rates recently in Vietnam. Since late 2008, the economy has suffered a number of negative impacts because of the global financial crisis and economic slowdown, including declining in economic growth, substantial difficulty in production and business activities of enterprises and a loss of business confidence. Banking operations are severely impacted by the reduction of credit quality and the increase in bad debts. Based on scenario analysis, this paper carries out stress tests to analyse the impact of macro conditions on the credit risk of Vietnamese commercial banks and finds that there is a negative relationship between NPL ratio and GDP growth. Furthermore, the paper also uses Credit Risk+ to calculate maximum credit loss for Vietnamese banking sector in the worst case scenario and reveals that the commercial banks cannot absorb credit losses under adverse macro scenarios. These losses could threaten the stability of the financial system.

JEL Codes: F34, G21 and G24

1. Introduction

The recent crisis has caused banking collapse in many countries. Now, Vietnamese commercial banks are in trouble with high non-performing loan ratio. Obviously, the banks play the lender role in the economy. Macroeconomic fluctuations will affect the business activities of corporations. These corporations are also bank's customers. Unless they could meet their debt obligations, the bank's income would be worsened. If credit risk happened seriously and the banks didnot have enough capital to compensate for losses of depositors, the credit loss could make the banks out of business. Thus assessing credit loss under adverse macroeconomic scenarios is necessary to fully understand the financial health of Vietnamese commercial banks. It is helpful for policy makers to make timely decision and to ensure the safety of the entire banking system; therefore, this paper will clearly answer the question: Could Vietnamese commercial banks have an ability to absorb credit loss if adverse macroeconomic scenarios happened?

The financial crisis also highlighted the use of macroeconomic stress testing as an important risk management tool. Stress testing is a technique measuring the volatility of asset portfolio, organizations or entire financial system under adverse scenarios. It has been popularly used by risk practitioners in large banks since World Bank and IMF carried out the Financial Sector Assessing Program (FSAP) in 1990. Stress testing helps financial institutions measure credit risk under unexpected macroeconomic scenarios. The volume of non-performing loans (NPL) in Vietnamese banking system has been increased rapidly since the financial crisis. The rates have prompted rising fears of the risk of a credit bubble in bad economic conditions.

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Vietnam State Bank pumped money to rescue commercial banks from the difficulty of solving bad debt. This can help these banks avoid crash, but cannot make the banking system better. Stress testing Vietnamese commercial banks is significant in determining whether credit loss may occur under adverse economic conditions. Consequently, these institutions can recognise their credit risk and increase capital early to prevent depositors from loss before it is too late.

There are many empirical studies of stress testing on the credit risk of banking in developed countries with various econometric approaches. However, there is not any research on this topic in Vietnam – a new developing country. Hence, the purpose of this paper is to do stress testing to analyse the impact of adverse macroeconomic conditions on the credit risk of commercial banks in Vietnam. The framework consists of three steps. First, a time series econometric method is applied to estimate the relationship between selected macroeconomic variables. The results are used to simulate adverse macroeconomic scenarios for the next two years. Second, a panel data econometric method is applied to estimate the relationship between NPL ratio and GDP growth. The data is the bank-level panel data with eight commercial banks listed in Vietnam covering the period from 2006-2013. Then, the results are used to simulate the quality of credit under these adverse scenarios. Third, this paper explores value of credit loss, using credit value at risk model (Credit VaR).

The paper provides a new empirical literature for Vietnam as it takes advantage of recent advances in modeling the link between the macroeconomic environment and banking default analysis. This result is particularly valuable to analysts and authorities who want to assess the credit risk in Vietnamese banking system. Understanding deeply the resilience of Vietnamese banking system under adverse macroeconomic scenarios helps them assess systemic risk exactly. The policy makers can make timely decision to insure safety for the entire national financial system.

The rest of this paper is organised as follows: Section 2 gives a brief literature review. Section 3 presents the methodology and research model, and Section 4 analyses empirical results. Finally, Section 5 concludes the paper and gives recommendations.

