



Study on Credit Risk in Logistics Banking Business

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Abstract. The study on the impact of stress testing on banks is carried out in extreme circumstances, which is an important task that banks need to carry out regularly or irregularly after lending. It focuses on the determination of macro-factors in stress testing of logistics banking business. Taking the relevant data of logistics banking business of the commercial banks in China as samples, an empirical analysis of stress testing is conducted in this study. The findings indicate that the growth rate of economic growth (GDP), real estate price and money supply (M2) has a significant impact on credit risk, while the interest rate factor is relatively weak. There are risks from the credit investigation to the post-loan management, and the risk control ability should be strengthened.

Keywords: Credit Risk, Stress Testing, Logistics banking business

1 Introduction

Logistics banking business indicates that commercial banks offer the comprehensive financing and settlement services by taking the pledge of commodities that are active in demand, stable in price, strong in liquidity, and satisfied in the requirements of pledge, by supervising the capital flow and logistics via logistics information management system of logistics enterprises^[1]. The stress testing based on macroeconomic factors is to investigate the adverse influence of macroeconomic downturn on the quality of credit assets of logistics banks. The difference in enterprise ownership leads to the different ability to bear pressure, and the different risks of the bank in logistics banking business. Therefore, the core enterprises in the logistics banking business are divided into two categories. It first separately examines the transmission mechanism of factors in the risk stress testing, and then comprehensively examines the measurement of macroeconomic factors in stress testing of risks in logistics banking business system.

This study first examines the transmission mechanism of macroeconomic factors in stress testing, and then comprehensively examines the measurement of macroeconomic factors in the stress testing of logistics banking business system.

The procedures of credit risk stress testing are as follows: macroeconomic factors are selected as stress indicators, non-performing rate and capital adequacy ratio as compression indicators, and enterprise income as risk driving factors. By establishing three-factor linear regression model, the comprehensive influence of macro factors on the income of various industries is calculated. Then, according to the correlation between

earnings and other financial statements, the simulation report and simulation rating under stress scenario are established. Finally, grade transfer, PD change, LGD change and five grade classification transfer are calculated. This study gets the bad rate changes under the influence of macro factors. The stress testing adopts scenario simulation method. Therefore, the direct relationship between macro factors and default rate is directly considered.

2 Method

2.1 Risk Transmission Mechanism of Macro Factors

The method of scenario construction is divided into portfolio driven method and event driven method^{[2][3]}. However, these two methods are suitable for discussing the relationship between scenario design and risk factors in stress testing. In the portfolio driven approach, risk control personnel first discuss and define the main risk factors of the assets they hold, and then construct the possible stress testing scenarios accordingly. The scenario construction of event driven method is based on the rare events that may occur, so as to discuss how these events will affect the corresponding risk factors in the portfolio. This scenario construction method is mostly used when the risk manager is faced with pieces of news or special events.

After selecting pressure scenarios and pressure projects, it is necessary to establish a technology transmission model between pressure factors and pressure projects, which is also the core of stress testing, so that pressure factors drive the changes of parameters such as PD, LGD and EAD in Basel Accord^[4].

Table 1. General Methods of Stress Testing Modeling

Pressure	Method
1. Selection of pressure testing methods	Sensitivity analysis, maximum loss analysis, scenario analysis, extreme value analysis
2. Constructing scenarios	Historical simulation scenarios, assuming special scenarios, Monte Carlo simulation scenarios
3. Determining shocks	Shocks from single market variables, shocks from internal volatility, shocks from relevant relationships
4. Model selection	Credit risk model
5. Defining	Define the impacted assets, the magnitude and time intervals of the impacts
6. Numerical analysis	Numerical analysis with considering the second round effect
7. Adjustment	Risk summation, credit asset repricing and comparison, and adjustment of risk control technology

Logistics banks should formulate reasonable stress testing model according to their

own conditions^[5]. The key point of stress testing modeling should focus on the choice of different methods in a single process. The methods of the seven main parts of stress testing is shown in Table 1.

Scenario stress testing is to assume when there is a change, it uses the pricing formula to revalue the value of the asset portfolio after a significant change in market, and subtract the original asset portfolio's value to obtain the loss. According to the relocation of the five-level classification under the stress testing and the credit asset distribution's five-level classification in the base period, the five-level classification results of each enterprise under the stress scenario are calculated.

2.2 Hypothesis and Basic Framework of Model

The risk concentration of credit assets of logistics banks and macroeconomic factors are assumed as follows:

H1: The credit assets of logistics banks are sufficiently dispersed, and individual assets make up a relatively modest portion of all assets. Therefore, the specific risk of the debtor can be dispersed to a large extent, and the default probability is mainly affected by macroeconomic factors.

H2: The income of the loan enterprises in the whole logistics banking chain is affected by macroeconomic factors, and can be effectively transmitted to the credit risk of logistics banks.

