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**STUDIES ON RISK MANAGEMENT
OF LOGISTICS BANKING BUSINESS
IN CHINA**

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PhD

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The Hong Kong Polytechnic University
Department of Logistics and Maritime Studies

Harbin Institute of Technology
School of Management

**Studies on Risk Management of Logistics
Banking Business in China**

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A thesis submitted in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

August 2021

CERTIFICATE OF ORIGINALITY

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ABSTRACT

The globalization of logistics banking chain management and the advocacy of the Belt and Road Initiative in China moving forward, logistics banking business as a financial instrument promotes the innovation and improvement of a cooperation among commercial banks, logistics enterprises, and trading enterprises. Commercial banks provide the comprehensive financing and settlement services to enterprises and one or more trading links in the logistics banking chain, by taking the pledge of commodities that are in active demand, stable in price, strong in liquidity, and satisfied in the requirements of pledge, and supervise the capital flow and risks via logistics information management systems. Credit risks, as the measurement of risks, faced by the logistics banking business system should be identified, measured, and controlled so that banks are able to keep profit. The research analyzes the credit risks in three studies from three aspects, pre-loan, in-loan, and post-loan periods through the studies as followed.

Pre-loan study analyzes the impacts of macroeconomic and political factors on the credit risks of banks in logistics banking business with statistical analysis and empirical examination. The statistic of macroeconomic condition and policy gives a basic view of the macro-circumstance of logistics banking business. In the empirical analysis, the Panel Smooth Transition Regression is applied to draw the effects of macroeconomic policy, especially monetary policy in the study on bank risks. This study is to reveal the nonlinearity in monetary-policy and bank-risk nexus, and to examine the statue of the impact on bank risks.

In-loan study explores the measurement model of default risks of logistics banking business in the case of the pledge financing. By VaR methods, the study reveals the condition of risk control. Default risk usually consists of endogenous factors and exogenous factors. The previous study discusses the bank credit risk caused by corporate defaults caused by external macro factors. This study discusses the endogeneity of default. And the study consider adjusts the factors of enterprise operation characteristics in analysis in order to keep the robustness of the system for the next study.

Post-loan study tests the long-term risks in logistics banking business after loan. This study is a supplement of risk measurement through VaR methods. It firstly focuses on the pro-cyclical effect and the ownership-allocation impact in logistics banking business as a basic description for the next long-term stress testing. This study proves that the different loan quotas provided by banks to enterprises are based on the different allocation of ownership. Then the study examines whether the ownership discrimination causes the influence from the allocation of assets on the credit risks via Stress Testing. By this study, the root cause of credit risk in logistics banking business is presented, which helps banks to select objects to lend and to control risk costs.

The studies together explore the risks of the logistics banking business in different aspects. The research contributes knowledge to the literature by the systematical explanation of the formation of risks and provide evidence to measure the risks in practical logistics banking business projects.

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List of Abbreviations

CPV	Credit Portfolio View
EAD	Exposure at Default
FD	Foreign Direct Investment
KMV	Credit Monitor Model
LB	Logistics Banking Business
LGD	Given Default Loss Rate
OLS	Ordinary Least Squares
PD	Probability of Default
PMI	Purchasing Manager's Index
PSTR	Panel Smooth Transition Regression
SME	Medium-Sized Enterprises

1 Introduction

1.1 Research Background

Modern logistics development has emerged as one of the key indicators of a nation's modernization and all-around national strength. The government has listed the logistics industry as one key development industry of the country. While domestic logistics companies devote their enthusiasm to warehousing, distribution, and electronic network, transnational logistics giants begin to aim at another crucial link of the supply chain, which is the capital flow.

Trade and logistics finance began with the globalization of supply chain management. As a financial instrument, it has been promoting industrial integrated innovation and coordinated development. However, commercial banks have not formed a more mature model of trade and logistics banking business, although trade and logistics finance has been explored for more than a decade since 2006 in China. Therefore, under the macroeconomic environment in China, it has always been the focus of the financial markets and the academic circles about how to construct the development strategy of trade and logistics finance and encourage the growth of industries and real economy, based on industry chains and supply chains, and on the integration of industrial capital and financial capital.

In recent years, the advocacy of the Belt and Road Initiative leads to that China's economy has been developing rapidly. As the interregional trade is developing, logistics industry has also made unprecedented progress. While logistics enterprises increased rapidly, the scale and strength of logistics enterprises have increased significantly. As a result, the amount of funds needed in the supply chain has

expanded, leading to the logistics business more intelligent and diversified. Logistics finance products have consequently come into being. As an innovative logistics service product, for the logistics sector, logistics finance offers financing, insurance, settlement, and other financial services, through the cooperation of financial institutions, enterprises and logistics companies. Logistics companies get new profit through logistics finance, and logistics finance also helps small-to-medium-sized enterprises(SME) to effectively solve financing problem. Foreign financial services are mainly promoted by financial institutions while domestic logistics financial services are mainly initiated by logistics companies as regulators. However, for a long time, the main source of financing in financial market is commercial banks, and similarly the credit funds in logistics finance are mainly from banks.

Considering the viewpoint of commercial banks, the pledge loan of logistics banking business (simply as logistics banking business, LB) 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, as shown in Figure 1-1.

The commercial bank offering the services of logistics banking business is called logistics bank. With the continuous development of logistics banks, it gradually upgrades from physical pledge which needs a lot of storage space, to data pledge including receipts pledge and stocks pledge. In the closed trade and logistics supply chain, the logistics bank evaluates the state of the upstream-downstream enterprises in the logistics supply chain as well as the main enterprise. It uses the cash flow generated by expected income as the direct source of repayment to provide financial

support and other comprehensive financial services for the enterprises and the transactions in the chain of logistics banking business.

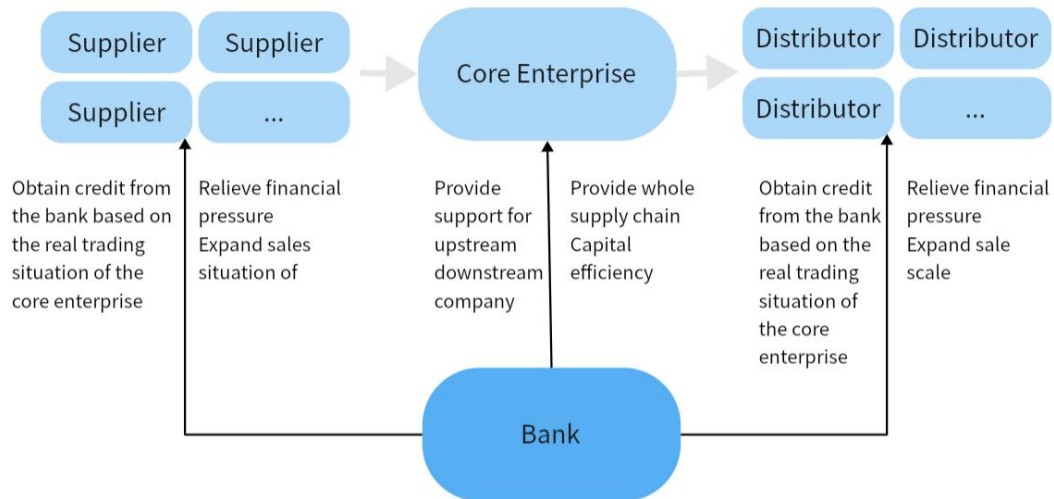


Figure 1-1 The Method of Logistics Banking Business

Logistics banking business is in the process that banks use Big Data, Blockchain, Internet of Things, and Cloud Computing Technology to analyze the data of logistics, information and capital flow, and solve the financing requirements in the transaction in the logistics banking chain between the core businesses as well as its upstream-downstream enterprises companies(Lewis J, Demand D,2011, Hua S, 2015). Therefore, logistics banking business can help banks attract stable customers, expand their business scale and enhance their competitiveness. And it also helps to solve the problems, such as high cost in storage, and regulatory and cumbersome operation in pledge loans. And the data help banks to simplify the pledge assessment, asset disposal and other services. Logistics banking business has become one of the innovative financial derivatives leading the real economy to the financial market, so it has become an important choice of businesses in the transformation and development for the commercial banks and the logistics industry.

The loose policy of the banking supervision department in China allows the logistics banks rapidly developing. By the date of data collection, 27 listed banks, including 5 rural commercial banks, 9 city commercial banks, 7 joint-stock banks, 6 large-scale commercial banks, have carried out logistics banking business, and are constantly expanding the depth and boundaries of logistics banking business.

However, because of the slack regulatory circumstance of logistics banking business, there are various unpredictable factors when enterprises finance, which bring risks to logistics banks and lead to the profit loss and the non-performing assets.

Due to the restrictions of our economic laws and regulations, state-owned banks cannot purchase logistics companies, financial services cannot be offered by non-financial institutions. Logistics banking business is the cooperation between logistics enterprises and banks. As a result, this firm deals with a wide range of market issues. Financial and logistical concerns are present in logistics financing at the same time. In order to allocate risks, mutually reciprocal, beneficial, and restrictive agreements lie in each case of cooperation, but there is no universal agreements or patterns for all logistics banking business cooperation. The risk division among financial institutions, pledger enterprises and logistics companies is inconsistent. Each subject will just highlight, and transfer risks, resulting in the unequal between risk and income, which may magnify the risk of logistics finance in a certain degree.

In China, the supervision of logistics industry is still in the developing stage, and the operational risks cannot be ignored. Logistics companies need to participate in the logistics banking chain, which relatively expands the scope of operation and increase

the operational risks likewise. At the same time, the reliable financing sources of logistics finance are mainly from commercial banks in China. This financing behavior is limited or influenced by macro-policy and macroeconomic circumstance, which also adds many uncertainties to logistics finance.

To control risks, logistics banks control the full process of capital flow and logistics of the pledge. Since the credit system has not yet formed completely in China, banks cannot make full use of their professional advantages to make a correct judgment on the prospects of enterprise development. small-to-medium-sized enterprises may also adopt false or unreal information to banks in terms of the procurement data, production data, and sales data, making banks unable to obtain the true information so that appropriate management measures cannot be taken to reduce the risk. As an indirect participant, logistics enterprises, on one hand, may provide false data to banks to attract their customers and this whitewash may cause mislead to banks. On the other hand, since the information of management of risk collected by logistics enterprises are almost the original data, it is uncertainty of the correctness of decision-making in credit risk management under the condition of information asymmetry between manufacturing enterprises and logistics enterprises. In addition, due to the imperfect management system and supervision mechanism, there will be some errors in the logistics banking chain, such as staff operational errors, decision-making errors in management, collateral damage for improper transportation or storage, moral hazard, and supervision oversight, all of which will lead to default risks.

The existence of various risks above means that the efficiency of logistics banking business decreases. As a result, increasing quantity of logistics banking

business does not bring a growth of corresponding profit. The performance of logistics banking business is affected, and meanwhile, the problem of the efficiency of logistics banking business is further highlighted.

Since the first logistics banking business in China came into being in 2006 (CFLP, 2017), previous literature on logistics banking business was mainly conducted in description of logistics banking business scope, and innovation of logistics banking business forms. With the increase of the forms and quantities of logistics banks, most domestic researches identify different risk forms, and describe risk types and risk management method through qualitative analysis. With the increasing progress of researches, scholars begin to study on the origins of risks and risk measurement theories in logistics banking business. Quantitative analysis follow the foreign researches and begin to focus on the loan pledge rate and profitability of logistics banks. There is still little systematic quantitative analysis on the measurements of the risks and the interaction of subjects of risks in logistics banking business specifically in Chinese macroeconomic and political circumstances. Therefore, this thesis is developed to analyze the risks of logistics banking business and explore rational approach of risk control in the macroeconomic and political circumstances in China.

1.2 Research Questions

In order to analyze the risks in logistics banking business, this thesis comprehensively identifies and measures the risks in different periods of financing in order to control the risks and prevent them.

The financing process of logistics banks includes pre-loan, in-loan and post-loan. Risk management's first stage is risk identification in logistics banking business. Only

by identifying the risks of logistics banking business can we summarize the sources of risks comprehensively and provide accurate basis for further risk measurement and risk assessment. Previous studies have shown that The primary risk that banks confront is credit risk. Credit risk is mainly caused by external factors and cannot be dispersed, while the risk caused by the enterprises' own behavior can be dispersed (Li Guanzheng et al., 2011).

Credit risk is the key point of risk management for banks in logistics banking business. Nowadays, the researches on risks mainly focus on economic cycle factors, which has achieved a lot abroad. For example, a topic of Basel III is to solve the pro-cyclical effect of credit risk (Basel III, 2009). But compared with other countries, Economy of China is more special. During the specific period of economic transition, economic circumstance changes have an important systematic impact on credit risk. Economic policy influences bank risks significantly. In addition, the many ownership structures of various businesses in the industrial chain (such as state-owned enterprises as well as private enterprises) also lead to different levels of credit risks. A large number of studies show that several systemic credit risks in China are related to Chinese special economic system. The impacts of macro-policy changes on state-owned enterprises differ from non-state-owned ones, leading to different changes in production costs and commodity prices, so different enterprises have different credit risks in logistics banking business. The People's Bank of China report (2003) points out 80% of the state-owned commercial banks' non-performing assets is related to the factors of economic transformation and ownership, including government intervention, policy support, and structural adjustment of the state and regional policies. State-owned enterprises have a high credit and a low risk of default. And in logistics banking business, banks identify risks via the condition of credit and

operation of the core enterprise. Thus, the unbalanced amount of loans granted by banks to state-owned and privately held enterprises has resulted in the discrimination against loans from non-state-owned enterprises. However, the results of such studies are based on research samples from around 2000. Great changes have taken place in the macro-economy. Compared with other non-state-owned enterprises, even small-to-medium-sized enterprises, state-owned enterprises have lower management efficiency and poorer liquidity. Are banks still more willing to allocate loans to state-owned enterprises? If so, is this credit risk higher? In addition, in logistics banking business, according to the different amount of loans provided by banks, the factors and the weights of factors influencing decision-making are also different. The larger the amount of enterprise pledge loan, the more cautious the bank will be, and the result of credit risk will be different. Therefore, another question is raised. How does the difference between state-owned and non-state-owned enterprises in logistics banking business change with different amounts of pledge? And how does the resulting credit risk change?

During the pledge loan period of logistics banking business, the risk measurement is the main part of the risk management of the whole course. Credit risks faced by banks are mainly caused by default factors of enterprises. At the same time, in the logistics banking chain default risks will transfer the risk to the upstream-downstream enterprises enterprises, causing the risks. Domestic banks lack systematic and standardized design of logistics banking business products, so there will be such problems as imperfect credit system, asymmetric information, and imperfect laws. In this context, there may appear default problems. For example, the loss of the seller enterprise of pledged goods results in the failure of the income to reach the accounts, leading to the enterprise failing to repay. As a result, banks need to

bear greater risks that earnings are difficult to achieve the expectation, and there are even losses. How to calculate the default risk of the enterprise which is in the pledge loan? What are the associated risks of the default risk?

After the loan of logistics banking business, the bank needs to consider the feature of the whole risk system in the logistics banking business. Different from risk measurement in the process of loan, the risk measurement after loan is a medium and long-term analysis. Post-loan risk measurement is regarded as a supplement to the risk measurement of logistics banking business. When major emergencies occur, all parts of the closed chain of logistics banks generate risk pressures. What impact does it have on the industry of the enterprises participating in logistics banking business? How can risk pressure be transmitted? What is the affordability of banks for the risk pressure?

In conclusion, the research questions are as follows:

How do the macro factors influence the credit risks of Chinese banks in the logistics banking business?

How are the credit risks measured in the logistics banking business?

What long-term influence of the macro factors on the credit risks in the logistics banking business?

1.3 Research Objectives

To address the research questions above, the general objective is set to measure credit risks in logistics banking business. To reach the objective of the research, three specific objectives are proposed.

A. Pre-loan analysis: decision-making of logistics banking business based on

macro-environmental factors. Descriptive analysis and empirical analysis of the impact of macro-factors on the systemic credit risk of banks in logistics banking business.

- B. In-loan analysis: the endogenous analysis of credit risk of logistics banking business in logistics banking chain system. To study the measurement of non-systematic credit risk caused by the operation condition of enterprises and to analyze the optimal mode of enterprise operation in risk control, by establishing the credit risk model of Logistics Finance.
- C. Post-loan analysis: risk control of medium and long-term logistics banking business. To measure the long-term impact of macro-factors on logistics banking system through the stress testing of risks. To explore causes of risks according to the characteristics of enterprises in the macroeconomic environment in China.

In order to achieve Objective A, the research first analyzes the economic policy environment faced by logistics banks through the statistics data of the macro-economy in China. Through descriptive statistical analysis, a foundation is laid for the research of logistics banking business risk. Then, the non-linear macro-factors' effects on bank risks are verified. By establishing a PSTR model, this research studies and verifies the impact of macroeconomic factor on bank risks. The expected default probability is used to measure the bank risks. The purchasing manager index is selected as the conversion variable and the control variable is the real estate price index. The empirical results obtained from the experiment are used to prove the non-linear monetary policy's impact on bank risks. This part lays a foundation for risk prediction and business decision-making of logistics banking business by exploring the impact of macro-factors.

The purposes of the first two researches constitute the analysis work of logistics banking business before granting loans. By analyzing the characteristics of the enterprises applying for loans and the impact of the economic and political environment, this study first establishes a preliminary understanding of the risks of logistics banking business, and then the bank makes decision on the object of loan issuance. For the same asset, it is better to choose less risky business to invest.

Objective B is to analyze endogenously the risk model of chattel pledge under the supervision of logistics enterprises, to establish the risk-return model with the factors of the volume of the pledge and the pledge rate, and then to analyze the optimal conditions of risk control through asset pricing model. After establishing the risk-return model to measure the risk of the core enterprise based on VaR theory, the study will extend it to the logistics banking chain level. By constructing a two-tier logistics banking chain structure, this study establishes the relationship between enterprise's operation and logistics bank's risk so as to obtain the optimal solution of risk control.

The study objective is to measure the credit risk during the process of logistics banking business. Firstly, it analyses the equilibrium point of risk and return from single-object logistics finance, and then extends to the study of risk-benefit balance of logistics banking chain. These two parts of the study can well establish the model basis of risk control.

Objective C is a scenario stress testing to study the risk of logistics banks based on macro-factors after the completion of logistics banking business. Starting from the unique background of the economic transition in China, this part of study firstly

proves that the different loan quotas provided by banks to enterprises are based on the different allocation between state-owned enterprises and non-state-owned enterprises. By this study, the root causes of credit risk are analyzed.

According to the different characteristics of bank credit assets, this study then examines the transmission mechanism of macro-factors in credit risk stress testing. Finally, the long-term risk status of logistics banks is comprehensively examined in order to reasonably carry out risk prevention.

Several research purposes are synthesized, from the three perspectives of pre-loan, in-loan and post-loan periods, to establish the model of the relationship between risks and various factors in logistics banking business and to obtain the empirical results of risk identification, measurement, control and avoidance.

1.4 Significance of the Research

The current new normal economic situation highlights the great pressure on commercial banks brought by the quality of pledged loan assets. In the past, commercial banks, which regarded expansion of scale and business development as the top priority, have changed their business ideas and taken the strict risk control as the top priority of their current work. To realize the whole-course control of credit risk, three aspects are focused on: before, during and after the loan. Pre-loan control means analyzing the root causes of risks, especially analyzing the sources of risks, and laying a foundation for future work to avoid minefields based on previous experience and lesson. Besides, credit control includes credit risk measurement. By establishing a pledge credit risk model, real-time calculation of the impact of each pledge loan business on the overall credit risk of the bank can serve as a foundation for

determining credit risk. Credit risk stress testing is used in post-loan control. The impact of abnormal loss on the asset quality of pledged loans can be judged through periodic or irregular risk stress testing. The research on these issues meets the requirements of Basel Agreement on credit risk management of banks, and has important theoretical and practical significance.