2. Literature Review

Since stress testing was used to analyse banking financial stability in FSAP, several papers have applied it by using macro credit models. These papers have tried to estimate the sensitivities of banking sector balance sheets to dramatic changes in the main macroeconomic variables. The estimated model is used to assess the impact of forward-looking stress scenarios on the financial system. Kalirai and Scheicher (2002) applied this model to analyse stress situation for bank default probability in Austria. They built a time series regression model between the accumulated loan losses and a wide range of macroeconomic variables including GDP, industrial output gap, the consumer price index, the money supply growth rates, the stock market index, exchange rate, exports, and oil prices. Based on the regressions, Kalirai and Scheicher (2002) then studied the hypothetical impact of historical worst cases in key macroeconomic variables. These changes in loan losses were then compared to the risk-bearing capacity of Austrian banking sector as it is captured by its capitalization. The paper found that, in the tentative simulation exercise, the greatest effect amount is up to 1.8% of core capital. However, using a linear model to measure the impact of large shocks is restrictive because in reality, macroeconomic fluctuations may have a nonlinear impact. This model is particularly ill-

suited for stress testing because it will lead to underestimation of the potential credit loss (Missina and Tessier (2007)).

Other studies analysed the macroeconomic determinants of banks' non-performing loans such as Pesola (2001) for the Nordic countries, Delgado and Saurina (2004) for Spain. Typically, these studies found that loan losses are negatively related to GDP growth. Boss (2002) also used the macro credit risk model to analyse the negative macroeconomic pressure on the probability of default in Austrian banks. The paper also found that productivity, an inflation rate, stock index, short-term nominal interest rate and oil price are the determining factors influencing default in loan repayments.

Virolainen (2004) employed Wilson (2004) framework to do stress testing credit risk for Finnish banking. They combined macro credit model and the value at risk (VaR) in order to generate a conditional probability distribution of loss. The default rate for bank loans was directly related to macroeconomic factors including GDP, interest rates, and total debt of the corporate sector in the macro credit model. The estimated coefficients of this model were used to simulate the impact of adverse macro scenarios on the financial system. Monte Carlo method was then adopted to simulate the default probability value in stress situations. The results of the stress tests suggested that Finnish corporate sector credit risk is fairly limited in the current macroeconomic environment. In the paper of Virolainen, the default rates are assumed to be affected by macroeconomic factors, whereas the inverse interaction is not allowed. This restriction is slightly unrealistic and could bias the results of macro stress tests.

3. Methodology

3.1 Data

The macroeconomic variables used in stress tests model are divided into two groups: economic activities (i.e. GDP growth), and monetary conditions and key prices (i.e. base interest rate, total domestic credit to private sector, exchange rate, consumer price Index, interest rate spread) collected from IMF, General Statistics Office of Vietnam and The State Bank of Vietnam. Some of these are only performed with annual observations in IMF database; therefore, additional information from General Statistics Office of Vietnam and The State Bank of Vietnam is combined to collect quarterly observations. These are reliable data sources and adopted by IMF so they are not different in definition. The limited macro variables are selected to construct scenarios. The paper estimates a correlation coefficient for each pair of variables using statistical software STATA and finds that nominal GDP, base interest rate, and total domestic credit to private sector are correlated and have statistically significance. These variables are consistent with the study of Virolainen (2004). The chosen variables are appropriate for Vietnam's economic situation and can explain Vietnamese commercial banks' credit quality.

The selected variables are defined as followed:

i. GDP growth, GDP, is computed by taking the first difference to the natural log of the seasonally adjusted nominal GDP series. It shows the impact of economic activity on credit quality. Nominal GDP is more appropriate for middle-income countries like Vietnam. The reason is that such countries are more often subject to large supply shocks and terms of trade shocks. Such unexpected shocks can force the credibility-damaging abandonment of CPI or exchange rate. But they do not require the abandonment of a nominal GDP,

which automatically divides an adverse supply shock equally between impacts on inflation and real GDP (Frankel and Jeffrey (2014)).

ii. Credit growth, CR, is computed by taking the first difference to the natural log of total domestic credit to private sector. It is adopted to test an impact of customer's borrowing capacity on the debt quality of commercial banks in Vietnam.

iii. Monetary policy rate, NR, is computed by Vietnam base interest rate. It is a tool to control business interest rate of commercial banks and determined by the balance of supply - demand in capital market, the goal of monetary policy.