H3: The influence of macro factors in income and credit risk has a lag. $T-1$ macro factors are to measure the income and credit risk of the T period.

H4: When the influence of macro factors are measured, the loan enterprises of logistics banks are divided into several industries for calculation.

To strengthen the stability of the data, the natural logarithm is used. On this basis, the relationship between the income of the loan enterprises and macroeconomic factors is described:

$$\ln W_{s,t} = \mu_{s,0} + \mu_{s,1}X_{1,t-1} + \mu_{s,2}X_{2,t-1} + \cdots + \mu_{s,t-1}X_{n,t-1} + e_{s,t} \quad (1)$$

$W_{s,t}$ refers to the income in which the enterprise is located;

$X_{n,t-1}$ refers to the value of the n^{th} macro factor in $T-1$ period. The expression of macro factors is discussed later.

$\mu_{s,t}$ is the coefficient

$e_{s,t}$ is the error term, including the noise caused by systematic factors.

This model is used to study the relationship between medium and long-term income of loan enterprises and macroeconomic factors.

2.3 Composition of Macro Factors

In the above macro factor income model, the selected macro factors should not only comprehensively reflect the impact of the macro environment, but also have a strong correlation with the logistics banks which are being studied. Through the research of

CPV Model, Single Factor Model and GVAR Model, three indicators are selected: inflation rate index (I), GDP index (GDP growth rate), and money supply index (M2 growth rate)^[6].

In foreign studies, it is found that exchange rate and other factors also have an important impact on corporate credit risk, but the previous studies show that the fluctuation of RMB exchange rate does not have the characteristics of cyclical fluctuations in China's unique market environment. Therefore, in this study, the currency rate and additional variables are not taken as the main indicators to conduct the experiment.

The year-on-year growth rate(Y+%) of M2 has a positive correlation with PD. In fact, when Y+% of M2 increases, both cash in circulation and enterprise deposits are increasing, the overall solvency of the debtor is becoming stronger, and the default rate is also relatively declining. Therefore, the positive correlation between this index and PD is opposite to the economic significance, so it is not introduced into the quantitative model of PD time series prediction. However, considering that the extreme situation of M2 still has a relative impact on PD in the economic environment, this index is used to modify the PD prediction value after the PD prediction model.

$$PD = \text{Quarterly New Defaults} / \text{Total Loans}. \quad (2)$$

In the existing research literature, the independent variables include GDP, price index, income and reward, finance and other macro variables. By analyzing domestic macroeconomic variables, the main variables, such as economic growth and financial indicators are involved. It is finally found that the consumer price index (CPI) and Y+% of GDP are more sensitive to PD. The correlation coefficient between CPI and PD is negative, showing a significant negative correlation. The correlation coefficient between GDP and PD is also negative, showing a significant negative correlation.

Therefore, two macro variables, Y+% of GDP and Y+% of CPI, are selected as the reference risk variables. The correlation coefficient of Y+% of GDP and Y+% of CPI in stress test is 0.67. It is obvious that Y+% of GDP and Y+% of CPI have obvious correlation, so it is not suitable to build the model together. Because GDP has more significant impact on the dependent variable, and the lag order is greater than CPI, it can be considered that GDP growth can cover the impact of CPI growth on the dependent variable. So the model only accepts Y+% of GDP as the independent variable. The time series method is applied to establish the model of default rate and macro factors. At the same time, the data transformation is done to Y+% of GDP to balance the order of magnitude. According to the design of stress scenarios, the quantitative model of PD and macro variables are used to calculate the PD obtained by the quantitative model. On this basis, the prediction results of PD quantity are revised. Finally, the PD forecast value and PD rising range under different scenarios are obtained. The stress testing of non-performing loans based on macro factors.

3 Stress Testing

Based on the construction of the model and the interpretation of relevant variables in the above, it is found that the dependent variables approximately obey the normal distribution. The test carries out multiple regression for each variable with the software function, and adopts the stepwise regression method for the way in which each variable enters the model, selects the independent variable that meets the criterion and contributes the most to the dependent variable to enter the regression equation, and then moves the variables in the model that meet the elimination criterion out of the model and repeats until the independent variables in the regression equation meet the criterion of entering the model, and the independent variables outside the model do not meet the criterion of entering the model. The method of input/remove variables is to input/remove variables, step (criterion: probability of F-to-enter ≤ 0.050 , the probability of F-to-remove ≤ 0.100), and loop.

Three kinds of stress intensities, mild, moderate, and severe, are considered in the stress scenario, assuming that the stress scenario lasts for one year, as shown in Table 2.