In addition to conventional risk factors, Chinese banks' credit risk is heavily impacted by institutional factors during the period of economic system transition. However, little research were conducted on this particular risk impacts both in domestic and abroad and has not attracted enough attention of banks. The quality of bank loans to the real industries has declined due to the drag of government financing platform and state-owned enterprises. Starting from the agent variable of institutional factors-ownership, this part studies the influence of ownership on credit risk, which is of great practicability.

When measuring the credit risk of enterprise pledge financing, this study establishes a credit risk model with the pledge rate as the main factor. The credit risk model is introduced to calculate the credit risk in the logistics banking chain, and to simulate the risk value VaR of loan pledge to calculate the credit risk. The application of these methods are exploratory and innovative and enrich the research tools in this field.

In studying the influence of ownership factors on credit allocation and credit risk, method is introduced in order to separate the single factor of ownership. The ownership of all samples is divided into two groups. By decomposing the conditional mean credit value of the two groups into variable explanation (industry characteristic

factor) and coefficient explanation (industry characteristic return rate), the proportion of credit risk of logistics banks derives from ownership factor. This study introduces the quantile decomposition method for the first time to decompose the credit disparities in any quantile. By constructing the counterfactual state, the influence of ownership discrimination is separated, and the proportion of credit risk of different credit lines is derived from ownership factors.

In the part of the study on a long-term impact of macro-factors on risks in logistics banking business, the measurement is the credit risk stress testing. Scenario stress testing based on macroeconomic factors is used to investigate the detrimental effects of macroeconomic downturn on the quality of loan assets of logistics banks. In the past, the single factor model is mainly to study the impact of macro-factors on credit risks. However, the macroeconomic and political circumstances in China constrain the single factor model to be applied. This study uses the stress testing of domestic logistics banking business. It focuses on the determination of macro-factors in pressure testing. And it is innovative in theory and significant in practice for the measurement of risk resistance capacity of logistics banks. Thus, the research has strong exploratory and innovative nature.

1.5 Dissertation Structure

This research studies the credit risk in the logistics banking business. Focused on the three stages of the whole-course management of the credit risk, it explores the origin of the credit risk before loan, optimizes the credit risk measurement model during loan, and performs the pressure test to control the credit risk after loan, and comprehensively studies the identification, measurement and control of the credit risk in the logistics banking business. In this way the inherent logic of this research is

presented.

Specifically, in the source analysis of pre-loan credit risk, starting from the unique macroeconomic environment of the economic transition in China, it employs to model the impacts of monetary policy on logistics banking risk using the Panel Smooth Transition Regression (PSTR) method via Chinese listed bank data. In loan by optimizing and improving the credit risk measurement model, it is accurate to find out the influence factors of credit risk and improve the accuracy. In post-loan management, it studies the allocation differences of industries of pledged loans with different quotas and the root of enterprise ownership caused by credit risk. The risk of abnormal loss is measured by the macro-factors of credit risk stress testing and selecting variables with stronger risk transmission.

The thesis consists of the following six chapters.

Chapter 1: Introduction. Including the background of this research, research significance, research ideas and methods, and the structure of the research.

Chapter 2: Literature and theoretical review. Combined with literature review, this chapter gives the theoretical basis of this study, including the basic theory of credit risk identification, the connotation and characteristics of credit risk, the representative model of modern credit risk research, evaluates the current research, and summarizes some problems still existing and directions to be improved. At the same time, this study briefly analyzes the current situation of credit risk management of banks in China, introduces and reviews the formation stage of non-performing loans and the severe situation of risk control, so as to provide the necessary background for the follow-up empirical research and analysis.

Chapter 3: Macro-factor's impact on the credit risks in logistics banking business. It analyzes the economic policy environment faced by logistics banks through the statistics data of the macro-economy in China. Based on analysis of the macroeconomic changes, it employs PSTR approach to model the monetary policy effects on logistics banking risks, by using Chinese listed bank data and makes a deep analysis on the macro-level of credit risk and the root cause.

Chapter 4: The credit risk measurement of logistics banking business, taking the enterprise pledge financing as the case. Taking the credit risk faced by banks as the research object, this chapter establishes the default rate measurement model of enterprises based on the endogenous factors of enterprises as independent variables. By analyzing the value of risk of logistics banks, the risk control strategy will be drawn. The measurement of credit risk of pledge financing advances the risk measurement in logistics banking business in practice.

Chapter 5: The measures of post-loan risk control. This chapter is the study on the macro-factor measurement of credit risk stress testing, which is a routine operation in the medium and long term. Stress testing based on macroeconomic factors is to examine the adverse impact of macroeconomic downturn on the quality of logistics banks' credit assets. This study will first examine the transmission mechanism of macro-factors in the stress testing of credit risks. It studies the distribution of credit information in the enterprises with different credit quotas. And then through the correlation between default rate and macro-factors, it comprehensively examines the measurement of macro-factors in the overall stress testing of credit risks of the logistics banking business system.

Chapter 6: Conclusion. This chapter summarizes the main research conclusions, main innovations and research limitations, and looks forward to future research orientations. Figure 1-2 shows the logical structure of the full text.

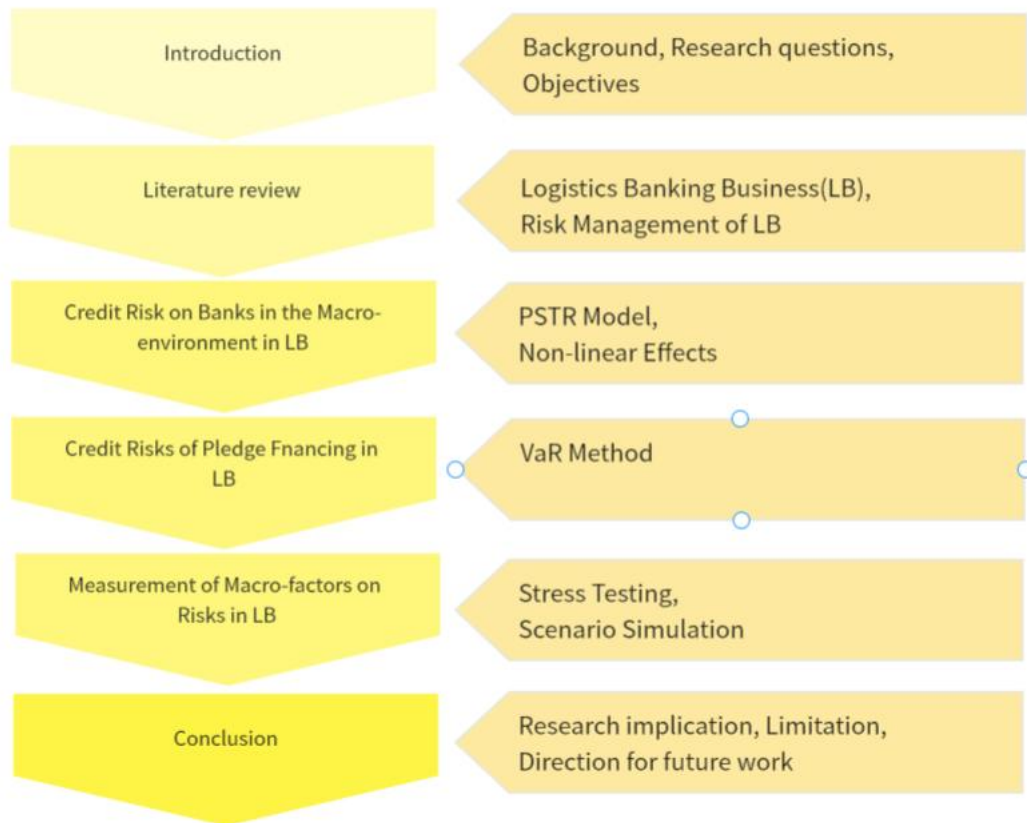


Figure 1-2 Logical Structure

2. Literature Review

2.1 Logistics Banking Business

2.1.1 Concept Introduction

Logistics banking business is a business type with the new financial system. Under the condition of global division of labor, the logistics banking chain management produces financing demand. Logistics banking business solves the financing problem . In the logistics banking business, industry and finance are combined and infiltrated. Logistics banking business provides financial products or services for one or some trading links in the logistics banking chain. All banks providing logistics banking business products or service can be called logistics banks.

The main form of logistics banking business is logistics finance, trade finance and logistics banking chain finance. Logistics finance includes warehouse receipt pledge, chattel pledge, advance payment and confirmed warehouse. Trade finance covers factoring and letter of credit. Due to their poor credit, SMEs in the logistics banking chain will face challenges with funding under the conventional finance model. By focusing on the state of the logistics banking chain system and depending on the credit standing of key organizations, logistics banks are able to offer flexible financial services to the upstream-downstream enterprises of the logistics banking chain.

In Figures 2-1 and Figure 2-2, conventional finance and logistics banking chain finance are contrasted. Simply said, due to the transactional relationships between logistics banking chain companies, the credit of the chain's core companies can operate as a partial credit guarantee for the financing of other companies in the chain. Banks can gain some insight into the credit of the logistics banking chain through the

credit evaluation of core businesses, which simplifies the terms and procedures for financing other businesses in the logistics banking chain.

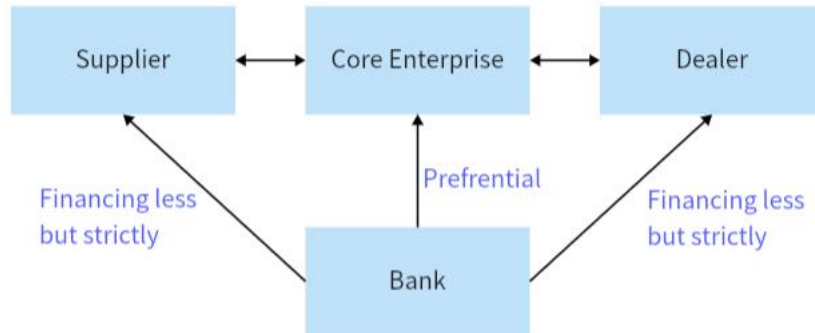


Figure 2-1 Traditional Financing

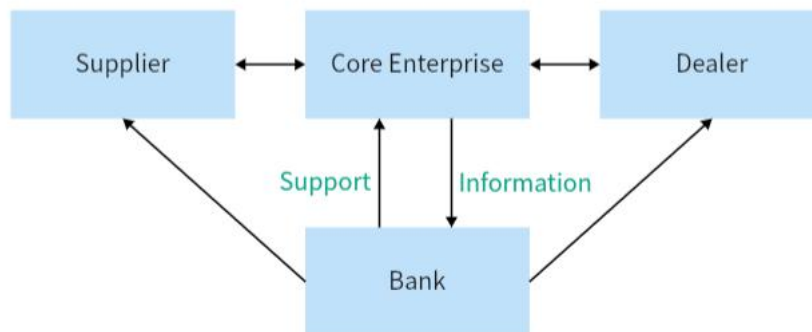


Figure 2-2 Financing in Logistics Banking Business

The corresponding relationship between logistics banking business and the logistics banking chain is revealed in Figure 2-3. In order to provide factoring, confirmation, and pledge services based on inventory and stock for upstream-downstream enterprises companies in the industrial chain, logistics banks depend on their main activities.

At the present stage, the logistics banking business has been continuously

developing and upgrading, and the logistics banking business has been upgraded to a data-based synergistic financial ecological system, as is shown in Figure 2-4. Through the transmission of industrial logic and financial services, data are generated continuously, and the credit of the participants of logistics banking business is depicted according to credit data. Through credit, in turn, they are provided with financial products and services. Therefore, the essence of logistics banking business is that logistics banks offer competent and extensive financial services in closed logistics banking chain transactions by assessing the creditworthiness of core enterprises and the upstream-downstream enterprises of the logistics banking chain and utilizing adaptable financial products and services.

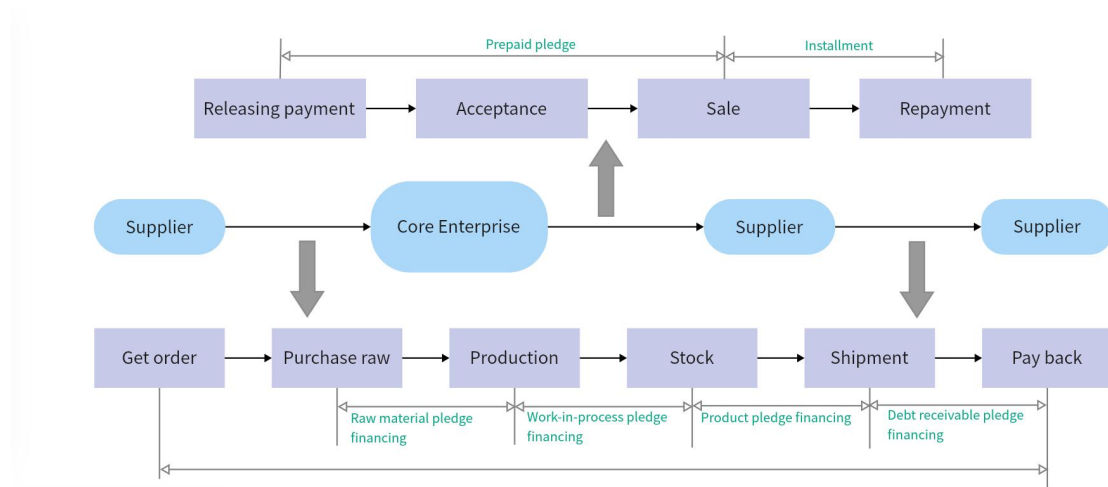


Figure 2-3 The Corresponding Relationship between Logistics Banking Business and the logistics banking chain

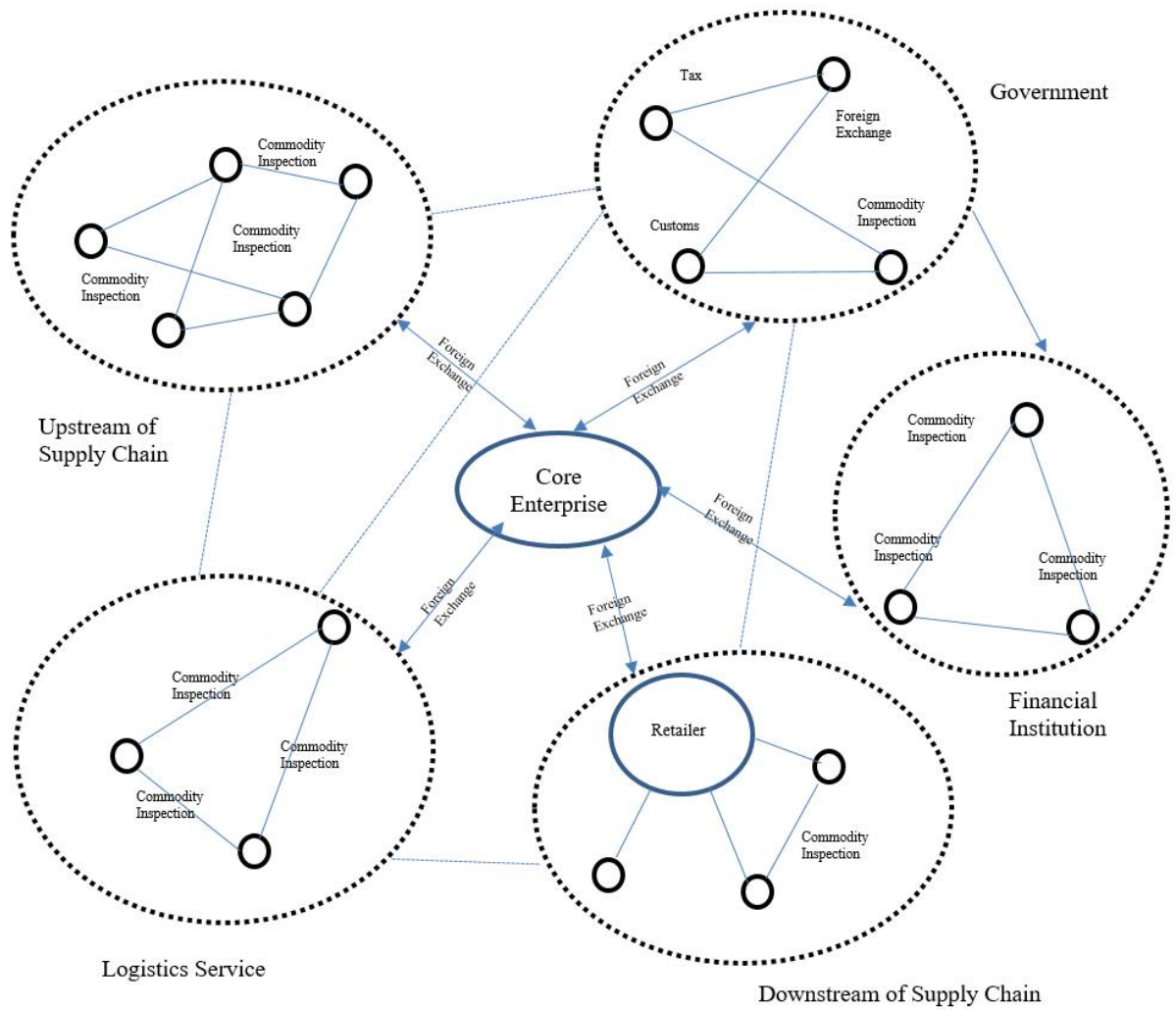


Figure 2-4 The Mode of Logistics Banking Business

2.1.2 Theoretical Basis

The development of logistics banking business depends on the transformation of credit-granting methods. And relying on data, high-quality logistics banking chain financing enterprises are selected. There are three theoretical bases in logistics banking business.

Structural financing theory: Due to the financing gap in the logistics banking chain transaction, banks manage the logistics, capital, and information flow of businesses, associate the credit of SMEs in the logistics banking chain with core

businesses, integrate data information into credit information, assess the actual situation of businesses in the closed logistics banking chain, and then decide on financing.

This is a structured financing process, in which the bank's attention to credit has changed from the traditional pledge mode to the data credit pledge mode.

The theory of self-repayment trade financing: Enterprises with financing needs can use their own trade estimates as a proof for repayment ability. Banks no longer overemphasize the financial characteristics and industry status of SMEs, nor simply make credit decisions based on the traditional credit rating of SMEs, but focus on the trade background and the control of each financing in order to get command of the closed operation of repayment. On one hand, SMEs can rely on their own receivables, advance payments and inventory and so on under the real trade background to make financing. On the other hand, they can rely on the support from upstream-downstream enterprises credits and on core enterprise credit to achieve financing.

Transaction cost theory: Transaction cost includes the cost of searching for information, signing contracts and supervising the performance of enterprises due to production and operation activities. Logistics banking business provides financing decision-making basis for enterprises in the logistics banking chain to reduce transaction costs of banks and improve transaction efficiency.

2.1.3 Subjects

The subjects of logistics banking business are the main factors affecting logistics banking business. The macro subject includes both the policy and technology

environment and the industrial subject has the function of providing services, managing risks and providing liquidity. The macro subject is the departments of procurement, production, sales, and logistics. The subjects of logistics banks have three characteristics. Each factor trades off with each other, for example, macro factors can promote and hinder logistics banking business. Financing enterprises and banks have to weigh gains and losses in information and interests. Balance promotes trust. Information asymmetry exists among the main bodies, so more advanced information technology is needed to improve efficiency and to reduce the transaction expenses. In addition, under the logistics banking business model, the cooperation among the participants is to fully utilize their benefits and resources.

The above theory lays a foundation for credit evaluation and risk management innovation of logistics banking business.