Macroeconomic data series are available at quarterly frequency, from the fourth quarter of 2007 to the second quarter of 2013. While the length of time series is somewhat short, many important macro events occurs. Credit growth was at the lowest record in 2012 because of weak demand of borrowing, low sale of product, and high inventory. GDP growth fell to 5.03% in 2012, the lowest within 13 years. Base interest rate declined drastically to 7% to prevent economic decline. Table 1 displays the summary statistics.

Table 1: Descriptive statistics for selected variables

Variable	Obs	Mean	Std.dev	Min	Max
Credit growth	22	0.0497157	0.0352623	0.0004537	0.124679
GDP growth	37	0.0356542	0.16733	-0.2303054	0.5460854
Base interest rate	52	0.0836538	0.0132885	0.07	0.14

The paper also uses NPL ratio of commercial banks as a proxy for default rate to assess loan quality of banks because the definition of NPL is similar to the default rate that other researchers have used in their studies. The sample consists of 8 listed commercial banks for a period of eight years (2006-2013). The paper opted for a selection of large banks, having a large amount of NPLs, and available data.

3.2 Methodology

The framework of stress testing consists of three steps in the following order:

Step 1: Macroeconomic model is designed to describe the relationship between macroeconomic variables using VECM analysis. Then, the result is used to simulate the adverse macroeconomic scenarios projected in two years. The model takes the following form:

$$y_t = c + \sum_{s=1}^{p} A_s y_{t-s} + \sum_{s=1}^{q} B_s ce_s + \varepsilon_t \qquad (1)$$

$$\text{Where } y = \begin{bmatrix} NR \\ D.LnCR \\ D.LnGDP \end{bmatrix}$$

Step 2: Microeconomic model is designed to assess loan quality under adverse macroeconomic conditions using panel data analysis. It is based on NPL ratio data of the listed commercial banks in Vietnam from the first quarter of 2006 to the second quarter of 2013. Then, the result is used to simulate NPL ratio under macroeconomic scenarios which are created in step 1.

The relationship between bad debt and GDP growth is selected to examine the impact of business cycles on loan quality. The paper will follow an AR (1) with the logit-transformed NPL ratio of listed commercial bank and s lags of GDP growth rate. The model is as follows:

$$\ln\left(\frac{\mathrm{NPL_{i,t}}}{1-\mathrm{NPL_{i,t}}}\right) = \mu_{\,i} + \alpha \ln\left(\frac{\mathrm{NPL_{i,t-1}}}{1-\mathrm{NPL_{i,t-1}}}\right) + \sum_{s=0}^{S} \beta_{\,t-s} \Delta\ln(\mathrm{GDP})_{t-s} + \varepsilon_{\,i,t} \qquad (2)$$

Where $NPL_{i,t}$ stands for the non-performing loans of each bank i in time t and GDP_t stands for GDP in quarter t. Because the NPL ratio is bounded in the range [0,1], the dependent variable is subject to the logit transform $\ln\left(\frac{\mathrm{NPL_{i,t}}}{1-\mathrm{NPL_{i,t}}}\right)$ to avoid Gaussian problem. The lagged dependent variable is included to explain the persistence of NPLs. The term $\mu_{\,i}$ refers to bank fixed effects. They are treated as stochastic. Idiosyncratic disturbances $\varepsilon_{\,i,t}$ are assumed to be independent between the banks and there is no correlation between time series. The model assumes that the impact of macroeconomic conditions on loan quality is symmetrical and ignores the non-linear effects and feedback effects from credit markets to macroeconomic activity. The coefficient α in equation (2) is expected to be positive but less than one and the coefficient β is expected to be negative to reflect the credit quality deteriorated during the economic downturn.

By the chain rule, the impact of GDP growth shocks on NPL ratios before converting into a logarithm is calculated by the following formula:

Short – run effect: $$\frac{\Delta \mathrm{NPL}}{\Delta\ln(\mathrm{GDP})} = \overline{\mathrm{NPL}} \times (1 - \overline{\mathrm{NPL}}) \times \sum_{s} \beta_{\,t-s} \qquad (3)$$

Long – run effect: $$\frac{\Delta \mathrm{NPL}}{\Delta\ln(\mathrm{GDP})} = \frac{1}{1-\alpha} \times \overline{\mathrm{NPL}} \times (1 - \overline{\mathrm{NPL}}) \times \sum_{s} \beta_{\,t-s} \qquad (4)$$

Step 3: Credit Risk+ is used to ascertain the amount of capital required for Vietnamese banking sector when credit losses occur in bad scenarios.