Table 2. Risk Factors and Scenario Assumptions of Stress Testing

Risk factor scenario		Mild pressure	Moderate pressure	Severe pressure
Major factors	Growth rate of GDP	7%	5.5%	4%
	Decline rate of house price	10%	20%	30%
	Growth rate of M2	12%	10%	8%
Auxiliary index		Average cost of financing		

In designing the method and process of stress testing, based on the principles of statistics and economics, the top-down method is to establish the connection between GDP, M2, house price growth, enterprise loan interest rate, and non-performing loan rate over the years, so as to predict the level of non-performing loan rate under stress scenarios. The modeling data are GDP year-on-year growth rate, house price year-on-year growth rate, M2 year-on-year growth rate, corporate loan interest rate, and quarterly non-performing rate of banks. Considering the impact of stripping non-performing assets when banks are listed on the market on the regression results, the data are selected from the quarterly data from March 2007 to March 2016. Among them, the defective rate is the dependent variable, and other indicators are the independent variables, which are all from the public data of the National Bureau of statistics. The growth rate of house price is based on 2006. The top-down scenario stress testing model of credit risk of logistics bank is as follows:

$$\ln \frac{NPR}{1-NPR} = -0.0668 \times R_{M2} - 0.1197 \times R_{GDP} - 0.4703 \times \exp(R_H) + e(t) \quad (3)$$

NPR is short for non-performing loan ratio. R_{M2} is short for year-on-year growth rate of M2. R_{GDP} represents year-on-year growth rate of GDP. R_H is fixed growth rate of house price. The model uses GDP growth rate, M2 growth rate, and house price fixed base growth rate as independent variables. The second-order autoregressive model corrects the error, regression $R^2 = 0.9672$, total $R^2 = 0.9961$. The coefficient T of each variable is significant, and the model effect is ideal. The loan interest rate factor fails to enter the final model. From the specific variable coefficients of the model, it is revealed that Y+% of GDP, Y+% of M2, and the negative growth of house price all lead to the increase of bad rate, and the economic explanation is more reasonable. The non-performing loan ratio under the pressure scenario can be obtained by bringing Y+% of GDP, Y+% of M2, and the growth rate of house price into the regression equation. Non-performing loan loss rate: the loss rate of non-performing loans of all kinds of loans under the benchmark state = (the sum of loan loss reserves) / (non-performing loan balance). The loss rate of non-performing loans under pressure is 43.64% of the historical average loss rate of credit loans of logistics banks. After adjustment in the period of economic recession, the result is 47.86%.

By using the model, the non-performing loan ratios of logistics banks in mild, moderate, and severe scenarios are shown respectively, and the capital adequacy ratio is reduced. The results show that the capital adequacy ratio under the three kinds of stress scenarios is lower than the minimum regulatory requirements. Table 3 shows the detailed results of stress testing.

Table 3. Results of Stress Testing

Scenario	Item	Amount
Benchmark scenario	NPL balance	202.66
	Total loans	22600.23
	Loss rate of NPL	43.75%
	Capital adequacy ratio	10.06%
Mild pressure	Total loans	22600.23
	Loss rate of NPL	1.1%
	Capital adequacy ratio	10.13%
Moderate pressure	Total loans	22600.23
	Loss rate of NPL	3.77%
	Capital adequacy ratio	9.65%
Severe pressure	Total loans	22600.23
	Loss rate of NPL	6.78%
	Capital adequacy ratio	8.82%

To check the robust, the interest rate for a one-year loan, which has the most direct impact on the bank's non-performing loan rate in the stress testing, is used as the risk change factor, and three stress scenarios are set: mild stress scenario, in which the interest rate for a one-year loan rises to 8%; severe stress scenario, in which the interest

rate for a one-year loan rises to 9%; extreme stress scenario, in which the next interest rate for a one-year loan rises to 10%. Then it conducts a new stress testing under different scenarios. In this test, it sets the GDP growth rate as the main factor of change, and also sets three scenarios: in the mild stress scenario, the GDP growth rate dropped; in the severe stress scenario, the GDP growth rate dropped; in the extreme pressure scenario, the GDP growth rate dropped.

4 Conclusion

This study mainly studies the measurement of macro factors in the credit risk stress testing of logistic banks in the New Basel Accord's framework. Based on macro factors, the scenario stress testing is to investigate the adverse effects of macroeconomic downturn on the quality of logistics banks' credit assets.

The macro factors affecting the credit asset stress testing of logistics banks are as follows: macroeconomic factors are selected as stress indicators, NPL ratio and capital adequacy ratio as pressure indicators, and operating income as risk driving factors. By establishing a three-factor linear regression model, the comprehensive impact of macro factors on the operating revenue of various industries is calculated. Then, according to the cross checking relationship between operating revenue and other financial statement subjects, the simulation report and simulation rating in the stress scenarios are established, and the rating migration, PD change, LGD change and five-level classification migration are calculated. The change of non-performing rate is finally obtained.

It shows that there have been risks from the credit investigation to the post-loan management, and it should strengthen the risk control ability. Logistics banking business should improve the internal control system's architecture of operational risk. The management of credit assets is relatively complex, and it should enhance management efforts, strengthen personnel quality, improve business processes, and strengthen information construction and risk dynamic supervision.

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