The trend of narrowing interest margin continues, the bad rate keeps rising, and the growth of banks' profit slows down. Faced the complicated economic situation and increasingly fierce market competition environment, banks have accelerated the pace of transformation and development. Logistics banking business is becoming an important choice for banks to transform and develop. Logistics banking business, as a cross-border integration of industrial capital and financial capital, relies on Internet of Things, block chains, Internet cloud and other technologies, and on data bases such as information disclosure and capital flow. To fulfill financing requirements of logistics banking businesses and accurately address the real economy's de-fragmentation, it might interfere with the trade transactions of core businesses as well as upstream-downstream enterprises businesses in the logistics banking chain. In this part of study, the analysis on the macro-market environment of logistics banks is

helpful to understand the realistic basis and internal logic of the development of logistics banks, and to provide important practical basis for the risk research of commercial and logistics banks accordingly. The part of statistic description is divided into the international economic condition analysis and domestic economic condition.

2.2 Economic Environment of Logistics Banking Business

Under the process of globalization and integration, the world economy is closely interrelated. The situation of the commercial logistics banking industry is significantly impacted by the extensive growth of trade, the transformation of the investment structure, the domestic economy's new normal, the supply side's structural reform, and the stronger financial supervision. Specifically, the characteristics of the domestic and foreign economic environments have an important effect on commercial logistics banks' ability to manage risk and make strategic decisions.

2.2.1 The International Economic Situation

Over the past years, the global economy as a whole has been operating at a low level, with insufficient momentum for development. As to the major economies, the economic recovery of developed economies is slow, and the development of the emerging markets is fast. As far as economic policies are concerned, the global monetary policy continues to be loose, the marginal utility of the unconventional monetary policy decreases, the industrial structure develops unevenly, and the root problems that restrict economic growth still exist. Moreover, global economic risk factors are still on the rise, and the negative feedback effect of the global economy caused by political and economic turmoil seriously affects the recovery .

(1) The Slowdown of the World Economic Growth

In 2016, the global economy grew by 2.4% and in 2017 it grew by 3%. However, the economic growth in 2018 was flat. The main reasons are as follows: 1. The new and old driving forces of the world economy are not changing smoothly. 2. Monetary policies are continuously being adjusted, new trade protectionism is constantly developing and conflicts of global macroeconomic policies and spillovers of negative effects occur frequently. 3. Increased devaluation of currencies and sharp fluctuations in exchange rates have exacerbated financial market risks. In the stock market, the major global markets fluctuate violently, which makes the real economy development difficult. 4. Political risks lead to economic and financial turbulence and social security instability, restricting the economic development rate. The global economic growth rate is shown in Figure 2-5.

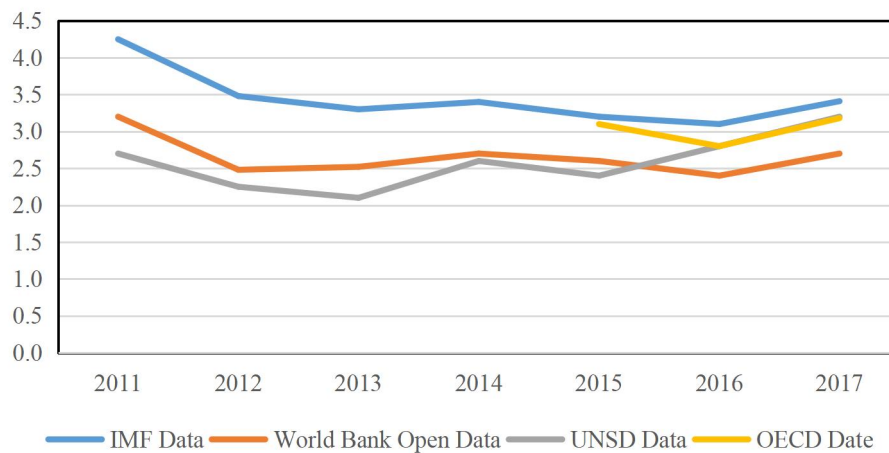


Figure 2-5 Global Economic Growth Rate

Data source: IMF

In 2018, developed economies grew at a rate of 2.4%, while developing countries grew at a rate of 4.2%. The development of the world economy is characterized by continuous differentiation of different economies, rising risks and fragile overall recovery. Overall, the world economy is hovering at a low level of adjustment, lacking the support of sustained and effective driving force. The influence

of developed economies on the world economic development is still insufficient. The continuous fermentation of many factors has restricted the developed economies in providing strong support for the world economic recovery.



Figure 2-6 GDP Growth Rate in US
Data source: US Bureau of Economic Analysis

As Figure 2-6 shows, the U.S. economy is slowly recovering. The U.S. economic recovery lacks strong momentum for sustained growth, so it still takes time for the United States to achieve a comprehensive economic recovery. The economic growth in the euro area is slowing and stabilizing. In 2016, the economic growth rate in the euro area was 1.7%, 0.3% down compared with a year earlier. During the whole year, it fluctuated between 0.3% and 0.5%, and the economy in the euro area was still on a low ebb, shown in Figure 2-7.

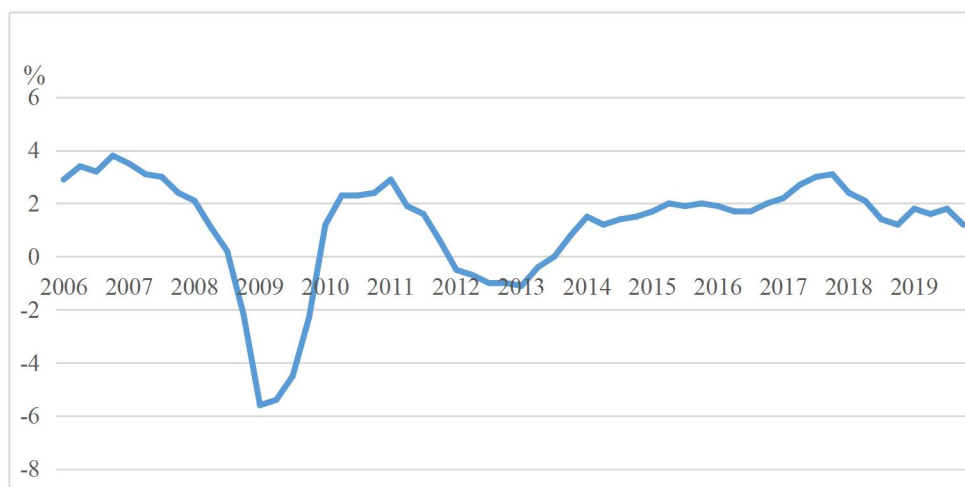


Figure 2-7 The Economic Growth in the Euro Area
Data source: International Monetary Fund (IMF)

Regarding monetary regulations, the implement of quantitative easing policies in major developed economies has sharply expanded the balance sheet of the central banks in these major developed countries. For example, the proportion of central bank assets in GDP in the United States, and the euro area increased from 6.15%, and 16.07% in the fourth quarter of 2007 to 25.00%, and 76.72% in the fourth quarter of 2015 respectively. In April 2016, the assets of central banks in major developed countries increased to \$1115 trillion, generally close to the historical height. The monetary policies of major countries vary. Some countries have entered the negative interest rate channel, the foreign exchange market unusually undulated, and American dollar generally appreciated against other currencies, with a competitive depreciation momentum among other major currencies. The yields of major treasury bonds have fallen and the hedging sentiment of investors has risen.

As for the emerging economies, the economic growth has steadily increased, and its impact on the world economy is deepening. The emerging economies generally depreciate against the dollar, resulting in capital outflows. In 2016, emerging market countries held \$3.2 trillion in debt. As a result, the financial vulnerability of the rapidly rising dollar debt in the emerging economies has increased. In addition, the rising levels of government debt in the emerging economies and increasing liabilities of non-financial institutions have increased the probability of financial risks.

The BRICS economies are showing a trend of differentiation. India's economy grows fast, Russia and Brazil's economy is in recession, and South Africa's economy is moving at a low speed. The economies both in Malaysia and Vietnam have developed rapidly, while Singapore, Poland and Taiwan, China have experienced a significant economic decline.

However, the world economic environment is continuing to improve with the accumulation of positive factors. There are signs of rebound in world economic growth. Major economies place a high value on the development of real economy. Through financial supervision and guidance, it is possible to transfer financial resources to real economy and support the transformation and upgrading of real economy. In addition, a new round of infrastructure investment and tax cuts will help improve the economic environment. In short, the world economy growth is facing challenges and accordingly the risk probability of financial markets is increasing.

(2) Deep Development of Global Trade

With the development of global trade, the structural adjustment of trade is gradually deepening. The structure of international commerce is evolving as a result of technological innovation and development in developing economies. A new aspect of the transformation in global trade is the shattering of established countries' monopolies through import and export substitution by emerging nations.

In general, the growth rate of the global trade has declined, from 7.5% in 2017 to 3.0% in 2018. Figure 2-8 is as follows. The main reasons are as follows: 1. economic cyclicity; 2. economic depression and contraction of trade and investment; 3. devaluation of currency and reduction of commodity prices; 4. changes in international division of labor, the structure changes of the import and export trade, and slowdown of the global logistics banking chain expansion due to the technological progress of the developing countries; 5. policy intervention in trade from some countries and regions because of the trade protectionism and trade barriers created in free trade zones for non-member countries.

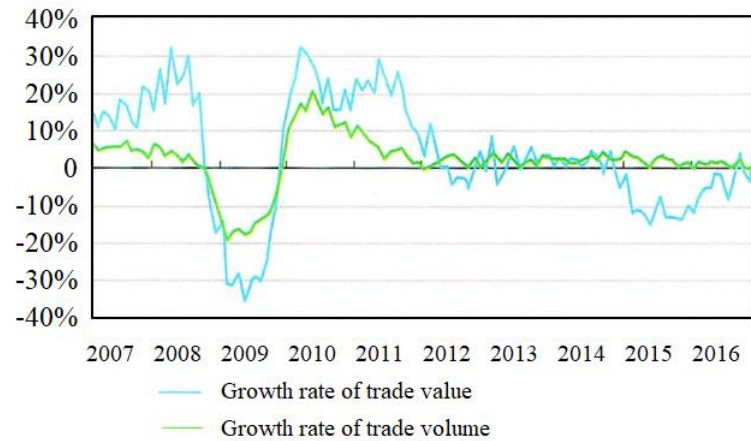


Figure 2-8 Trends in Global Trade

However, new features have emerged in the global trade. 1. Developing countries' voice and status in the global trade are constantly rising. With the further development of China's the Belt and Road Initiative and Asian Infrastructure Investment Bank (AIIB) projects, the economic links among developing countries will become increasingly close, and they can further promote the normalization development of the three ring structures. 2. Trade in services is becoming an important growth point of the global trade, which is transforming from physical trade to culture, education and finance. 3. The trend of anti-globalization under trade protection is obvious. The "re-industrialization" of developed countries has brought about technical barriers to manufacturing trade, hindering the development of global integration and affecting the trade development.

(3) Optimizing of the Structure of International Investment

With the global economic integration, international investment activities have increased. Foreign Direct Investment (FD) plays a more significant function in global capital flows. The spillover impact of FD is advantageous for optimizing host nations' industrial structures and changing the driving force behind economic development.

However, international investment is developing slowly. Both the investment policies and the structures of the major participating countries are complex, and structural contradictions in the investment markets of various countries exist.

At present, many countries in Asian emerging market economies including China, have relaxed their access and conditions for foreign investors. Nevertheless, a multilateral rule-based trading system needs to be opened to deal with further policy changes and the long-term impact on the global investment.

2.2.2 The Domestic Economic Situation

In 2017, the domestic economy grew by 6.9%, while economic growth fell to 6.6% in 2018, the lowest since 1990. Although the economic growth slowed down, the economy maintained a medium-high-speed development. Overall, Although regional economic development has been distinctly varied, the quality of economic growth has increased dramatically. The industrial structure has continued to improve and the power transformation has steadily promoted. Economic downward pressure has increased, and foreign trade has improved, but there are still obstacles to the division of the industrial chain and the rise of value chain.

(1) Slow and Stabilized Growth of the Economic Growth

From the policy point of view, China has stimulated market power through such policies as decrease of fees and taxes (tax reduction and exemption, and abolition of administrative fees). Steady and moderate monetary policies promote stable economic growth. In terms of financial risk prevention, macro-prudence and micro-prudence are combined in the financial supervision. The financial "deleveraging" process is

continuously advanced, and the financial risk resolution is accelerated.

From the perspective of kinetic energy structure, the content of technology and human capital has shown a significant upward trend, and the progress of technological innovation and equipment transformation in traditional industries have accelerated. New market players and models are maturing. Labor productivity continues to rise, and total factor productivity continues to optimize.

The implementation of the national strategy, such as Beijing, Tianjin, and Hebei's coordinated growth under the Belt and Road Initiative, as well as the synergy and superposition effect of the Yangtze River Economic Belt development strategy and significant linkage effect, provides important assistance for the regional economy's coordinated growth. Free trade zones, innovation demonstration zones and reform pilot zones have innovation demonstration effects, linkage effects and growth effects to encourage shared regional economic growth.

(2) Obvious Differentiation of the Investment Structure

The change of investment structure has led to the the industrial structure being modified. The scale of investment in secondary and tertiary industries is increasing. Industrial investment and manufacturing investment are increasing. Investment in infrastructure construction has increased substantially. Among them, the investment in water conservancy management, public facilities management and road transport industry has increased significantly, while investment in railway transport industry has declined.

Due to the Belt and Road Initiative, foreign direct investment has increased by

4.2% to \$129.83 billion in US dollars. At the same time, the structure of the foreign investment has been constantly optimized, cross-border M&A has become more significant in terms of economic restructuring, so that the optimization of the industrial chain is promoted and the internal driving force of economic development is enhanced.

(3) Deep Promotion of the Supply-Side Reform

It is required to resolve overcapacity, to centralize the clean-up of shell enterprises, to shut down and dispose of scattered small-to-medium-sized enterprises, to optimize the capacity management of large-sized o and to reduce the excess real estate investment and the real estate inventory, in order to defuse financial risks. The central bank carries out debt reduction and promotes enterprise innovation.

Investment growth has slowed down, but financial capital is moving from fictitious economy to real economy. Consumption structure has changed from living consumption to high-level consumption. For example, the consumption demand of tourism, pension, health and environment has increased. Export structure is changing from product export to capital and technology export. The effect of structural adjustment is increasingly apparent, and the overall macroeconomic situation is gradually a bottoming process.

2.2.3 Impact of Economic Environment on Logistics Banking Business

The changes of the economic environment have brought a profound impact on the financial needs of enterprises, and then affect the mode and risk of logistics banking business. The economic environment leads to the increase of risks, liquidity

constraints and the difficulty of risk management of logistics banks.

Specifically, in the downturn period, the real economic risk will spread to the financial industry credit risk. The traditional risk management of physical pledge loan increases the operating cost of banks and affects their profitability. Therefore, logistics banks have continuously developed financing business based on warehouse receipts, receivables and advance payments as pledges.

The central bank controls the rising cost of capital by restraining money supply. Therefore, large customers with high credit, such as state-owned enterprises, listed companies and government investment enterprises, will depress asset pricing, thereby reducing bank profits. Therefore, commercial banks pay much attention to small-to-medium-sized enterprises, improve asset pricing, optimize the allocation structure, and enhance the profitability through the provision of logistics banking business.

In the environment of rapid development of financial economy, the commercial logistics banking business industry finances the logistics banking chain upstream-downstream enterprises according to the credit of core enterprises. In this process, through mastering logistics, information and capital flow, and based on the real trade background and closed trading chain, banks lock risk in the trading process relying on financial science and technology, and manage risk relying on data-driving. The risk management concepts, means and innovations supported by financial technology provide support for the development of logistics banking business.

2.2.4 Politic Environment of Logistics Banking Business

Logistics banks can effectively help commercial banks expand their development space and enhance their competitiveness. Regulators have gradually realized the supporting role of commercial logistics banking business for the real economy, formulated better risk supervision policies, and stimulated the development of commercial logistics banking business.

The regulatory authorities have given the commercial logistics banking business industry a relaxed development environment at the policy level. (Major policies of regulatory authorities)

(1) Opinions on Financial Support for Stable Industrial Growth, Structural Adjustment and Benefit Increase

It is recommended to vigorously develop accounts receivable financing, financing service platform, to promote large enterprises and government procurement entities to actively confirm accounts receivable, and to help SMEs suppliers to finance.

(2) Opinions on the Further Implementation of the Action Plan on Internet Circulation

Important measures to promote the circulation revolution and develop the new economy have been introduced one after another, which will thoroughly change the way of thinking and mode of economic development in the past, and use modern circulation technology to break through various barriers from production to consumption for cross-border integration.

(3) Implementation Plan for the Special Regulation of Internet Financial Risks

It is proposed to further standardize various forms of Internet finance, to optimize the market competition environment, to reverse the situation that some forms of Internet finance deviate from the correct direction of innovation, and to establish a sound and long-term mechanism to promote the sound and healthy industry development.

(4) The 13th Five-Year Development Plan for Domestic Trade Circulation

Circulating enterprises are encouraged to use investment funds, chattel pledge and other means of financing, raise funds for domestic trade circulation and development through multiple channels, reduce the cost of enterprise financing, and steadily promote logistics banking chain finance.

(5) Guiding Opinions on Financial Support for the Construction of A Manufacturing Powerful Country

To promote financial institutions, and actively build the financial industry's supply chain to actively develop various forms of industrial chain financial services.

(6) Made in China 2025

To solve the problem of manufacturing industry development, financial support needs developing fully for technological innovation and industrial upgrading in manufacturing industry.

(7) Policy Measures for Promoting the Healthy Development of Private Investment

It is proposed to promote the unified registration legislation of chattel pledge, to establish a nationwide centralized and unified registration system of chattel pledge and accounts receivable based on the Internet, and to realize information sharing, so as to facilitate financial institutions and other relevant parties to inquire and handle

pledged loans.

It can be found that the government supervision for the commercial logistics banking business industry are increasing, such as the policy logic from promotion to vigorous development, the supervision from loose promotion to preliminary formation of the regulatory policy. Under the background of supporting the development of real economy, the commercial logistics banking business industry has been paid more and more attention by the state.

Under the influence of the policy, the logistics bank has changed its focus from attending credit-granting enterprises statically to the whole logistics banking chain dynamically and transaction operation. Therefore, the related enterprises of the transaction chain pay more attention to innovation and product quality.

2.3 Development of Logistics Banking Business

2.3.1 Development from the Perspective of Banks

State-owned banks, joint-stock banks, and urban commercial banks all carry out logistics banking business. The focus and requirements of different types of banks vary.

State owned banks have advantages in brand effect, asset scale, resource base, and operational model, and have launched logistics banking business earlier, which has developed deeply and complex. Some banks(for example Bank of China) take advantage of foreign exchange and foreign trade business to deepen the development of free trade zones and form cross-border businesses. Some banks (for example

Agricultural Bank of China) take the advantage of the physical industry logistics banking chain, based on a complete logistics banking chain, service infrastructure and product production to generate income, and solve the financing problem of the physical industry through logistics banking business. The common point is that banks actively cultivate core customers, build a complete product line, and improve the visibility of logistics bank products.

Joint-stock banks have also launched logistics banking services since 2006. As one of the earliest commercial banks to propose the concept of logistics finance, China Merchants Bank, proposed an overall development strategy for logistics banking chain finance and then an overall service plan for logistics banking chain financing. The development of logistics finance business in domestic commercial banks shows that enterprise structure and management mode affect the competitiveness of logistics financing business.

The logistics banking business of city commercial banks started relatively late, but has a strong momentum. Banks have leveraged their advantages closely related to the region and taken advantage of the development of financial technology to promote the development of logistics banking business, with forward-looking and inclusive characteristics. Banks are based on the local economy, serving small-to-medium-sized enterprises and local enterprises, and on this basis, exploring high-quality large customers. Banks promote the business channel and product development while serving the general public.