The difference and the contribution of this paper is that an extended version of Wilson's model is set up. In step 1, the multivariate model is applied to impose feedback effects between macroeconomic variables so the model proposed here seems more realistic than the previous one. The non-linear relationship between macroeconomic variables makes forecasted scenarios be better than using historical scenarios. It helps assess credit risk for banking sector exactly because historical scenarios may not occur in the future. Furthermore, new technique of credit risk measurement (Credit Risk+) is applied. The great advantage of the Credit Risk Plus model is its parsimonious data requirements. The key data inputs are mean loss rates and loss severities, both of which are potentially amenable to collection, either internally or externally. Therefore, it is appropriate when the data of Vietnamese banking system is not sufficient.

4. Results

4.1 Macro Model for Building Scenarios

Dickey-Fuller test is used to test time series data for stationarity. The paper finds that the set of data is nonstationary. The series are cointergated so VECM model is applied to examine the relationship between macroeconomic variables to build macro scenarios.

The estimated coefficients are fully consistent with the expected relationship between the variables. The results show that a tightening monetary policy will make credit growth decline. GDP growth rate has a positive impact on credit growth and it is statistically significant at 5% level, confirming that economic recovery will increase credit expansion. The finding is similar to the previous study such as Pesola (2001), Boss (2002), Virolainen (2004). The estimated result is presented in the following table:

Table 2: Results from macro model

Variables	D_CR	D_GDP	D_NR
_ce1	-0.4757834*	1.275001	-0.0548657
_ce2	-0.8818686**	-4.491861***	-0.0004548
LD.CR	-0.1394635	-2.331084***	-0.025174
L2D.CR	-0.5592344**	-1.916251***	0.0211695
L3D.CR	-0.1213959	-1.194696**	0.0007842
LD.GDP	0.606688**	2.592943***	0.0098791
L2D.GDP	0.5443557**	1.808489***	0.0117589
L3D.GDP	0.2318492	0.5803097	0.017294
LD.NR	0.5498097	-3.889901*	0.1833175
L2D.NR	-1.814869***	-2.25402	0.0377072
L3D.NR	1.167797**	-2.949625*	-0.0859708
_cons	-0.0000697	0.0000136	0.0009199
Observation	18	18	18
R-Squared	0.9442	0.9792	0.8046
AIC	-17.15794	-17.15794	-17.15794
HQIC	-16.89876	-16.89876	-16.89876
SBIC	-15.27827	-15.27827	-15.27827

*** p<0.01, ** p<0.05, * p<0.1

The post estimations point out that the above results are stable. The error terms are not autocorrelated and they also pass the test of normal distribution so the model is reliable, consistent in terms of statistical significance.

Based on the results of VECM model, the paper builds macroeconomic scenarios, including a baseline scenario reflecting the trend of GDP growth as expected and three adverse scenarios. The four GDP growth scenarios are as follows:

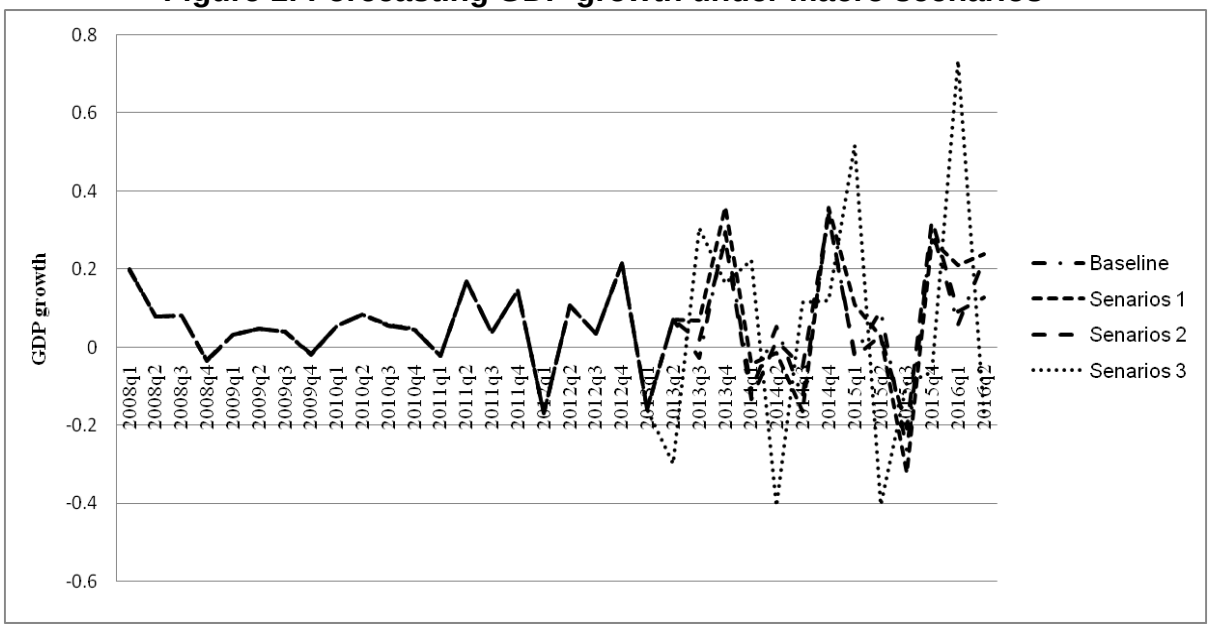
- ***Baseline:*** This scenario aims at capturing the normal growth of economic activity. The results of the VECM model are used to forecast future GDP growth without shocks.

- ***Scenario 1:*** The results of the VECM model are used to simulate GDP growth when the base interest rate increased to 11% in Q2-2013. This shock is calculated by taking the average of the base interest rate plus 2 standard deviations during 2007-2013.

- ***Scenario 2:*** The results of the VECM model are used to simulate GDP growth under a negative shock to credit growth equal to 2.1% in Q2-2013. This shock is calculated by taking the average credit growth minus 2 standard deviations in the period.

- ***Scenario 3:*** The results of the VECM model are used to simulate GDP growth under a negative shock to GDP growth decreased by 30% in Q2-2013. This shock is calculated by taking the average GDP growth minus 2 standard deviations in the period.

Figure 1: Forecasting GDP growth under macro scenarios



4.2 Microeconomic Model

This section analyses the sensitivity of bad debt under the macroeconomic scenarios. The estimated coefficients are highly statistically significant, and strong support to the negative relationship between NPL and GDP growth. The estimation results are used to simulate loan quality under the macroeconomic scenarios.

First, the paper uses panel data methods to estimate equation (2). Then, these results are used to calculate equation (3) to find out the NPL ratios under GDP growth scenarios. They are consistent with expectations and have statistical significance in both pooled OLS and fixed effects method. The coefficient of the lagged NPL ratio variable capturing the persistence of bad debt is about 0.84. The coefficient of lagged GDP growth is negative and statistically significant as expected. This is consistent with previous studies that an increase in NPL is caused by a decrease in GDP growth. The result table is presented below:

Table 3: Estimation results with panel data

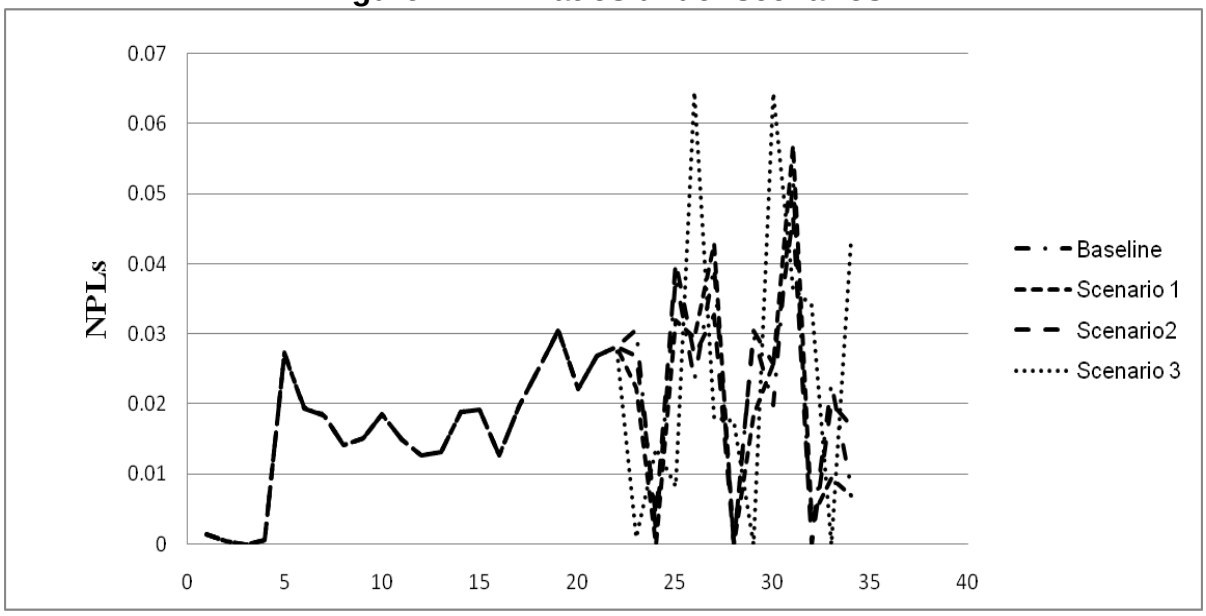
	Pooled OLS [1]	Fixed effect [2]
L.Logit (NPL)	0.9168713*** (0.0434289)	0.8425786*** (0.0662001)
D.LnGDP	-0.9622535*** (0.3646571)	-0.9587635** (0.3684347)
LD.LnGDP	-1.196764*** (0.4354076)	-1.220903*** (0.441531)
L2D.LnGDP	-0.8854442** (0.4347497)	-0.8850943** (0.4396382)
Observations	108	108
R-squared	0.8161	0.6440

Standard errors in parentheses
***p<0.01, **p<0.05, *p<0.1

Using fixed effect estimation results; this paper estimates the impact of scenarios of GDP growth on NPL ratios. In column [2] of table 3, the coefficients of the lagged GDP growth variables add up to -3.06. Plugging this in equation (3) and using the average NPL ratio (1.64 percent), we see that the 2.9 percent decline in GDP growth (this value is the decline of GDP growth in Q2-2013) will cause a 0.14 percent increase in NPL ratio in the short term (i.e., 0.0164 × (1- 0.0164) × 3.06 × 2.9). In turn, using equation (4), the predicted long term increase in NPLs would be 3.7 percent (i.e., 0.14 ÷ (1 - 0.84)), nearly 1.3 times higher than June 2013.

Then, the paper simulates NPL ratios data outside the sample in four scenarios of GDP growth. The results show that the credit quality will be deteriorating and instable in the coming years as follows.

Figure 2: NPL ratios under scenarios



For the baseline scenario, the highest NPL ratio would be 6.9 percent in the third quarter of 2014. Simulation NPL ratios outside sample allows us to know NPL ratios of the third quarter and the fourth quarter of 2013 (the NPL ratio reaches 3.7 percent in September 2013). NPLs simulated in the worst case scenario are higher than the baseline, but they

are on the same trend. The most serious deterioration is described in scenario 3 when the NPL ratio reaches a maximum of 16 percent. The following table is a summary of statistics on NPL ratios data outside sample.

Table 4: Statistic summary of simulated NPL ratios under scenarios

	Baseline	Scenario 1	Scenario 2	Scenario 3
Mean	0.0283014	0.0262672	0.0262309	0.0426304
Minimum	0	0	0	0
Maximum	0.1145709	0.1326405	0.0957732	0.1603466
Std. Dev	0.037178	0.0418483	0.0314371	0.0619606
Skewness	1.170757	1.636051	1.063665	1.101229
Kurtosis	3.289565	4.5481	3.067778	2.722003

4.3 Model Credit Risk+ for Estimating Credit Loss

The Credit Risk+ model is a statistical model for default risk that poses no assumptions about the causes of insolvency. This method is similar to managing market risk, but does not explain what causes fluctuations. Credit Risk+ model considers the default rate as the random variable and combines with the standard deviation of default rate to track the volatility of the default rate.