2.3.2 Development from the Perspective of Product

In China, logistics banking business started in 2006 and reached a financing balance of 6.9 billion RMB in 2012, 8.12 billion RMB in 2013, and approximately 12 billion RMB in 2016. In recent years, due to the objective factors, the financing scale has fluctuated. Logistics banking business has brought rich intermediate business income and deposits derived from business.

The logistics finance led by banks has incomparable advantages in terms of funds and customer sources. But there are risks control and technological deficiencies, compared to the logistics finance led by the internet. Logistics banking business should collaborate more with external parties, apply Internet , and be more diversified.

Data statistics show that the interest rates of logistics banking business are decreasing year by year, while the non-performing loan ratio is increasing year by year, and the interest rate spread is continuously decreasing. Therefore, banks should pay more attention to small-to-medium-sized enterprises. Banks provide convenient and stable logistics banking products to enterprises for their financing through core enterprises, and reduce the impacts of economic downturn and interest rate reduction.

2.4 Risk Management of Logistics Banking Business

2.4.1 Risk of Logistics Banking Business

Compared with the risk of traditional credit, the risk of logistics banking

business is different in two aspects. One is that the subjects of risk assessment are different. Traditional credit regards a single enterprise as the main body and pays attention to static financial data. In logistics banking business, however, more attention is paid to the risk of the whole logistics banking chain, so the risk assessment is the evaluation of the logistics banking chain transactions. The other is that the degree of risk focus is different. Traditional credit risk is the credit risk of a single enterprise. And the logistics banking business takes the core enterprise as the starting point, and integrates more SMEs in the logistics banking chain into the scope of the service.

Table 2-1 Risk of Logistics Banking Business

Credit risk	Default risk. Loans cannot be repaid on time, leading to the possibility of losses of banks, logistics enterprises and enterprises participating in logistics banking business.
Operational risk	The possibility of tripartite losses results from improper operation, human error and system error in the logistics banking chain.
Legal risk	When controlling the supplier's liquidity assets (including inventory, receivables, payables, etc.), legal risks may arise, including legal invalidity of financial institutions and their agents, uncertainty of legal provisions, invalidity of legal system, etc.
Trade authenticity risk	When enterprises in the logistics banking chain perform financing through logistics finance, the authenticity of trade between upstream-downstream enterprises and core enterprises is the most basic guarantee of financing. False information will cause risks.
Logistics supervision risk	The risk is caused by decision-making mistakes due to the inadequate supervision of logistics enterprises.
Pledge risk	The risk is caused by the change of the value of the pledge in the logistics banking business. The fluctuation of the price of the pledged goods or the failure of the accounts receivable will result in the possibility of default of the financing enterprise.

It is precisely because of the particularity of the logistics banking business model that logistics banking business risks include aspects of not only the risks similar to those of traditional credit business, such as policy, law, market, operation, credit and morality, but also trade background authenticity risks, logistics supervision risks and pledged asset risks, which are different from traditional credit business. The risk classification is shown in Table 2-1(Tianyu W, 2017).

2.4.2 Factors of Logistics Banking Business Risks

There are various unpredictable uncertainties which will bring risks to the business of logistics banking business and lead to the loss of profits and the emergence of non-operational assets of logistics banking business. The risks affecting logistics banking business can be divided into macro-factors, medium-scale factors and micro-factors, among which macro-factors include economy, policy and logistics banking chain, medium-scale factors contain logistics banking chain structure, management, process, and the micro-factors cover the main qualification, finance, transaction background, performance ability and operation condition of financing enterprises. By distinguish the relationship between these factors and risks, it provides an important basis for logistics banking business to avoid and control risks.

Macro-factors are the general term of factors that affect the normal operation of logistics banking business due to changes in external conditions, mainly including economic cycle, industrial environment and upstream-downstream enterprises network. Among them, the economic cycle has a trend of non-systematic impact on the logistics banking business industry. Industrial environment has a structural impact on logistics banking business. And the upstream-downstream enterprises network has

a direct impact on the enterprises and their counterparts in the logistics banking chain.

Medium-scale factors are those that are part of the logistics banking chain by nature, such as its structure, management, and synergy. The entire chain is affected by the financial risks brought on by the banking and logistics industries because of risk transmission.

The micro-factors mainly include the qualifications, financial status, trade background and performance ability of logistics banking chain financing enterprises. They demonstrate the viability of businesses and the legitimacy of transactions, so they have an impact on the risk of logistics banking business.

The above three kinds of risk factors will affect the financing volume, financing cycle and financing rate of logistics banking business. Moreover, these factors are often combined to determine the degree and magnitude of risks. This situation will directly affect the risk management methods of logistics banking business.

2.4.3 Risk Management

The risk management of logistics banking business mainly includes risk identification, risk assessment and risk control. The flow chart is shown in Figure 2-9.

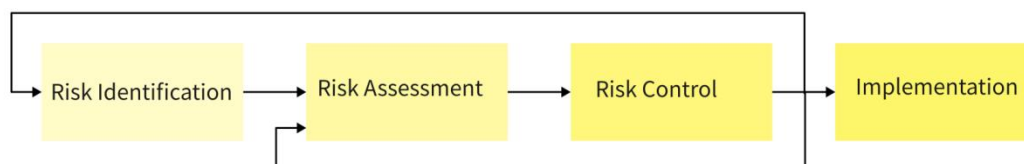


Figure 2-9 Risk Management of Logistics Banking Business

Risk identification is the basis of risk management, which is used to judge the risk factors that may cause losses, to analyze the nature of risks and to classify them systematically. Risk assessment is to analyze, describe and quantify the identified risks, and to obtain the risk resistance capacity of logistics banking business and the risk control measures. Risk control is to take appropriate measures to minimize the possible loss caused by risk, based on risk assessment.

2.5 Method of Risk Measurement

2.5.1 Credit Risk

The risks that banks face are broken down into eight categories in the Core Principles of Effective Banking Supervision (The Basel Committee, 1997): credit risk, state and transfer risk, market risk, interest rate risk, liquidity risk, operational risk, legal risk, and reputation risk. When a borrower or market counterparty defaults, there is a chance that the loan assets will suffer losses and be unable to timely recoup the principal and interest.

Generalized credit risk also includes the possibility of losses to banks due to the debtor's credit reduction which leads to the devaluation of the financing assets. Credit risk is the most important risk faced by banks. Historical experience shows that credit risk management is the basis for banks to take a foothold. It is most likely that poor control of credit risk leads to bankruptcy and financial crisis.

From a narrow point of view, credit risk, also calculated as default risk, refers to the uncertainty of the risks of credit funds. It shows the possibility that the enterprise, the most important loan customer of the bank. As a result a default causes the bank to suffer losses. There are two cases included. One is that the principal and interest of the

loan cannot be fully recovered, so that banks directly suffer capital losses. The other is that the loan cannot be recovered on time, resulting in non-performing assets and difficulties of bank capital turnover.

Credit risk, as a major risk of financial institutions, has the function of dealing with the interaction between market risk and default risk, and exposing the total risk exposure of trading entities. The three main risks of Basel New Capital Accord are credit risk, market risk and operation risk. Credit risk has become the most important and difficult risk among the three. Because the bank's business is to rely on the risk to obtain returns, and the lending and financing business is the main business of the bank, so a certain proportion of credit risk is inevitable. Intensifying the management of credit risk is to avoid non-systematic credit risk so as to guarantee the profitability of both banks and enterprises.

2.5.2 Characteristics of Credit Risk

The premise of measuring and managing credit risk is to grasp the characteristics of credit risk. Compared with market risk and operation risk, credit risk has the following characteristics:

(1) Asymmetric Distribution of Credit Risk

Generally speaking, fluctuations of the market price are symmetrically distributed with expectations as the center of the distribution. The return distribution of market risk belongs to normal distribution. The default events of enterprises are of small probability and asymmetric, so the probability distribution of credit risk is asymmetric. Taking the logistics banking business as an example, the probability of timely repayment of pledged financing enterprises is very high, and the banks will get

the agreed return. However, if the enterprise defaults, even if the possibility of default is low, the bank will incur a greater loss. Therefore, the return of bank lending and financing business is fixed and capped. But once a default occurs, the expected loss of the bank varies with the operation condition of the enterprise and the logistics banking chain. This is also known as the Heavy Tail phenomenon of credit risk distribution.

(2) The Transfer Ability of Credit Risk

In financial activities, credit risk is transferable. For example, the upstream enterprises in the logistics banking chain fail to deliver on time due to the decline in production capacity, resulting in the financing enterprises unable to deliver on time to the downstream vendors, so it is unable to obtain agreed revenue. In this way, the upstream credit risk will infect the core enterprises and downstream enterprises, forming a credit risk chain which is the cumulative sum of credit risk of banks. As a result, the credit risk in the chain of logistics banking business increases exponentially.

(3) Credit Paradox

There is a paradox in credit risk management. In theory, banks should be as decentralized as possible in lending, which is conducive to eliminating the risk effects associated with it. But in practice, because of the transfer ability of credit risk of enterprises, it is difficult to disperse the credit risk of banks.

(4) Mainly Non-Systemic Risk

Although various risks, such as market risk, political risk and natural disaster risk, can be reflected through credit risk, the repayment ability of enterprises mainly

depends on non-systematic factors related to enterprises, such as financial status, operational ability and repayment intention of enterprises. Credit risk is not reflected in these pricing models. Market risk can be decomposed and transferred by means of options, futures and swaps while credit risk can only be controlled by means of structural means, such as bankruptcy isolation, credit risk assessment and so on.

(5) Difficult to Obtain Credit Risk Data

There is obvious information asymmetry before and after the bank loans to enterprises. Moreover, the holding period of enterprise loans is long and the frequency of default events is low. So credit risk data is not as easy to obtain as market risk. Especially in our country, the credit system is not perfect, the credit system has not been established, and the historical data about default events and default rates of enterprises are seriously lacking, thus leading to difficulties in validity testing of credit risk pricing models such as simulation, stress testing and off-line prediction. Therefore, the measurement of credit risk is much more difficult than that of market risk, and the quantitative research results of credit risk are far fewer than those of market risk.

2.5.3 Model

The banking business abroad started earlier, and the research on credit risk measurement by scholars began in 1960s. Comparatively speaking, the credit risk research in China started relatively late, and most of the research is to establish and optimize the model based on the foreign research results.

Generally speaking, Multiple Discriminant Analysis, Multiple Non-Linear Regression Analysis, Artificial Intelligence, Portfolio Credit Risk Measurement

Model, and Internal Rating Based Method are the five steps that may be used to divide credit risk research.

(1) Multiple Discriminant Analysis

Multiple discriminant analysis is the most basic risk research model at present. Initially, Beaver (1966) proposed a single variable decision model and carried out empirical tests. The findings demonstrate the effectiveness of the ratios of net income to total assets and cash flow to total liabilities in predicting default. Altman (1998) developed the multiple discriminant method-based Z-score model. The ZETA model was later created by Z-score.

Laitinen (2000) found that the cash ratio, shareholder equity ratio, and cash flow ratio are significant indicators to assess default risk. He did this by applying the Taylor series method to logit regression analysis. According to Charitou and other researchers (2004), the logit model is more accurate in predicting default risk than other methods are.

(2) Multiple Nonlinear Regression Analysis

Because of the non-linear relationship between default risk and influencing factors, the application of multiple linear discriminant model has some limitations. Credit risk has been assessed using a logical and probit multiple nonlinear regression model. Ohlson (1980), Madalla (1983) and other scholars have applied Logistics Model to carry out empirical analysis, and obtained corresponding conclusions. Zmijewski (1984) used Probit Model to predict ruin probability. The results show that the difference of sample selection has a significant impact on the discrimination and prediction value of the model within the group, but does not affect the parameters of

statistical factors and the total prediction accuracy.

(3) Artificial Intelligence Method

Around 1990, Credit risk measurement techniques based on artificial intelligence have become more common. Nowadays, BP Neural Network is a commonly used credit measurement model. Odometer (1990), Altman (1994), and Trippi and Turban (1996) successively used neural network model to study credit risk and financial crisis early warning. The neural network has more advantages than multiple discriminant analysis method does. In this process, Messier and Hansen (1988) introduced expert analysis system into risk measurement for the first time. Varetto (1988) argues that expert analysis is more conducive to identifying default rates. But up to now, the disadvantage of expert analysis is that the sample size is not large and there is a certain degree of subjectivity.

(4) Portfolio Credit Risk Measurement Model

Numerous novel methods of credit risk measurement have been put forth in response to the capital markets growth and the complexity of credit risk. Based on the BSM paradigm, KMV launched the Credit Monitor paradigm in 1993. Having been developed by Longstaff and Schwarz (1995), the model is now considered as one of the most mature and well-known credit risk measurement models. On this basis, The Risk Metrics Model was introduced by J.P. Morgan (1994) utilizing Value at Risk (VaR). Later, he created Credit Metrics with KMV (1997), a two-phase system for calculating credit risk. David Jones and Mingo (2001) optimized the Risk Metrics Model.

CSFP Credit Suisse Financial Product, 1997 developed the Credit Risk + Model.

Saunders and Wilson (1998) established the Credit Portfolio View Model by using the basic dynamics principle. The model is designed to examine how macroeconomic conditions affect changes in borrowers' or individuals' credit ratings.

(5) Internal Rating Based Method

Basel Committee (2001) put forward the opinion that banks should use internal rating based method to measure credit risk as far as possible. Additionally, the Committee categorizes it into basic and sophisticated internal rating-based methods. Financial institutions must determine default rates (PD) for various borrowing levels based on internal data, and default risk exposure (EAD) and given default loss rate (LGD), in addition to these default rates. The aforementioned limits are set forth in the high-level law by the bank, but they must first be approved by the regulatory agencies in order to be put into practice.

Berger (2005) made an empirical study on the internal rating system (SBCS) of SMEs and its effect. Frame (2004) subsequently verified the similar results as well. SBCS can reduce the cost of bank loans and improve the information transparency of enterprises. However, Carey and Hrycay (2001) pointed out that in order to test the effectiveness of internal ratings, at least a ten-year historical sample should be needed.

However, the application of internal rating system encounters some difficulties. It is difficult for domestic banks to meet international standards. No matter whether from regulatory requirements and regulatory system or from credit environment and human resources, information transparency is not enough to obtain the data required by the internal rating system.

For domestic credit measurement research, no matter whether it is banks or

scholars, it is basically the theoretical analysis and introduction to the foreign research. The reason is that the awareness of credit risk is developed late in China, the supervision system is imperfect and the data is missing, which results in less quantitative research. Subsequently, some scholars have improved the existing model based on the unique economic environment of our country, and made empirical analysis. Most empirical studies and related literature have been formed in recent years.

Chen Zhongyang (2001) and Li Zhihui (2001) introduced the method, the model and the technology of quantitative technology of credit risk management, and put forward suggestions for improvement. Shen Peilong, Ren Ruoan (2002) and Wu Chongfeng (2012) compared and analyzed the theoretical basis of the model, the advantages and disadvantages of the main methods of the credit risk measurements and presented the improvement suggestions as well.

Wang Qiong (2002) made a theoretical comparison between KMV model and other models. Compared with other credit risk models which only focus on financial data, KMV model is more suitable for evaluating the credit risk of listed companies. Zhang Zhimei (2006) improved the KMV model for China's banks and applied it to the personal credit measurement of China's banks. At the same time, she applied compensation pricing method, single factor model, Monte Carlo simulation and VaR model to the credit risk analysis of Chinese banks.

He Shuhong and Wang Shanmin (2007) used additional information test and multiple collinearity test to select independent variables to improve the stability and accuracy of selected sample variables of the model, and established a credit risk

measurement function based on Fisher's discriminant principle. The empirical results show that the model has good stability and accuracy, and has stronger recognition ability for ST sample sets with bankruptcy risk.

By using KMV model, in order to evaluate the likelihood of default, Yan Lirui (2009) conducted an empirical examination of the credit risk of Chinese listed enterprises. The empirical findings reveal that default probability is a more accurate way to assess the credit risk of publicly traded corporations, indicating that the model has better applicability in China. Establishing the historical default database of listed firms is also crucial at this time.

In the study of internal rating system, Zhang Zhang and Fu Qiaoling (2003) pointed out that the advantage of internal rating is that banks can calculate the capital prepared to prevent credit risk by calculating the probability of customer's loss at different levels and the potential loss of banks. However, the internal rating system must meet the minimum standards of the Basel Committee, including risk management system, rating system and data collection capacity, as well as monitoring system.

Luo Kaibian (2005) proposed the establishment of credit risk cumulative model. Firstly, by using default probability model, the measurement of the transition probability and default probability of historical credit rating is made. Then, through the credit transfer matrix, the model is corrected by bringing in new data from each subsequent economic cycle. Finally, the correction model of credit risk is obtained to reflect the impact of macroeconomic factors.

Liang Ling et al. (2008) studied the calculation of bank credit risk capital on

account of internal rating method. Based on the migration rate matrix of mortgage asset classified loans, the default probability of various types of loans in banks' loan business is obtained. Because of the management principle of bank credit examination, and the execution principle of asset clearance, banks cannot make profits through litigation when clearing pledges, but can only obtain the principal and interest of loans. According to the above principles, the calculation model of the comprehensive default loss rate of collateral pool is established. Based on the above model, IRB method is used to calculate credit risk.

2.6 Method of Stress Testing

2.6.1 Introduction

The difference between the generation and development of stress tests and methods lies in that stress tests can measure the losses of financial assets and portfolios in case of abnormal macroeconomic fluctuations. It can be used as a supplementary risk management method. The method has been widely used. With the rapid development of the financial market, the financial links between countries are becoming closer and closer. The impact of the outbreak of the financial crisis is not limited to one country. Therefore, when extreme economic fluctuations occur, it will cause huge losses to the world economy. However, the role of the method in this case is not obvious, so the practical and technical circles have developed a stress test method to measure the losses in extreme economic fluctuations. Since then, stress tests have been widely used in financial institutions. Only when they are combined with stress tests can we comprehensively measure financial risks.

2.6.2 Concept Definition

International securities regulators pointed out that the stress test (assuming that the market is in the most unfavorable situation (such as a sudden sharp rise in interest rates or a sudden fall in the stock market), analyzes the impact on the portfolio; More specifically, stress testing is to identify and quantify the risks that may occur under extreme circumstances faced by the portfolio. The International Monetary Fund defines stress testing as a set of procedures designed to evaluate the effects of unusual but plausible macroeconomic shocks on the susceptibility of the financial system. According to the China Banking Regulatory Commission, stress testing involves subjecting the entire financial institution or asset portfolio.

2.6.3 Measurement

The impact of a single risk factor or a combination of risk factors can be considered while dividing the sensitivity analysis technique and the scenario simulation method. The impact analysis of a single risk factor is known as sensitivity analysis, whereas the impact study of one or more risk factors is known as scenario analysis. A sensitivity study might examine, for instance, how dropping home values affect commercial banks' economic capital or loan default rates. The investigation of the effects of a reduction in housing prices, a weakening of the dollar, and a decline in economic growth on the rate of default on bank loans or the level of economic capital falls under scenario analysis. The historical scenario analysis is to calculate the loss value by substituting the scenarios in the historical economic fluctuation period into the simulation process, while the hypothetical scenario analysis is to calculate the loss value according to the artificial imagination based on a certain basis.

2.6.4 Classification

According to the different scope of concern, in order to track the changes in asset portfolio values brought on by abnormal-but-reasonable shocks, the first type of stress test is based on institutions (asset portfolios). They are known as micro stress tests, and their goal is to estimate the possible impact of shocks on a certain business or asset portfolio of financial institutions. The financial system is the topic of the other stress test. It is employed to gauge the financial system's susceptibility to abnormal-but-reasonable macroeconomic shocks. Its objective is to assess how shocks affect the overall financial system. It is called macro stress testing.

2.6.5 Macro Stress-testing Model

Financial regulators can use it to more effectively monitor the risks posed by financial institutions. It is used to measure the extreme macroeconomic volatility impacts on the stability of the financial system. Micro stress testing has been a crucial risk management technique for banks since its widespread adoption in the early s in the global banking sector. After this, large financial institutions' transnational activity increased in frequency as the trend of financial globalization accelerated, which led to the increasingly serious problem of potential financial risk contagion. As a result, the attention to the entire financial system continued to rise, and the role of macro stress testing in measuring the risks of the entire financial system became more and more obvious. The macro stress test method was initially utilized as a key component of the analysis tool to measure the stability of the financial system in the financial sector assessment project undertaken by the International Monetary Fund (IMF) and the World Bank (WB).

Subsequently, with the help of the project, the method became a tool widely used by the policy authorities of its member countries in the analysis of the stability of the financial system. The policies of various countries developed their own macro stress test models in the current week. In the long run, the macro stress test will inevitably become a crucial component of the stability measurement of China's financial system Law.

2.6.6 Typical Model

(1) Stage Model (Default Dependency Model)

Goodhart uses a nonlinear method to aggregate the stress test results of a single commercial bank, and introduces the default dependency function, a new research method, into the model analysis, focusing on the dynamic impact of macroeconomic changes on the commercial banking system. The advantages and innovations of the model are as follows: ①The joint default risk among commercial banks is analyzed under nonlinear conditions, and the stability and default dependence among commercial banks are simulated; ②This paper analyzes the individual characteristics and related incentive problems among different banks from multiple angles. ③It studies the relationship between micro individuals and macro-economy, focuses on the ratchet effect in stress testing, and emphasizes that risk contagion is one of the main factors causing financial crisis. The defects and shortcomings of the model mainly lie in that the practicability and operability of the model are not strong due to the large amount of calculation of the model, and the model is not strong in explaining the results of the stress test.

(2) CPV Model

Among the existing theoretical credit risk factor models, the single factor model proposed by Gordon (2003) and the credit portfolio view(CPV) model proposed by McKinsey & Co are representative models to measure credit risk based on macroeconomic factors. Among them, the single factor model is to set up a single macroeconomic factor, which can not distinguish the different effects of macroeconomic factors related to the economic cycle on the credit risk of logistics banks, so it is not suitable for the analysis in this study. Based on the open factor framework, CPV model can be used to measure a variety of macroeconomic factors. The CPV model simulates the joint conditional distribution of default and transfer probabilities of various industries and credit ratings in each country by relating these probabilities to macroeconomic variables such as interest rate, unemployment rate, GDP growth rate, exchange rate, government expenditure, and savings level. When economic conditions deteriorate, downgrades and defaults increase. The opposite is true when the economy improves. The model generates the probability distribution of default transfer. If the data are available, the concept can be used to various debtor groups and classifications in any nation. These debtors may be employed by a variety of sectors of the economy, including financial institutions, agriculture, construction, and services. However, the application of the above model in the practice of domestic logistics banks is relatively less.

2.7 Summary

Literature review introduces the concepts of logistics banking business, risk management and credit risk, and the methods of risk measurements.

It firstly introduces that logistics banking business provides financial products and services to one enterprise in a closed logistics banking chain or to a logistics banking chain system. Banks assess the credit of the core enterprise in the logistics banking chain in order to gain the credit of upstream or downstream enterprises which need financing. Besides the concept, the part of review introduces the subjects, the operation methods of logistics banking business, and the basic theories of loan and financing in logistics banking business.

Secondly, it introduces the risks of logistics banking business, and the main logit of risk management. What is learned in this part is that the means of risk management is to calculate and control the credit risks in the whole procedure of logistics banking business.

Thirdly, it summarizes the characteristics of the credit risks, and the measurement methods of credit risks. The research on credit risk measurements started much earlier by foreign scholars than by domestic scholars. The popular theories of credit risks measurements include multiple discriminant analysis(Z-score, ZETA model, logit model), multiple non-linear regression analysis(Probit model), artificial intelligence(Neural Network, Support Vector Machine), portfolio credit risk measurement model(VaR, Credit Metrics, Credit Risk+ Model), and Internal Rating Based Method. And the domestic researchers have developed the models in order to adapt the macroeconomic circumstances in China.

In conclusion, there are differences between traditional bank loan and financing business and logistics banking business. The former is to deliver financial services and goods to a single item, while the latter serves the whole logistics banking chain system. Thus, the research uses the general methods of credit risk measurements for reference and develop the advanced models for different procedures of logistics banking business to analyze the risks in logistics banking business system.

3. Study on Credit Risk on Banks in Logistics

Banking Business in the Macro-environment

3.1 Introduction and Theory

3.1.1 Introduction

Risk management of logistics banking business should cover the Whole-course of business, namely risk identification, measurement, prevention and control, before, during and after loan. An important part of pre-loan risk control is risk identification, a process of analyzing the causes of risk events according to the changes of external situation of business entities and their own conditions. By confirming the loan risk in the macro environment, the bank decides whether to lend in the logistics banking business in order to produce the logistics banking business. This chapter studies the pre-loan risk identification of logistics banking business based on China's macroeconomic background.

The main risk of bank logistics business is credit risk between which systematic risk and non-systematic risk can be distinguished. Systematic credit risk is caused by macro-factors while non-systemic credit risk results from the difference of the main characteristics of the loan business. Credit risk is the main concern of risk management for banks and financial regulatory authorities when determining the pre-loan risk.

China's 12th Five-Year Plan proposes to build a framework of counter-cyclical system of financial macroprudential management. Under the bank-led financial system, the risk situations of banks is relevant to the macroeconomic and financial

system stability. Conversely, systemic financial stability and macro-economy influence the risk situation of banks. One of the important factors to be considered in building a logistics banking business risk management framework is monetary policy's effect on bank risks.

Previous part show that risks of macro factors has pro-cyclical effects (Basel III, 2009). When the changes in macro environment occur, the main body of logistics banks will be affected to different degrees. With the change of the same macro-factor, enterprises with different asset characteristics will also be affected to varying degrees. In the logistics banking chain of logistics banks, if the core enterprises and the upstream-downstream enterprises are influenced by the same macro-factors, the overall credit risk will increase geometrically. According to the previous description, 80% of the bad assets of logistics banks are generated in the process of economic transformation. Originally, banks tend to lend to state-owned enterprises with sufficient assets and good credit. SMEs will suffer from credit discrimination, making it challenging to finance from banks. However, as the economy, technology, and network information technology have advanced, state-owned businesses' liquidity has gotten worse and their operational efficacy hasn't improved much. If logistics banks still tend to distribute assets to state-owned enterprises, is it possible to cause more serious credit risk?

Therefore, this chapter analyzing empirically how macroeconomic variables affect bank risks is drawn from the statistical description. Finally, in the next step of studies, empirical research analyzes the impact of different characteristics on credit risk when macro-environment changes. The description model is shown in Figure 3-1.

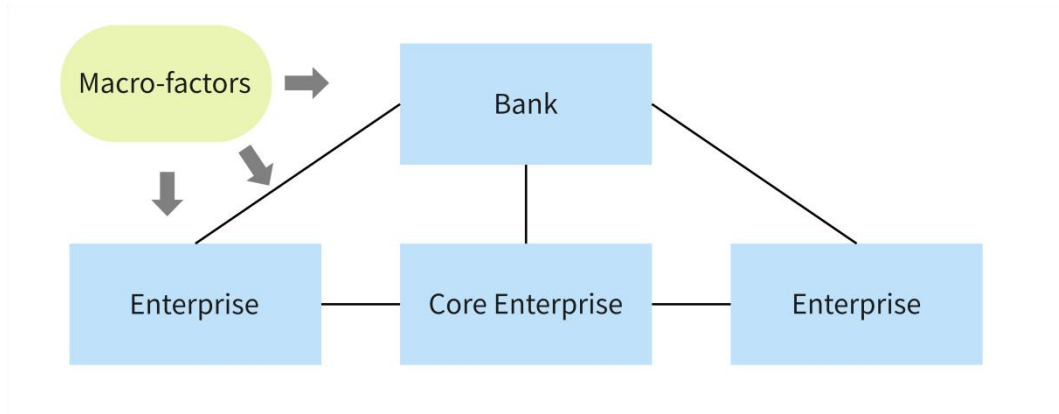


Figure 3-1 Impacts of Macro-factors on Credit Risk in Logistics Banking Business

When a study is made on the statistical analysis of the macroeconomic impact on logistics banks in logistics banking business, it is uncovered that this systematic impact of macro-factors cannot be easily eliminated or ignored. To understand the risks that the banks suffer, it is necessary to consider first what and how macroeconomic circumstance influences the banks. In China, the financial market and industrial economy are mainly involved by the government adjustment. Macroeconomic policy is a main measure of the government to adjust macroeconomic condition. Loose monetary condition leads to excessive expansion of financing and is a significant factor in financial imbalances and economic volatility. To explore the impact of the macro-factor on credit risks of the logistics banks in this influenced market, the study examines how monetary policy affects bank risks in logistics banking business.

3.1.2 Theoretical Basis

Macro policies mainly affect the way and mechanism of bank risks. The mainstream view(Adrian T., Shin H.S,2009, and Borio C., Zhu H, 2008) is that bank risks are negatively impacted by low interest rates, mainly through the following

seven mechanisms: (1) Asset valuation mechanism. The decline of interest rate increases the value of assets and collateral, which will reduce the bank's estimate of default probability, loss and volatility, and encourages banks to take risks. (2) Looking for the yield mechanism. The fall in the bank's target income is caused by the low interest rate, which also encourages the bank to invest in financial products that have a high potential for profit but high risk. (3) A method for asset substitution. The percentage of hazardous assets in the portfolio will rise on account of the drop in interest rates. Until the safe asset to risky asset ratio reaches a new equilibrium, the demand for risky assets from risk-neutral banks will boost. (4) Leverage stabilization mechanism. Low interest rates will promote growth in asset prices, boost the capital of listed banks, and increase bank demand for bank assets, all of which will raise the leverage ratio. Low interest rates' impact on bank assets has been accelerated by this response. Such a vicious cycle will eventually make the banking system complicated to maintain a stable state in the face of asset shocks, so the risk is also higher. (5) The communication mechanism of the central bank. Low rates of interest result in weak monetary policy and lax government oversight, encouraging banks to risk. (6) Mechanism for misalignment between assets and liabilities. When the monetary policy is broadened, the interest rate is low and only short-term deposits are accepted by banks. They frequently use leverage because long-term project funding and short-term deposits are incompatible. The danger of bank failure increases as leverage increases. (7) Mechanism for habit formation. Investors typically spend more when interest rates are low, and a wide credit spread is anticipated (the spread that compensates investors for the underlying assets' default risk and is higher than the risk-free interest rate). As a result, banks face greater risks if investors take out additional loans from them or invest in their high-risk financial products.

According to several research, there is uncertainty on how monetary policy would affect bank risks. This is because a variety of factors affect portfolio reallocation and risk transfer, two forces that mutually cancel each other out (Gianni De Nicol, Giovanni Dell'Aricecia, Luc Laeven, and Fabian Valencia, 2010). The monetary policy is brought out with time, the banking system, or bank characteristics (Giovanni D, Luc L, and Robert M, 2010, Vasso I, Steven O, and José P, 2009), the effect on bank risks may alter.

3.1.3 Measurement

The measurement test of monetary policy's effect on logistics banking risks mainly focuses on the directionality of monetary policy's effect on logistics banking risks and the difference of the impact due to the different characteristics of bank balance sheet.

Banking underpins the Chinese financial system and the risk posed by banks also directly affects the country's financial stability. Expansionary monetary policy frequently leads to excessive credit expansion and induces financial imbalances and economic fluctuations, influencing bank risks.

Limited numbers of evidence from both theorizing and practice in China on the monetary policy's effect on logistics banking risks in logistics banking business, not only because of the lack of logistics finance business development, but also due to few researches on the monetary policy indicator. The impact of interest rates is the main focus of studies on the consequences of monetary policy.

Monetary policy has a nonlinear effect on risks. Risk behavior of banks is

subjective and irrational. The monetary policy implementation changes the characteristics of risk management. The change in risk appetite is sluggish, gradual, and non-discrete, and so as the changes in decision making. The effect on logistics banking risks vary across different macro environments and the types of monetary policy, and are uncertain due to the counteracting determinants.

3.2 Method

3.2.1 Introduction of PSTR Model

Nonlinear relationship is a common and complex phenomenon in the financial field. There is also a possibility of nonlinear effect on logistics banking risks. Due to the different macro environment, bank characteristics and types of monetary policy, the impact on logistics banking risks is different, and the impact enthusiasm and intensity are uncertain. After monetary policy into practice, the changes of bank risks preference, risk cognition and risk decision-making have the characteristics of time lag, gradual and non discrete changes. The impact may change correspondingly in different states, with Asymmetric Change Characteristics in different states. Therefore, this impact is nonlinear. In this way, if we theoretically analyze the impact under the linear paradigm through a linear model to test the direction and intensity of the impact, there will inevitably be serious deviation, and the effectiveness of analysis and prediction will be greatly reduced. In econometrics, PSTR model has advantages in studying non discrete change processes and nonlinear characteristics. Therefore, it is necessary and feasible to improve and develop the nonlinear PSTR model of the effect on risks from China's monetary policy in the logistics banking business and provide reliable empirical evidence for the view that monetary policy has a nonlinear risk effect in the logistics banking business.

3.2.2 Method of PSTR Model

Researchers are now realizing that the nonlinear model can better capture economic events and economic laws. (Chang, 2006). Hansen (1999) used a panel threshold regression (PTR) model and first presented threshold effects, which presuppose that a transition between two regimes exhibits an abrupt leaping effect. The Panel Smooth Transition Regression (PSTR) model, was developed by González et al. (2005) to address these flaws (Chang and Chiang, 2011).

The transition between regimes takes place smoothly and gradually over time rather than discretely or abruptly in a PSTR model.

The PSTR model is given by:

$$y_{i,t} = \mu_i + \beta_0' x_{i,t} + \sum_{j=1}^r \beta_j' x_{i,t} g_j(s_{i,t}^{(j)}; \gamma_j, c_j) + \varepsilon_{i,t} \quad (3-1)$$

where $i=1, \dots, N$, $t=1, \dots, T$, and N and T denote the cross-section and time-dimension of the panel, respectively. y is the dependent variable, μ_i represents the fixed effects, X_{it} is the k -dimensional vector of time-varying exogenous variables, $r + 1$ is regimes amount. $s_{i,t}^{(j)}$ represents the threshold variables including lagged endogenous factors as well as exogenous ones. $g_j(s_{i,t}^{(j)}; \gamma_j, c_j)$, $j = 1, \dots, r$ are the transition functions, with a range between 0 and 1 normalized. β is the regression coefficients, ε is the residual term, and c_j means the threshold parameters. γ_j slope parameter by which transition rates from one regime to another are indicated.

The logistic specification can be utilized for the transition function, following

Granger and Teräsvirta (1993) and Teräsvirta (1994) in the time series context and González et al. (2005) in a panel framework.

$$g(s_{i,t}; \gamma, \mathbf{c}) = \left[1 + \exp \left(-\gamma \prod_{l=1}^m (s_{i,t} - c_l) \right) \right]^{-1} \quad (3-2)$$

with $\gamma > 0$ and $c_1 \leq c_2 \leq \dots \leq c_m$. The PSTR model reduces to a PTR model when $m = 1$ and $\gamma \rightarrow \infty$.

When $m=1$, the model is referred to as being in the low regime or high regime, respectively, if the transition function is either 0 or 1. The model transitions between the low regime and the high regime smoothly because the values of the transition function transit between 0 and 1 gradually.

When the value of S_{it} is the position parameter c , the conversion function's value is 0.5, which converses the model's mechanism using the position parameter as its symmetry center. In the process of high-low system conversion, the coefficient of the parameter will be smoothly converted between β_0 and $\beta_0 + \beta_1$. The PSTR model also changes correspondingly with the transformation variables when the time t and the individual i change continuously. Between different mechanisms, dependent variable y_{it} has the function of nonlinear smooth transformation. If s_{it} is the lag term of dependent variable y_{it} , the model (3-1) is self-excitation smooth transformation model. The variables chosen should reflect the cross-section element's nonlinear transformation, if s_{it} is not the dependent variable in the model (3-1).

González et al. (2005) raise that to capture the nonlinearities caused by regime switching, it is sufficient from a practical standpoint to merely take into account the situations of $m = 1$ or $m = 2$.

PSTR model is a parameter model with available state variables, which can accurately reflect the smooth transformation of the model between different mechanisms, and can track the smooth or gradual changes between mechanisms, which is more consistent with reality. PSTR model combines the advantages of panel data and nonlinear model. Nonlinear parameters are estimated in the model, or the selected variables are also nonlinear. In this study, it mainly refers to the nonlinearity of the parameters to be estimated, which can well show and express the heterogeneity of panel data.

Hansen (1999) proposed to set a threshold value (variable q_{it} exceeds the threshold value c) in the model, classify and divide all cross-section data based on the threshold value, form different systems on this basis, and use the linear method to estimate the parameters and test PSTR model.

González et al. (2005) propose a three-step approach to apply to PSTR models: (i) specification, (ii) estimating, (iii) evaluation, and choice of the number of regimes (option of r). This methodology is similar to that employed in the time series context. Some clarification on each part of empirical analysis follows Figure 3-2.

The empirical analysis studies monetary policy's nonlinear effects on logistics banking risks based on PSTR model from the viewpoint of monetary policy tools as well as intermediary. Firstly, it measures the situation by the intermediary target, money supply, and study the non-linear effects on logistics banking risks in general. The study applies Matlab simulation to calculate expected default rate as the measurement of bank risks in logistics banking business. And the result expects that

there is non-linear impact on bank risks, which is influenced by the changes of macro-condition as well as bank's characteristics.

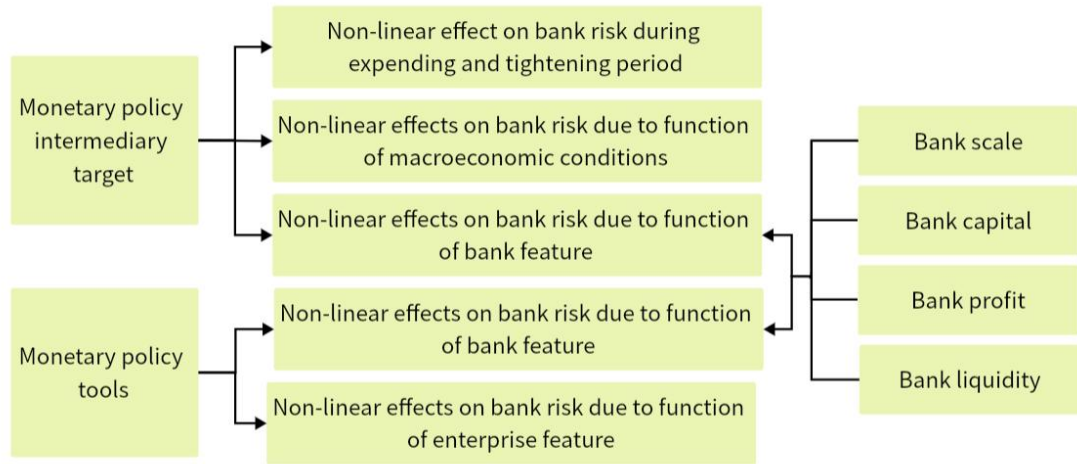


Figure 3-2 Methods of Non-linear Effects on Banks from Monetary Policy

The identification step compares the homogeneity to the PSTR substitute by testing the null hypothesis $\gamma = 0$. First-order Taylor expansion is utilized since the null hypothesis predicts the existence of unidentified nuisance parameters.

$$y_{i,t} = \mu_1 + \beta_0^* x_{i,t} + \beta_1^* x_{i,t} s_{i,t} + \dots + \beta_m^* x_{i,t} s_{i,t}^m + \varepsilon_{i,t}^* \quad (3-3)$$

where $\beta_1^*, \dots, \beta_m^*$ are multiples of γ , and in the Taylor expansion $\varepsilon_{i,t}^* = \varepsilon_{i,t} + r_m \beta_1^* x_{i,t}$, r_m is the remainder. Testing $\beta_1^* = \dots = \beta_m^* = 0$ in Eq. (3-3) to examine the null hypothesis of linearity. Under the null hypothesis, LM-test statistic is a $\chi^2(mk)$ distribution asymptotically.