The output of the Credit Risk+ model can be used to determine the amount of required capital to prevent commercial banks from credit risk that is not expected. The input variables required include total loans of the banks in the sample as proxy for risk contributions, the NPL ratios as proxy for credit risk, and the standard deviation of the NPL ratios in the worst case happens in scenario 3 as proxy for the volatility of the credit risk. The output table is presented below:

Table 5: Results Credit Risk+

Unit: VND billion

Outputs - Risk Contributions, Percentiles and loss distribution				
	Expected	Risk		Credit Loss
Name	Loss	Contribution	Percentile	Amount
Bank 1	17,497	265,080	Mean	47,523
Bank 2	3,193	36,021	50.00	0
Bank 3	10,549	191,749	75.00	0
Bank 4	3,083	31,744	95.00	326,877
Bank 5	3,574	35,738	98.00	450,922
Bank 6	1,147	10,529	99.00	656,034
Bank 7	5,864	56,473	99.50	810,981
Bank 8	2,615	28,700	99.75	975,476
			99.90	1,199,241

The results show that the maximum loss at a 99 % confidence level cannot exceed VND 656,034 billion that accounts for 65 percent of total outstanding loans of these banks. It is nearly 37.5 percent of the total assets of these banks. The banks can absorb loan defaults

up to the value of its shareholder equity without depositors suffering any losses. Therefore, the paper will compare total maximum loss of eight listed commercial banks to their total available capital, then the research question can be answered.

Vietnam's banking system has some unique features. First, eight largest commercial banks dominate Vietnam's banking industry. Second, average credit growth during 2000-2010 was higher than deposit growth and GDP growth, which might cause negative impacts on the health of the economy. Most banks have their income heavily depending on lending activities with interest income/total income ratio of some banks reaching above 90% in 2010. Since the beginning of 2011, the banking sector has gone through hard times, due to high NPL ratio. Therefore, this paper focuses on the impact of macroeconomic variables on credit risks of Vietnamese commercial banks.

Table 6: The category of listed commercial banks in Vietnam

Unit: VND billion

	Listed Commercial Banks	Total Asset	Equity	Loan loss provision
1	Joint Stock Commercial Bank for Foreign Trade of Vietnam	436,471	40,769	5,837
2	Asia Commercial Bank	169,404	13,045	1,665
3	Vietnam Joint Stock Commercial Bank for Industry and Trade	522,601	48,528	5,236
4	Vietnam Export – Import Commercial Joint Stock Bank	156,349	14,529	646
5	Military Commercial Joint Stock Bank	173,932	14,990	1,501
6	Southeast Asia Commercial Joint Stock Bank	23,664	3,198	234
7	Saigon-Hanoi Commercial Joint Stock Bank	104,525	9,803	1,779
8	Sai Gon Thuong Tin Commercial Joint-stock Bank	160,504	14,391	1,636
	Total	1,747,450	159,254	18,533
Source: Financial Statements of Banks				

Table 6 shows that the total shareholder equity is only VND 159,254 billion and loan loss provision is only VND 18,533 billion. The sum of them is still less than the amount of credit loss under the worst case scenario (VND 656,034 billion). The results show that the commercial banks have not been well-prepared to face the credit losses under the adverse macroeconomic scenario. This could threaten the stability of the entire financial system.

5. Conclusions

This paper provides a framework for macro stress testing on credit risk in Vietnamese commercial banks. The framework helps measure the vulnerability of commercial banks against various macroeconomic shocks based on relationship between GDP growth and NPL ratio. The results show that the framework successfully simulates the related

responses of credit risk under adverse scenarios. The paper also finds that the capital of banks is not enough to ensure the stability of the whole banking system.

A distinguishing feature of this paper is that the sample period employed to estimate the model includes several severe financial crises. Thus I avoid the shortcoming of performing stress tests with a model based on "too benign historical data." Another distinctive feature of the paper is that I consider macroeconomic variables in VECM models, in order to improve the forecasting accuracy. Finally, I calculate the amount of credit loss by Credit Risk+ to report credit risk for commercial banks in Vietnam.

The model has contributed to the field of credit risk assessment, but it still has some limitations. First, the model assumes a linear relationship between NPL ratio and GDP growth. Second, the model assumes the historical correlation between loan quality and macroeconomic conditions are symmetric. Third, the model does not include the feedback effects between credit quality and economic growth. In particular, the macroeconomic model allows credit volume to change over time, while the microeconomic model assumes that individual banks maintain a constant credit portfolio. All these restrictions can cause a potential underestimation of bank credit losses. Further research is needed to address these shortcomings.

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