This test is the same as in the time series context, helpful to choose the appropriate transition variable, which lowers the associated p-value, and the appropriate sequential order of m in Equation (3-3).

The evaluation process entails (i) conducting misspecification tests to determine the regime amount and (ii) verifying the correctness of the estimated PSTR model.

The tests of parameter constancy over time and of having no residual nonlinearity, which were introduced by Eitrheim & Teräsvirta (1996), is proposed to be modified by these. The number of regimes in the PSTR model can be determined using the test of no remaining nonlinearity, which in the context of panel data is read as a test of no remaining heterogeneity.

González et al. (2005) suggest estimating a linear model first; if the homogeneity hypothesis is rejected, then a PSTR model; if the no remaining heterogeneity hypothesis is rejected in the PSTR two regimes model, then a PSTR model with three regimes should be estimated, until the test is completed.

3.3 Variable and Data

3.3.1 Variable

The dependent variable (bank risks), independent variable (monetary policy indicators), conversion variable, and related control variable are the primary variables used to analyze the non-linear impact on logistics banks during the expansion and contraction periods of monetary policy .

Dependent Variable

The literature on the connection between bank risks and monetary policy primarily uses the volatility of return on capital, the volatility of return on assets, the ratio of loan loss reserves to total loans, non-performing loans and loans, bankruptcy risk, and expected probability of default (PD) when choosing the dependent variable, bank risks index. Theoretically, expected default probability is the preferred indicator to measure bank risks (Altunbas, 2011). The volatility of related stock price and return is unquestionably an excellent choice to illustrate the risk behavior of banks given the

nature of risk. Thus, the expected probability of default (PD) is selected as the explanatory variable to measure bank risks.

Other advantages of PD: (1) Easy availability of data. PD is primarily based on financial information from financial statements and stock trading data of listed firms, and the results are relatively objective. (2) Timeliness of model response. Because PD is a dynamic indicator which can update model input information with the changes of the stock trading data of Listed Companies and the financial statements regularly issued by listed companies, so PD has the ability to promptly reflect changes in the bank's and target company's credit risk levels. (3) The foresight of the model. The error introduced by using past data to represent future trends is mitigated through PD indicators. PD is derived using the stock market's current real-time market conditions. The stock market's return rate and market value change can offer perception into the performance and level of a company in a given market, as well as the expectations of that market and its potential future direction (Feng Z, 2009).

Default happens when the point of default, also known as the moment at which the enterprise's assets value falls below a specified threshold, is reached. At this level, the value of the enterprise's assets is equal to the value of its liabilities. Generally speaking, when the company defaults, that is, at the default point, the asset value is positioned between the total liabilities and short-term commitments. The company's net worth is determined by subtracting the market value of its assets from its default point.

$$\text{Net Value of Enterprise} = \text{Asset Market Value} - \text{Default Point} \quad (3-4)$$

The volatility of assets is used to reflect the asset risk of the company. The size of

the firm under investigation and the state of its industry might be related. It is equivalent to the yearly change percentage of the company's asset value multiplied by the standard deviation. The volatility of the associated asset can be increased by financial leverage. While companies with significant asset volatility, such as computer software, benefit from low leverage, those with low asset volatility, like the banking sector, typically employ high levels of leverage. It may be seen by using several levers that stock volatility is lower than asset volatility, which will vary greatly with the change of industry and asset scale. Therefore, although asset volatility is similar to stock volatility, it is also two different concepts. The above determinants are a way to estimate the default risk completely. It compares the fluctuation range of the company's net worth and asset value to obtain the calculation index shown in the following formula, which is called the default distance:

$$Default\ Distance\ (DD) = \frac{Asset\ Market\ Value - Default\ Point}{Asset\ Market\ Value \times Asset\ Volatilit}$$

(3-5)

KMV Model applies a database of historical default information, estimates the default distance corresponding to the expected default rate, and fits it into a smooth curve, so as to estimate the value of PD through the known default distance. KMV Company defines three main steps in the process of determining PD: (1) Calculate the asset volatility and value. (2) Determine the default distance (DD) (3) Determine the PD.

It assumes that the company's Asset Market Value will fluctuate according to the following random procedure:

$$dV_A = \mu V_A dt + \sigma_A V_A dz \quad (3-6)$$

where V refers to Asset Market Value, μ , refers to the drift rate, σ_A is Asset Market Value volatility, and dz is a Wiener process. There is a correlation between the market value of the company's shares and the face value of the debt due at time T.

And the assets' current market value:

$$V_R = V_A N(d_1) - e^{rT} X N(d_2) \quad (3-7)$$

Where the market value of the company's shares is represented by V_R , N is normal distribution function, and r represents risk-free interest rate.

$$d_1 = \frac{\ln\left(\frac{V_A}{X}\right) + \left(r + \frac{\sigma_A^2}{2}\right)T}{\sigma_A \sqrt{T}}$$

$$d_2 = d_1 - \sigma_A \sqrt{T} = \frac{\ln\left(\frac{V_A}{X}\right) + \left(r - \frac{\sigma_A^2}{2}\right)T}{\sigma_A \sqrt{T}} \quad (3-8)$$

In the above formula, asset value and standard deviation of return are implicit variables, which cannot be obtained from the market. In order to solve these two variables, another equation is needed :

$$\sigma_E = \frac{V_A}{V_E} N(d_1) \sigma_A \quad (3-9)$$

To avoid the prediction error of default frequency due to the change of debt market value, the above formula is iterated to obtain:

$$\ln V_A^t = \ln V_A + \left(\mu - \frac{\sigma_A^2}{2}\right)t + \sigma_A \sqrt{t} \varepsilon \quad (3-10)$$

Where V_A^t refers to the market asset value at the time of t . ε denotes the random garden of the income following the conventional normal distribution. μ and denotes the expected rate of return on the assets.

Assuming that the company's asset value exhibits the features of a log-normal distribution, the listed company's default distance is:

$$DD = \frac{E(V_A) - DP}{E(V_A)\sigma_A} \quad (3-11)$$

The expected value of assets in the future is $E(V_A)$. DP refers to the default point, which is expressed by the linear combination of the company's long-term liabilities and short-term liabilities. The coefficients before the two are usually selected as 0.5 and 1 respectively, that is $DP = SD + 0.5LD$, the sum of the company's short-term debt and half of the long-term debt. The default probability is $P_t = N(-DD)$, where N is the standard normal distribution function.

Independent Variable

Independent Variable is Monetary policy. Studies in the past use interest rate as the indicator index of monetary policy, i.e. higher interest indicates contractionary monetary policy and vice versa. Money supply can then represent China's monetary policy stance. However, it is obvious that the use control of the base currency should always be under the reasonable and direct control of the national government, and there are quite a few different monetary aggregates.

Broad money supply (M2) can be a good monetary policy indicator in China. The People's Bank of China (PBC) has set monetary policy intermediate targets for only broad money, without including narrow money and the new RMB loans from

2007 and on. The PBC establishes annual growth targets for broad money and monitors movements in broad money in its quarterly reports.

Transition Variable

Broad money, represented by M2, is used as a transition variable in order to explore how monetary policy affects the economy in contraction and expansion phase on bank risks. Money supply changes reflect changes in monetary policy, the expansion and contraction of monetary policy. When in an expansion period, monetary policy stimulates aggregate demand by boosting the money supply. The money supply (M2) is at a high level when the money supply is higher than the money required for normal economic operation. When it is in the tightening period of monetary policy, the level of total demand is reduced by reducing the money supply, reduces the amount of money in circulation, and brings the total demand and supply back to a balanced state, so as to accomplish the ultimate objective of monetary policy. Therefore, the money supply (M2) is at a low level. Mark as M.

Control Variable

Macroeconomic conditions can affect bank assets and liabilities, thus affecting their risk levels. The purchasing manager's index (PMI) and the real estate price index are selected as the control variables.

3.3.2 Data

Since 2007, the expected target of monetary policy set by the People's Bank of China is broad money (M2), which no longer includes narrow money supply (M1) and new RMB loans. The measurability and controllability of quantitative

intermediary targets have significantly decreased since 2012 as a result of the ongoing promotion of China's interest rate marketization and the explosive growth of shadow banking, Internet Finance, and asset management channel businesses of financial innovation. Thus, from 2007 to 2016 the macro money supply was primarily the intermediate aim of the central bank's monetary policy from 2007 to 2016 before progressively shifting to the money market interest rate. The data window from 2007 to 2016 is an ideal range to study the impact of monetary policy with money supply as an indicator on bank risks. Logistics banking business in China is in its early stages of development. The modes and types of logistics banking businesses developed by banks are straightforward. The traits of loan firms are comparable, and it is possible to control the effects of the micro-factors within enterprises on risks. In addition, the data is specified in the period from 2007 to 2016 in order to include complete and detailed data that can be obtained. Therefore, the study firstly chooses data from 2007 to 2016 to analyze the pro-loan credit risks.

The data are collected from the RESSET Financial Research Database, one of the main supplier of financial databases in China. The quarterly observations from April, 2007 to March 2016 are used based on thirteen Chinese banks listed on the A share market. Three banks are excluded because of limitation of data availability before they became listed banks. The basic data of the selected banks conducting logistics banking business are collected.

According to Gujarati (2000), the multi-collinearity issue will be serious if two regressors have a zero-order correlation coefficient that is higher than 0.8. The correlation coefficients are 0.005 (P&M), -0.04(H&M), and 0.5(H&P). And the correlations are acceptable.

3.4 Model Estimation and Test

3.4.1 Model Setting

Taking the intermediate target of money supply as the index of monetary policy, this study constructs PSTR model to measure the impact on bank risks-taking in China's macroeconomic environment.

The following PSTR model is constructed to study monetary policy's implications on bank risks in the contraction and expansion phase.

$$PD_{i,t} = \mu_i + \beta_0 M_{i,t} + \beta_1 P_{i,t} + \beta_2 H_{i,t} + (\beta'_0 M_{i,t} + \beta'_1 P_{i,t} + \beta'_2 H_{i,t}) \cdot g(M_{i,t}; \gamma, c) + \varepsilon_{i,t} \quad (3-12)$$

where $PD_{i,t}$ = expected default frequency; $M_{i,t}$ = broad money; $P_{i,t}$ = purchasing managers' index; $H_{i,t}$ = real estate price index.

3.4.2 Model Specification

When the observation data used in the modeling have nonlinear characteristics, we can establish a nonlinear model to find the rule of mechanism transformation, so as to determine the position parameters and the transformation rate. Therefore, the heterogeneity test (non-linear test) should be carried out first. When the model passes the nonlinear test (rejecting the original hypothesis: the model is linear), a PSTR model is established to study the nonlinear relationship and transformation characteristics between variables; Otherwise, only linear regression is needed to test the estimation.

Table 3-1 Linearity Tests

Test	Statistic	P-value
Lagrange multiplier -Wald	22.101	0.044

H_0 : linear model; H_1 : PSTR model with at least one threshold.

In Table 3-1, the linearity test results are presented and demonstrate that, at the 5% level of significance for the Wald test, the null hypothesis is rejected. This suggests that the model is, in fact, nonlinear. It provides supporting evidence for the nonlinear model that is applied in the empirical analysis. Assuming a two-regime model, the test for no nonlinearity remaining is shown in Table 3-2. As a result of the findings, it cannot be determined if the model has one threshold or two regimes. This suggests that the low and high money supply regimes are separated by a single threshold level of the money supply.

Table 3-2 Tests of No Remaining Nonlinearity

Test	Statistic	P-value
Lagrange multiplier -Wald	1.884	0.762

H_0 : PSTR with one threshold; H_1 : PSTR with at least two thresholds.

It sets $\alpha = 0.05$, $\tau = 0.5$, that is, when the significance level is 0.025, Table 3-2 indicates that the model accepts the original hypothesis ($r = 1$), and there is no need to continue the test. Therefore, the final model is a PSTR model with only one transformation function.

3.4.3 Model Estimation Results

Parameter estimation is performed using the nonlinear least squares approach. The transition speed (γ) and location parameter (c) initial values are calculated using the grid search approach prior to the parameter estimate. The starting value is better

the more iterations there are. The iteration number is set to 20,000 to guarantee accuracy and reduce program execution time. In Table 3-3, estimated model parameters are shown.

Table 3-3 PSTR model estimation. Dependent variable: PD.

Parameters	Value
β_0	1.900×10^{-9} *** (4.333)
β_1	-0.006 *** (-8.706)
β_2	-0.001 (-1.133)
β'_0	9.003×10^{-6} (0.911)
β'_1	-0.004** (-1.287)
β'_2	0.001*** (18.322)
γ	0.233
c	6.979×10^6

The values in parentheses are t-statistics. ***/**/* denote significance at the 1%,5% and 10% levels, respectively.

In this two-regime PSTR model, the location parameter (6.979×10^6) is inside the changing interval to the transition variable (M), and positive and slow transition speed is present. With a growing transition variable, the model eventually approaches the high regime when the money supply exceeds 6.979×10^6 million Chinese Yuan. With the transition variable increasing, the model rapidly approaches the high regime when the money supply is below 6.979×10^6 million Chinese Yuan. Upon changing the transition variable's value, the effects of monetary policy and other variables on bank risks transition transitions between the high and low regimes gently and smoothly.

The money supply exceeded the location criteria only in the first quarter of 2009, the third quarter of 2010, the second quarter of 2009, and the fourth quarter of 2011, while in the remaining quarters, the money supply was below the location parameter, showing that money policy and other variables impact bank risks mainly in the low regime.

The index of real estate price has a negative effect with a statistically insignificant coefficient in the low regime (β_2) and a positive effect with a statistically significant coefficient in the high regime ($\beta_2 + \beta_2'$). This proves that an upward shift in real estate price index will bring a greater risk to banks when the money supply is over 6.979×10^6 million Chinese Yuan. Banks loan substantially to the relatively hot real estate market under the condition of adequate money supply, which may bring high returns but also increases risk.

3.4.4 Robust Checks

The robustness test uses the variable replacement method to replace and modify the measurement indicators. There are many monetary policy indicators to test the nonlinear effects on logistics bank risks in different macro environments. In addition to the expected default rate (PD), the proportion of risky assets in total assets is commonly used. Therefore, the PSTR panel regression model is established with the expected default rate (PD) as the dependent variable, the money supply represented by broad money (M2) as the independent variable, the Manufacturing Purchasing Manager Index (PMI) as the conversion variable and the control variable is the real estate price index (H), as shown below.

$$PD_{i,t} = \mu_i + \beta_3 M_{i,t} + \beta_4 H_{i,t} + (\beta_3' M_{i,t} + \beta_4' H_{i,t}) \cdot g(PMI_{i,t}; \gamma, c) + \varepsilon_{i,t} \quad (3-13)$$

The linearity test was performed and the results were as follows.

Table 3-4 Linearity Tests

Test	Statistic	P-value
Lagrange multiplier -Wald	28.600	0.043

H_0 : linear model; H_1 : PSTR model with at least one threshold.

In Wald test, the original assumption of linearity is rejected at the 5% significance level, indicating there is a nonlinear relationship.

Table 3-5 Tests of No Remaining Nonlinearity

Test	Statistic	P-value
Lagrange multiplier -Wald	1.774	0.420

H₀: linear model; *H₁*: PSTR model with at least one threshold.

In the hypothetical two-body model, the test results without residual nonlinearity are given in Table 3-5. The results show it can not reject the null hypothesis, which means that the model has only one threshold and two regimes.

The PMI reflects different situations of the macroeconomic environment. With the change of PMI, bank risks is smoothly transformed in different systems. The macroeconomic environment has no significant difference in the regression results of money supply after bank risks variables, indicating that the model has a high robustness and has a stimulating effect.

3.5 Summary

In the first part of the study, economic condition is summarized, which gives a data foundation for further study. And the second part is to analyze the macro-factor's influence on bank risks. The Panel Smooth Transition Regression (PSTR) method is to empirically investigate how monetary policy affects bank risks. The outcome also demonstrates the precise link between macroeconomic policy and bank risks, and it provides supervision departments with guidance on how to safeguard the effectiveness of monetary policy and financial stability to control bank risks and manage risks in the logistics banking business sector. The study's findings lend

credence to the employment of a nonlinear model to describe the relationship between macroeconomic policy and bank risks of logistics banking business. It indicates that similar to stock market and currency market, the asymmetric effect also exists in the sample of commercial banks. The effects of control variables are also informative. Overall, when the real estate price index is low, it has a statistically negligible coefficient, but when it is high, it has a statistically significant coefficient and has a positive influence.

And this chapter concludes the impacts of macro-factor on logistics bank risks on both aspects, namely the impacts of the macro policy implement to bank and that of the macro policy preference of enterprises. The logistics banking business is influenced by macroeconomic factors, and macroeconomic changes will increase the cost of enterprise investment, reduce financing demand, and thus affect the recovery of future cash flows from logistics banking business on the logistics banking chain. At the same time, environmental changes affect the judgment of enterprise's background and expectations, and affect the stability of logistics banking chain network relationships, thus reducing investment in cooperation funds, and affecting strategic cooperation relationships. In logistics banking business, paying real-time attention to changes in macro factors and identifying their impact on logistics banking business can help logistics banks and enterprises take proactive measures to reduce risks.

4. Study on Credit Risk of Pledge Financing in Logistics Banking Business

Based on the analysis of pre-loan credit risk in Chapter 3, this study will further study the improved model of credit risk measurement in loan. Risk measurement in loan is essential for the efficient use of risk management, capital supervision and economic capital allocation in the whole course of logistics banking business.

4.1 Introduction

In logistics banking business, the cooperation between participating entities fully leverages their respective advantages, achieves resource complementarity, and thus achieves optimal allocation of financial resources. Under traditional financing models, small-to-medium-sized enterprises in the supply chain compete for financial resources. In logistics banking business, small-to-medium-sized enterprises in the supply chain cooperate with each other to obtain financial resources, and there is a cooperative relationship. The participating entities are in a reasonable allocation, improving overall interests, promoting cooperation, and achieving a balanced state of win-win situation. In addition, if an enterprise applies for a credit loan, the bank will make a thorough analysis of the financial advantages, managerial level, and development chances of the borrowing enterprise. Banks require stable operation of each enterprises, good credit records of banks, and a certain level of restrictions on profits and assets and liabilities of enterprises. Credit loan does not need a guarantor, and the credit of the enterprise is the guaranteed instead, generally suitable to state-owned enterprises and institutions, as well as the enterprises registered by the Industrial and Commercial Administration Department. In logistics banking business, logistics banks

based on financial technology to provide financing services for the upstream and downstream small-to-medium-sized enterprises in the logistics banking chain. In this process, the logistics bank will obtain high latitude and frequency of financial data, as well as reputation related management data. This data will be integrated, analyzed and managed for risk management and early warning control.

4.1.1 Business Mode Analysis

With the deepening understanding of logistics banking business, the model of logistics banking business is constantly developing. The evolution of the logistics banking business model reflects the development foundation and logic of the logistics banking system, leading financial business innovation. The development of business models ranges from bank-to-company financing, bank-to-chain financing, to bank-to-system financing.

In bank-to-company financing, the supply chain core enterprise and logistics bank have a lending relationship. Banks extend credit to core enterprises based on their credit qualifications and other characteristics to meet their financing requirements. Banks can only provide financing for core enterprises based on their understanding of them. At this stage, logistics banks are not fully integrated into the logistics banking chain and do not consider the financing situation of other enterprises in the supply chain. Core enterprises value the game with banks and enhance trust between them. At the same time, core enterprises focus on optimizing logistics and improving fund turnover. Banks conduct risk assessment and control through the information system of core enterprises, combined with external data.

In bank-to-chain financing, logistics banks not only focus on core enterprises,

but also on upstream and downstream small-to-medium-sized enterprises. Banks rely on the credit information of core enterprises and provide financing products and services for enterprises on the logistics banking chain based on trade information. The core enterprise is an important pillar of logistics banking business and a comprehensive risk manager. Logistics banks are financial resource providers that provide liquidity for the logistics banking system. At this stage, banks pay more attention to the credit of small-to-medium-sized enterprises. Therefore, core enterprises should have comprehensive information and data on the production and transaction processes of upstream and downstream enterprises' products, and provide decision-making basis for banks to provide financing gaps for small and medium-sized enterprises. In this way, the overall performance of the logistics banking chain has improved, and the opportunities for value enhancement have increased.

The logistics banking business of bank-to-chain mode has improved the cooperation between upstream and downstream enterprises. Banks use the information of the logistics banking chain to analyze the trade background and business situation of enterprises, and judge their credit. The logistics banking business controls corporate financing risks through a closed operating mode, which means that the flow of funds is limited to the logistics banking system and will not be used for other investments. The transaction cooperation and information synchronization of logistics banking business have improved the speed of cash flow turnover, optimized the allocation of funds in the supply chain, and increased the market competitiveness of various enterprises.

The bank-to-system financing of logistics banking business has transformed the

logistics banking chain into a complex logistics banking network based on network technology. In this network, the subject is no longer limited to both parties of the loan, but has expanded to industry regulatory authorities, government departments, and other third parties. In logistics banking business, banks standardize the information they receive and continuously exchange information with core enterprises. Ultimately, the risk of the logistics banking network is calculated through comprehensive information on information, trade, capital flow, and logistics, and the business's capital flow is adjusted in real-time. In this process, the logistics banking business will generate new products, promote Financial innovation, accelerate the development of industry segmentation, and promote the common development of financial market and real industry.

The prerequisite for forming a logistics banking network is to build a complete and transparent information platform for enterprises and banks in the logistics banking chain, meeting the requirements of information aggregation, data analysis, and resource integration for various entities. The logistics banking industry ecosystem is the upgrade and innovation of the supply chain, and also the direction for the integration and development of industry and finance in the future.

4.1.2 Business Model Process

In logistics banking business, the pledge loan is the main measure of enterprise financing. The pledge loan is a commonly used type of loan for enterprises, meaning that enterprises (pledor) will obtain financing by pledge of assets with a certain value from banks (pledgee) and logistics companies (supervisor) cooperate in the pledge and cargo supervision. The pledor uses movable property or rights as collateral for the

creditor's rights when requesting a loan. When the pledgor fails to fulfill the debt, the pledgee has the right to prioritize repayment with the property in its possession in accordance with legal provisions. Pledge includes movable property or rights (such as bills of exchange, bills of lading, warehouse receipts, bonds, checks, certificates of deposit, and promissory notes), transferable shares and stocks, property rights in transferable trademark exclusive rights, patent rights, and copyrights, and other rights that can be pledged.

Taking inventory pledge as an example, the logistics bank pays the payment to the upstream enterprise, and the upstream enterprise sends the goods to the warehouse designated by the bank, which is supervised by a third party. Downstream enterprises pay off the loan, the bank receives the payment, hands over the deposit receipt of the goods to the enterprise in the downstream, and the enterprise obtains them. This process is a static pledge.

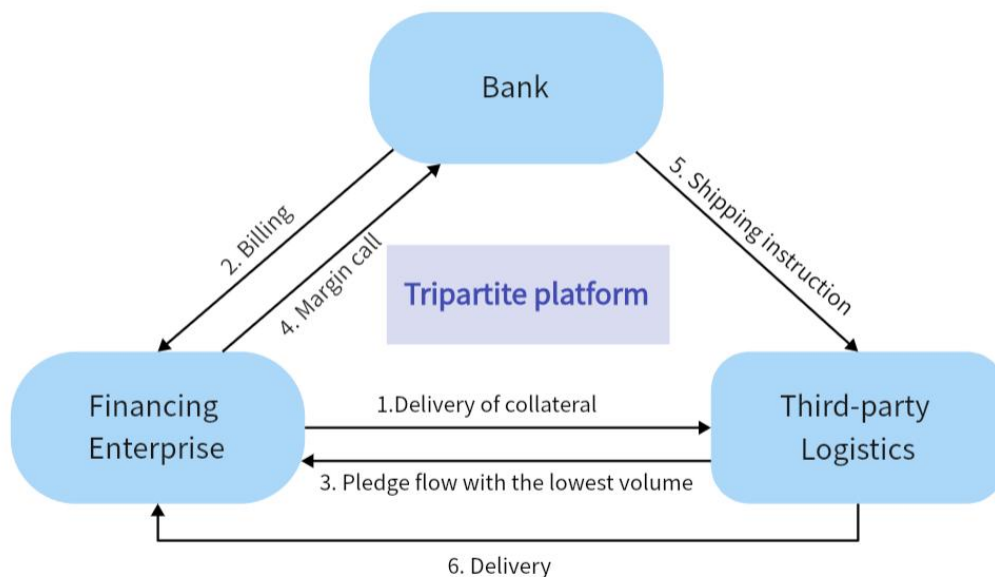


Figure 4-1 Pledge Business Model Process

Figure4-1 describes the process of dynamic pledge. The difference between static

pledge and dynamic pledge mentioned above is that in the logistics banking system, some inventory products can flow. Process 3 indicates that third-party regulatory agencies have provided the lowest volume of pledge flow to downstream lending enterprises helping downstream enterprises to repay as soon as possible.

4.2 Risk Analysis

4.2.1 Cause of Risk

In the pledge financing business, the default is based on a variety of endogenous and exogenous factors. Endogenous factors reflect the credibility of enterprises and the credit rating system of banks can reflect the credit of enterprises. Exogenous factors refer to the external factors which have an impact on the operation of enterprises in logistics banks, such as the changes in market environment. The previous chapter explores the risks influenced by exogenous factors, while this chapter discusses the risks generated by endogenous factors in the logistics banking business.

In traditional loans, risks are dispersed in various aspects of enterprise operations such as production, operation, and sales. Logistics banking business avoids dispersed risks. In pledged loans, the main risk lies in the liquidity of the pledged goods.

The commonly used collateral mainly includes accounts receivable and inventory. The cash flow converted from the pledged property in the future is the primary source of repayment. Loan enterprises need to sell or process the pledged goods at the correct price in a timely manner to ensure that the funds flow back to the bank. Therefore, the pledged loans are mostly at risk from the liquidity of the pledged property. The lack of pledged goods, price fluctuations, changes in liquidity, and quality all pose risks. The

liquidity of pledge involves the game between enterprises and banks in the choice of the collateral. Banks prefer fixed assets which are highly valued and not easily damaged. Companies, however, are not willing to pledge their real estate and other fixed assets because mortgaging fixed assets means the company is facing bankruptcy. And it proves that enterprises are generally not liable to default and the risk is low for banks if the real estate is chosen as the collateral for loans. The credit situation, operational status, repayment period of accounts receivable, and possibility of refunds of the trading party also pose risks. When the price of goods is lower than the loan exposure, the likelihood of financing companies defaulting increases. Therefore, the first step is to assess the products' quality: whether they are suitable for storage and whether they are easily damaged. Secondly, it is necessary to investigate the market where the goods are located and evaluate the price stability of the goods in the market. Pledged goods should be selected with mature trading markets and quality inspections to ensure stable prices and quality, and smooth transactions.

In addition, artificial false and non-standard delivery orders are also the main risks of logistics banking business. A significant risk in logistics banking business is for financing companies to use incorrect delivery notes and propose goods. There are also risks associated with operational processes. In the actual operation of business, the enterprises are not synchronized or the joints are not closely connected, causing operational risk of logistics banking business.

Because of the difficulty in inventory management and supervision of the warehouse and logistics goods, the financing cost of physical assets is increased. And to ensure stable quality of collateral and easy storage of inventory, logistics banks generally choose to use warehouse receipt pledge and bill pledge, which save on

warehouse rental fees and storage supervision costs, as well as avoid the risk of product loss. The pledge has always been in circulation in the market. In the transaction of loans, logistics enterprises are entrusted by banks to supervise the pledge. Therefore, the strong liquidity of the warehouse receipts is conducive to enterprise financing, so logistics banks are more flexible. Therefore, the pledge of warehouse receipt has become a good mode to study the risk of logistics banking business.

4.2.2 Risk Characterization

By means of financing and loans in logistics banking business, enterprises can expand production and increase cash flow to maintain operation and improve operation performance. But in China, it is difficult for enterprises, especially for the manufacturing enterprises, to borrow money, which is a common long-term issue. Because the entry threshold for traditional manufacturing industry is relatively low, and numerous enterprises' products are located in low-end areas, facing overall problems such as disorderly competition, operational difficulties, high energy consumption, low efficiency, overcapacity, and poor innovation ability. The non-performing loan rate is generally higher than that of other industries. At the same time, national policies support the manufacturing industry, and many small and medium-sized manufacturing enterprises have emerged. These new enterprises also face the problem of opaque enterprise information and low cash flow. Historical data also confirms that in the manufacturing sector, the default risk is continually rising. In 2016 the default rate of manufacturing enterprises is 3.35%, and it increases to 9% in 2018 when the average default rate is only around 1.8%. With the increase of default rate in the logistics banking business market, banks will be even stricter on controlling

the standard requirement of enterprise loans, which will hinder the growth of enterprise assets and lead to increasing risks.

In logistics banking business, the credit risk of banks mainly comes from corporate default. When a company defaults, if the cash flow in the logistics banking system cannot cover the loan amount, there is a risk. Banks will face significant risk difficulties if they are unable to promptly identify lost assets, enhance provisions for writing off bad debts, and cease recognizing interest revenue under the proper circumstances. The main factor causing the default risk is bad management. Business condition mainly is the credit and operation status of enterprises. The default rate of enterprises with poor operation condition is expected to be high.

In the previous literature, some studies give a theoretical foundation for the risk study of pledge. Early studies pointed out that the key to corporate financing lies in the effect of operating and market circumstances on the value of pledge. The change of pledge price will identify the risk's level. In the risk control, logistics supervision in logistics banking chain stands a significant part in logistics banking business. The value of collateral in the financing process of enterprises is always affected by the market, and modifying the pledge rate can control the loan risk of banks in logistics banks through its effect on the default rate of enterprises.

4.2.3 Probability of Default

The credit risk faced by banks, also known as default risk, is generally estimated using the probability of default (PD). It refers to the likelihood of a borrower defaulting at a certain point in the future. Credit ratings serve as a fundamental tool for assessing credit risk by calculating the probability that a borrower will default on

their obligations. Only after carefully calculating the default probability of borrowers can banks accurately calculate the expected losses and objectively and accurately evaluate customer credit conditions, thereby ensuring commercial banks' systematic and efficient credit risk management.

The measurement methods of the default probability for commercial banks can be summarized into four types.

(1) A measurement method based on internal credit rating historical data, which is a method in which commercial banks and rating companies use the average of historical default probabilities as the corresponding default probabilities of enterprises under different credit ratings based on long-term accumulated credit rating historical data;

(2) A measurement method based on option pricing theory, which is a credit monitoring model, also known as KMV model, created by KMV Company in the United States using option pricing theory to predict default probability. It is a forward looking dynamic model mainly suitable for measuring default probability of publicly listed companies;

(3) The measurement method based on insurance actuarial theory has been used in recent years as a tool to estimate the expected default probability;

(4) A measurement method based on the principle of risk neutral market refers to a market where all investors are prepared to accept the same anticipated return from any risky asset as they would from risk-free assets, and all asset's price can be determined by using a risk-free interest rate to discount the asset's anticipated future cash flow. Compared to historical transfer probabilities, risk neutral models provide

forward-looking default predictions.

4.3 Method

4.3.1 Value at Risk

Value at risk (VaR) is the anticipated minimal loss within a given level of significance (usually 1% or 5%) throughout the course of a projected market scenario. It can be stated as a percentage of the portfolio value or in monetary terms. VaR is most frequently expressed as profit or loss, but it is typically simpler to estimate VaR based on returns.

When using the VaR model, certain implicit assumptions are made. Although the future trajectory of financial asset portfolios is comparable to the past, some unexpected financial market events show that sometimes changes in the future are not directly related to those in the past. As a result, the VaR method must be used in conjunction with sensitivity analysis, stress testing, and other analytical techniques in order to fully capture the market risk of financial assets.

4.3.2 Estimation of VaR

There are three steps to estimating VaR.

① Risk Decomposition. It is to convert portfolios into the portfolios exposed to risk factors. The products of logistics banking business usually contain different risk exposures, which need to be decomposed to accurately capture their potential losses.

② Collecting the historical data or estimates of each risk factor in the VaR model. In financial models, one of the most common sources of input is historical data, but users

can replace estimates based on judgment or optional prediction models. In parameterization and Monte Carlo methods, at least a starting point is taken from the history of the acquired data typically. For historical simulation methods, historical data is necessary.

③ Using data to estimate the value of VaR. This step in different estimation methods has the most significant difference.

There are three typical methods for estimating VaR in the above: parameter method, historical simulation method, and Monte Carlo simulation method.

(1) Parametric Method

Parameter method, also known as analytical method or variance covariance method. The parameterization method first decomposes the investment portfolio's risk. The return distribution of the risk component in the portfolio is typically assumed to be normal. Then, it makes advantage of each risk factor's expected return and the standard deviation of the return to estimate the VaR.

The parametric approach often presupposes that the risk factor's return distribution will follow a normal distribution, and the expected value and standard deviation take into account all aspects of the normal distribution. Thus, finding a 5% portion in the distribution is a 5% VaR. Normality is a presumption made by parametric approaches generally, but it is not a requirement. Additional distribution parameters, including skewness and kurtosis, are necessary if different distributions are employed. Although it is possible to utilize more precise representative distributions, this rarely done in practice and adds complexity to the VaR estimate

process.

The presumption of normal distribution makes it easy to estimate parameters from historical data, but when historical data may be misleading, we need to make judgments to adjust parameters. The parameter technique is the best if the normal distribution can be utilized as an accurate representation of the real distribution and the parameter estimation is reliable or can be made into a reliable estimation by making the necessary adjustments. The parameter estimation of VaR under the parameter method, especially the covariance, is very sensitive. If the relationship between the underlying asset and the return of the portfolio is discontinuous, or has some characteristics that lead to the truncation of the non normal distribution, this portfolio is not suitable for the parametric method. After some adjustments, it can adapt to the parameterization method. The efficiency of parameter methods for investment portfolios is constrained by these modifications, which are useful but not flawless.

(2) Historical Simulation Method

The historical simulation method is to trace the historical gains and losses of an investment portfolio over a specific time frame, and arrange the historical gains and losses in descending order to find the profit and loss values that meet a given confidence level. First, the portfolio is divided into risk factors, and data on each risk factor's historical return rate from the chosen review period is collected. We reprice the current investment portfolio based on the daily returns during the historical review period and rank the results from maximum loss to maximum return. Choose a point on the outcome distribution beyond which a 5% result will result in larger losses in

order to estimate a day's VaR at a 5% confidence interval. Unlike parameter methods, it does not use estimates of mean, standard deviation, or correlation to describe distributions.

Based on actual events, the historical simulation technique calculates VaR, which is an advantage. But on the contrary, it cannot determine whether historical events will repeat themselves, or whether they will do so in the same manner or with the identical probability as the historical data suggests. In addition, the historical simulation method can adjust the time window. It can translate daily revenue data into annual revenue and calculate annual VaR, supposing the distribution is steady. Although it is always preferable to use annual data to estimate annual VaR, a longer review duration will be needed..

(3) Monte Carlo Simulation Method

Monte Carlo simulation, also known as random sampling or statistical testing methods. Propose your own hypothesis based on the statistical characteristics of a given distribution, randomly select random numbers, and perform calculations to understand the possible return distribution of this investment. This method can be used for companies to commit a significant sum of funds in new projects, or for complex option pricing. This method can better approximate the actual distribution situation. Compile the simulated statistical results into a table to obtain a gauge of the comprehensive impact of these many component processes on overall risk.

These three methods use different methods to specify these inputs, while parameters and formal data history is not necessary for Monte Carlo methods. Users are only required to input estimates of certain parameters (expected returns, standard

deviations, and skewness and kurtosis of certain models) during the calculation process.

4.3.3 Risk Assessment Indicators

There are several main methods for determining weights.

(1) Expert Weighting Method

The expert weighting method is relatively simple, with a few experts in the industry directly weighting each indicator based on their own experience.

(2) Delphi Method

Similar to the expert empowerment method, based on expert prediction. However, so as to eschew subjectivity and one sidedness of a few experts, the Delphi method method adopts the method of anonymous multiple rounds of correspondence with experts, and obtains relatively unified empowerment opinions by summarizing many experts' opinions.

(3) Analytic Hierarchy Process

It is a decision analysis method based on hierarchical weight. The advantage is that complex decisions can be quantified and simplified with less information. But the result is only yes or no, there is no intermediate result.

(4) Fuzzy Analytic Hierarchy Process

An enhancement to the Analytic Hierarchy Process is the Fuzzy Analytic

Hierarchy Process. By adding the fuzzy result set of the problem and quantifying it through the fuzzy result set of many influencing factors, the results' accuracy is further increased.

4.4 Model Design

4.4.1 Model Hypothesis

Generally the loan decision of a bank depends on the estimation of credit risk in loan. Cases which determine whether an enterprise decides to apply for pledge loan are not complicated. First, the cash flow of enterprises is insufficient, such as uncollected accounts receivable, supplier arrears, and other factors. Such business condition reflects a higher probability of default. In this case, banks are not generally willing to lend to these companies. Second, enterprise loans are used to improve production technology and upgrade production lines. Such enterprises are generally in good debt condition and have strong repayment ability. The increase of their production capacity and profit will not be reflected in the short term. Third, enterprise loans are used for reproduction to be able to satisfy high demand and supply of the anticipated market and to seize the market share. The occurrence of lending is immediate. The study concentrates on the case of investment reproduction to measure default risks. The situation considered in the study does not include the time lag caused by operational errors and process delays.

In a standard system of pledge financing business, the subjects are rational and not illegal. Therefore, the scope guaranteed by the pledge is limited to the funds incurred in the system, such as financing funds, interest, and custody fees, excluding additional profits or other capital flows outside the system. In addition, under the

constraints of China's legal provisions, there is no liquid pledge in the treatment of collateral that has defaulted upon maturity (the ownership of collateral is directly transferred to the creditor). When an enterprise defaults on its maturity, the pledged property will be realized by means of discount, auction, etc. If it cannot be realized, the court will be sued. This study does not consider the extreme situation of unrealized. The pledgee shall have the priority of compensation, and the bank shall only take back the remaining cash deducting the loan principal and interest.

Based on Buzacott's research, the following research hypotheses are proposed.

Hypothesis of static model

H1: The funds loaned by enterprises are only used to purchase the same kind of goods again, and are managed in a unified way with the original pledged goods, supervised by logistics enterprises.

H2: The time for an enterprise to reorder goods with the borrowed funds shall be within the time limitation for the occurrence of logistics banking business.

H3: The range of value guaranteed by a pledge (pledge) includes only the principal claim, interest and the cost of keeping the pledge.

H4: If the enterprise fails to pay back the loan at maturity, the capital obtained after the transaction of the defaulted pledge shall first compensate the principal and interest of the bank. If there is any surplus, the remaining part shall be returned to the enterprise.

H5: No consideration is given to the additional revenue in the logistics banking business.

4.4.2 Financing Decision Analysis

In the closed account, the sales income of the pledge is prioritised in the pledge process and repaid to the bank. The market demand is $F(\xi) = P(x < \xi)$, and its density function is $f(\xi)$.

An analysis is made on the loan decision-making of enterprises.

If the enterprise does not choose to loan, the return in T is:

$$X_1(\xi) = \begin{cases} K_\xi + p'(q_0 - \xi) - sq_0 & \text{if } \xi \leq q_0 \\ Kq_0 - sq_0 & \text{if } \xi > q_0 \end{cases} \quad (4-1)$$

If the enterprise chooses to loan, the return in T is:

$$X_2(\xi) = \begin{cases} K_\xi + p'(\omega q'_0 + q_0 - \xi) - s(\omega q'_0 + q_0) - p\omega q'_0(1+z) & \text{if } \xi \leq \omega q_0 + q_0 \\ K(\omega q'_0 + q_0) - s(\omega q'_0 + q_0) - p\omega q'_0(1+z) & \text{if } \xi > \omega q_0 + q_0 \end{cases} \quad (4-2)$$

q_0 is the initial inventory of the production enterprise. q'_0 is the initial inventory of the pledge production. T is the time limitation of the loan. ω is the pledge rate, and p is the purchase price of the pledged goods. K is the selling price of commodities. When the commodities are not fully sold with surplus stock, the discounted trade price is p' , and the storage cost per unit commodity is s .

The bank loan interest rate is z , and the deposit interest rate is z' . The discrepancy between interest rates charged on deposits and loans is what determines bank profitability. Bank loans typically have higher interest rates than deposit rates. The spread between the interest rates for loans and deposits, minus the banking cost, constitutes bank profits.

When the enterprise does not to loan, it can consider $q'_0=0$, and we get $X_1(\xi)$ in

(4-2). To make the return highest, the enterprise make the choice of doing loan or not, considering the value of $\Delta X(\xi) = X_2(\xi) - X_1(\xi)$.

When the enterprise loans, the optimal volume of pledge is:

$$E(X_2(\xi)) = (K - s)(\omega q_0' + q_0) - p\omega q_0'(1 + z) - (B - p') \int_0^{\omega q_0' + q_0} f(x) dx \quad (4-3)$$

Thus,

$$\frac{\partial E(X_2(\xi))}{\partial q_0'} = \omega(K - s - p(1 + z)) - (K - p')F(\omega q_0' + q_0) \quad (4-4)$$

$$\frac{\partial^2 E(X_2(\xi))}{\partial q_0'^2} = - (K - p')\omega f(\omega q_0' + q_0) < 0 \quad (4-5)$$

When $\frac{\partial E(X_2(\xi))}{\partial q_0'} = 0$,

$$q_0' = q_0^* = \frac{F^{-1}\left(\omega \frac{K - s - p(1 + z)}{K - p}\right) - q_0}{\omega} \quad (4-6)$$

$$E(X_1(\xi)) = \int_0^{q_0} (K\xi + p'(q_0 - \xi) - sq_0)f(x) dx + (1 - F(q_0))(Kq_0 - sq_0) = (K - s)q_0 - (K - p') \int_0^{q_0} F(x) dx \quad (4-7)$$

$$\Delta E = \max(E(X_2(\xi))) - E(X_1(\xi)) = (K - s - p(1 + z))\omega q_0^* - (K - p') \int_{q_0}^{\omega q_0^* + q_0} F(x) dx \quad (4-8)$$

ΔE is a function of q_0 , and it goes up then down.

Where q_0^p is the value when $\frac{K - s - p(1 + z)}{K - p} \omega q_0^* = \int_{q_0^p}^{\omega q_0^* + q_0^p} F(x) dx$.

When $q_0 = q_0^p$, $\Delta E = 0$.

When $q_0 < q_0^p$, the enterprise will not choose to loan.

When $q_0 \geq q_0^p$, the enterprise will choose to loan, and the volume of the pledge is q_0^* .

$$q_0^* = \begin{cases} \frac{F^{-1}\left(\omega \frac{K-s-p(1+z)}{K-p}\right) - q_0}{\omega} & q_0 \geq q_0^p \\ 0 & q_0 < q_0^p \end{cases} \quad (4-9)$$

The value of q_0^p is related to the pledge rate ω . And the initial inventory q_0 , the pledge rate ω , the interest rate z , and the distribution of supply and demand for commodities in the market influence the enterprises' decision of pledge loan. The pledge rate that the bank determines is generally no more than 70%. With the bank-given pledge rate, the enterprise determines the volume of the pledge.

4.5 Risk Value Analysis of Banks

4.5.1 Theory Introduction

VaR represents the smallest possible value of return in a given period of time at a specific degree of probability (confidence), and its definition is as follows.

$$V_a R_\eta = \sup\{\alpha | P_r\{\pi(x, y) \leq \alpha\} \leq \eta\} = \sup\{\alpha | P_r\{\pi(x, y) \geq \alpha\} \geq 1 - \eta\} \quad (4-10)$$

Among them, the return function for the deterministic and random variables x and y is represented by $\pi(x, y)$, and $V_a R_\eta$ is the η -quantile of random variable y .

VaR depicts higher-than-quantile returns.

4.5.2 Model Description

It is proved by researchers that if consumer demand is consistent with the typical distribution, the value of the best pledge rate depends on the fluctuation of the market demand. The greater the fluctuation, the higher the pledge rate. From the game between enterprises and banks, it is obvious that when the market is good, enterprises tend to apply for more loans, while on the contrary, they will be relatively conservative. In order to maximize the interests, banks prefer to reduce the pledge rate on the premise of certain prediction of the market.

The study assumes that market demand follows normal distribution $N(\mu, \sigma^2)$. According to VaR Method, the asset pricing model of the bank is below.

When the enterprise does not choose to default, the value of the asset is

$$W(\xi) = pq(1 + z - q') \quad (4-11)$$

When the enterprise defaults, the value of the asset is

$$W(\xi) = \begin{cases} \min\{Kq_0, pq(1 + z) + sq_0\} - pqz' - sq_0 & \xi > q + q_0 \\ \min\{K(\xi - q) + p'(q + q_0 - \xi), pq(1 + z) + sq_0\} - pq(1 + z') - sq_0 & q \leq \xi \leq q + q_0 \\ \min\{p'q_0, pq(1 + z) + sq_0\} - pqz' - sq_0 & \xi < q \end{cases} \quad (4-12)$$

After obtaining bank loans, enterprises can choose additional purchase quantity q , then the total inventory is $q + q_0$. $W^0 = pq$ is the initial value of the loan. R is the rate of return on investment (ROI). $W^* = W^0(1 + R^* - z')$ is the minimum return on investment at a confidence level of α . R^* is the minimum ROI at a confidence level of α . And $P(W(\xi) \leq W^*) = \alpha$.

Researchers prove when the inventory is less than or more than a certain amount, the Value at Risk is a fixed value.

When $q \leq q^a$, and $q \geq q^b$, $P(W(\xi) \leq W^*) = Q$.

When $q^a < q < q^b$, (given α)

$$W^* = (K - p')(F^{-1}\left(\frac{Q}{\alpha}\right) - q) + (p' - s)q_0 - pqz' \quad (4-13)$$

$$VaR = W^0 - W^* = pq(1 + z') - (K - p')(F^{-1}\left(\frac{Q}{\alpha}\right) - q) - (p' - s)q_0 \quad (4-14)$$

The bank can limit the value at risk by the determination of q . Q is the value of endogenous default probability of enterprises determined by the credit rating system of banks. C is a given real number. In order to control the volume of additional purchase q , the bank has its measure to control the pledge rate ω .

Thus, the value at risk is limited with C at a confidence level of α , when

$$\omega \leq \frac{C + (K - p')F^{-1}\left(\frac{Q}{\alpha}\right) + (p' - s)q_0}{(K - P' + P + pz')q_0} \quad (4-15)$$

The borrowing enterprise can make the pledge decision with the highest expected return under the given pledge rate. From the aspect of the conclusion, when the initial inventory is high enough or the pledge rate is low, the enterprise will not choose pledge financing. The premise of enterprise financing is the shortage of funds, so the factor that affects the enterprise decision-making is the pledge rate. From the perspective of the bank, assuming that the bank understands the decision-making mode, the range of pledge rate that meets the conditions of its value-at-risk can be formulated according to this mode. Under the monitoring of logistics enterprises, the pledge risk model keeps the risks of borrowing enterprises and banks within an affordable range by controlling the pledge amount and pledge proportion. The subsequent study uses the collected data for validation and obtains the conclusion.

In the logistics banking system, by endogenous analysis of default, enterprises

establish reasonable loan decisions, and banks effectively avoid risks. Subjects in the logistics banking chain, prudently build bank-enterprises relationships, and prevent risk contagion. At the same time, the market establishes a mature capital market system to support innovative development.

4.6 Summary

The study analyzes the credit risk measurement in loan. In the case of pledge financing, it draws the relationship between the default risk when the enterprise in loan and the endogenous factors of the pledging process. And it proves that the initial inventory, the pledge rate, and the condition of demand-supply of commodities in the market influence the enterprises' decision of pledge, if the enterprise is economic rational. In the measurement of VaR, the study concludes that the pledge rate is the main tool for banks to control default risks in loan. When the pledge rate is fixed, the impact of initial inventory on enterprise loan decision-making is determined by initial inventory and market demand. And the value of risk depends on the volume of additional purchase. To control the volume of additional purchase, the bank has to control the pledge rate. This study expands the business scope of traditional logistics enterprises, enhances their enterprise competitiveness, and further promotes the development of logistics finance.

This part of theoretical analysis helps to build new technology banking businesses, and provide innovative financial products and services. Logistics banking business establishes a multi-level financing guarantee system, give the guiding role of policy based financial institutions its due consideration , expand the application of financial technology, and enhance the economic capacity of the service industry. The financial

market should have a clear policy direction, gathers consensus on development, highlights key areas, focuses on structural optimization, improves supporting mechanisms, strengthens technology empowerment, improves service quality and efficiency, innovates financial products, and meets diverse needs.

5. Study on Measurement of Macro-factors in Logistics banking business

This research improves the model for measuring credit risk in the previous chapter, and analyzes the root cause of pre-loan credit risk factors. In this chapter, the measures of post-loan risk control will be thoroughly studied. As an important supplementary study on VaR model which is a traditional risk measurement method, 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. With the help of stress testing research, the risk of banks can be quantitatively reflected in major emergencies. Combined with Value at Risk (VaR), it depicts the whole picture of the risks of the logistics banking business risk system. Different from VaR in routine operation test, credit risk stress testing is a routine operation in the medium and long terms. This chapter primarily focuses on the effects of macro factors in the stress testing of logistics banking business. This chapter focuses on the determination of macro-factors in the stress testing of logistics banking business.

5.1 Introduction

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 different ability to bear pressure, the different the 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. Therefore, this study has got 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. The stress testing procedure is shown in Figure 5-1.

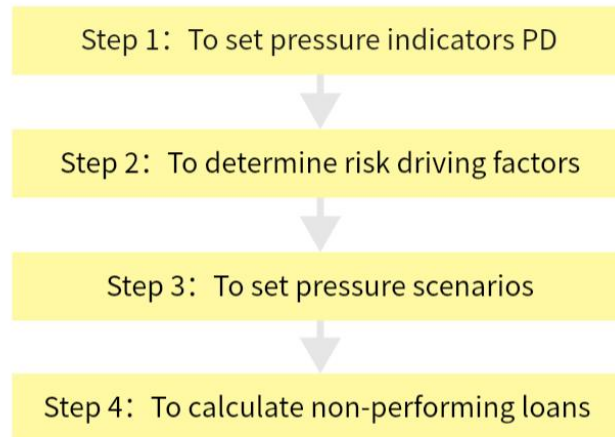


Figure5-1 Procedures of Stress Testing

5.2 Method

5.2.1 Risk Transmission Mechanism of Macro Factors

The method of scenario construction is divided into portfolio driven method and event driven method. However, these two methods are suitable for discussing the relationship between scenario design and risk factors in stress test. 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 test, so that pressure factors drive the changes of parameters such as PD, LGD and EAD in Basel Accord. Taking the macro factors in customer stress testing of logistics banks as an example, the transmission

mechanism is shown in Figure 5-2.

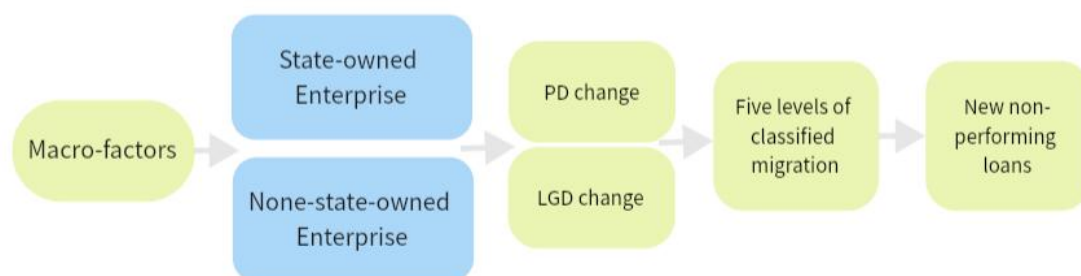


Figure 5-2 Risk Conduction Mechanism of Macro-factors in Stress Testing

5.2.2 Macro Factor Stress testing Design Mechanism

Logistics banks should formulate reasonable stress testing model according to their own conditions. 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 5-1.

Table 5-1 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

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 vc to obtain the loss. The specific steps are:(1) The GDP, M2 and CPI values given in the stress scenario are brought into the design model to calculate the operating income under the stress scenario.It compares the difference between the listed company's operational income's actual and anticipated values of the listed company under the stress scenario, and gets the change of the operating income. (2)Assuming that under the stress scenario, the rating migration matrix of an enterprise shifts according to the change degree of its rating grade, and the shape of the migration matrix does not change during the shift process, the rating migration matrix of an enterprise under the stress scenario is calculated. According to the grade distribution of enterprises under the stress scenario, the default probability value (PD value) under the stress scenario is calculated. (3)Selecting four indicators as parameters to calculate the LGD value of each enterprise under pressure: the change of enterprise PD, the change of enterprise debt ratio, the change of collateral value and the change of collateral liquidity.It is to multiply the calculated PD value and LGD value under the stress scenario to obtain the EL value under the stress scenario, and compare it with the EL value of the enterprise in the base period to obtain the change of EL.(4)It is assumed that in the stress free situation, the migration of the five categories remains unchanged. And it supposes that under the stress scenario, the migration matrix of the five-level classification will shift according to the change of its EL, and the shape will not change during the shift. 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.

5.2.3 Hypothesis and Basic Framework of Model Establishment

Based on the relevant contents of Basel Accord and combined with the stress measurement practice of domestic commercial banks, a stress testing model is designed to measure the long-term effects of macro variables on logistics banks' credit risk.

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:

$$\ln W_{s,t} = \mu_{s,0} + \mu_{s,1}X_{1,t-1} + \mu_{s,2}X_{2,t-1} + \dots + \mu_{s,t-1}X_{n,t-1} + e_{s,t} \quad (5-1)$$

$W_{s,t}$ 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.

5.2.4 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 bank which are being studied. According to the research of Fei J (2015), through the research of CPV Model, Single Factor Model and GVAR Model, and on the basis of Chapter 3, three indicators are selected: inflation rate index (I), GDP index (GDP growth rate), and money supply index (M2 growth rate).

GDP growth rate (GDP): This index reflects the economic growth and economic cycle of a nation, and it is the core index. It is widely used as an important macroeconomic factor in many empirical studies. And GDP can be seen as the output's increase rate of all enterprises in a country. It is known that the output directly affects the profitability of the enterprise, and involves the solvency of the enterprise as well.

Inflation (I): This indicator represents the level of price increase. During the period of economic prosperity, there will be moderate inflation. In a recession, deflation usually occurs. Thus, inflation is an important indicator of the economic cycle. It is acknowledged that the operating costs and profitability of enterprises are greatly affected by inflation. At the same time, it will also affect the credit risk of enterprises. CPI and PPI are two important indicators of inflation. Since PPI primarily serves as an index to gauge the degree and pattern of changes in industrial ex-factory prices, focusing on the change of production costs, it does not fully reflect the impact of inflation on enterprise income. More importantly, the index can not cover agriculture and service industry. Therefore, in this study CPI index is selected as a measure of inflation rate.

Broad money growth rate (M2): Broad money is an important indicator of money supply. With the expansion of the money supply, it is helpful to to strengthen the supply-demand link of funds in the market. The cost of funds of enterprises will show a downward trend, and promote the continuous increase of economic activity. This can bring the increase of business income to enterprises, meanwhile, reduce the existing credit risk of enterprises.

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

5.2.5 Significance Analysis of Macro Factor Industry Income Model

The model is to measure the transmission mechanism of macro-economy and industry. The control variables in the model are GDP growth rate, inflation rate I and monetary growth rate M2, and the dependent variables are the annual income of the industry in which the loan enterprise is located.

Table 5-2 The Impact of Macro Factors

Independent Variable	Dependent Variable	Regression	R ²
GDP&M2&CPI	A1	$A1=19.5832+0.2198CPI+0.0626GDP+0.0666M2$	77.97
GDP&M2&CPI	A1	$A1=19.6441+0.2250CPI+0.0005GDP+0.0272M2$	69.01

Considering the availability of data, the operating income of listed companies is used as the transmission medium of macro factors to the risk, and the operating income of listed companies is divided into asset intensive industries, light manufacturing industries, wholesale and retail industries, transportation industry, construction industry, real estate industry, infrastructure industry, investment industry and service industry. The result of the three factor regression analysis of the control variables and dependent variables, Table 5-2, shows that the three-factor model has relatively good explanatory effect, and the overall is relatively significant.

5.2.6 Calculation of Default Rate of Logistics Banking Business

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.

$$PD = \text{Quarterly New Defaults} / \text{Total Loans.} \quad (5-2)$$

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. Table 5-3 shows the correlation coefficient of macro variables in stress test.

Table 5-3 Correlation Coefficient of Macro Variables in Stress Test

	Y+% of GDP	Y+% of CPI
Y+% of GDP	1	0.67
Y+% of CPI	0.67	1

From the correlation coefficient between variables, 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. Based on this, 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.

5.3 Stress Testing

The overall credit risk stress testing is in accordance with the relevant provisions of China Banking Regulatory Commission. The relevant data of domestic A-share-holding listed commercial banks are selected as samples. According to the regulatory requirements, the internal data, macroeconomic data and real estate market data over the years are collected. The statistical model with stable statistical performance selected in the previous stress tests in recent two years is adopted.

5.3.1 Model initialization and change

Based on the construction of the model and the interpretation of relevant variables in the above, we first repair the missing value of the independent variable value according to the time series method. Since the value in 2016 is the last value in

each variable, the method is to replace the missing value with the mean of the effective value of several adjacent points, which is replaced by the mean of the values in 2015 and 2014 in this model. It is found that the dependent variables approximately obey the normal distribution. Carry out multiple regression for each variable with the software function, and adopt the stepwise regression method for the way in which each variable enters the model, that is, according to the pre-set criteria (the default criterion of the system), 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/removed variables is when Input/removed variables, step (criterion: probability of F-to-enter ≤ 0.050 , the probability of F-to-remove ≤ 0.100), and loop.

5.3.2 Scenario Assumptions of Macro Factors

The subjects of stress testing are from April 2007 to March 2016 (Wind database). Pressure indicators are capital adequacy ratio and non-performing loan ratio. The capital adequacy ratio under pressure is calculated as follows:

For new non-performing loans under pressure, the provision for loan impairment is calculated according to the proportion of 40% and the capital is deducted. Meanwhile, the corresponding new provision is deducted from the risk weighted assets. The pressure scenario is set to the relevant requirements of the CBRC,

including GDP growth rate, real estate price and M2 growth rate. 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 5-4.

Table 5-4 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		

5.3.3 Method and Process of Stress Testing

In designing the method and process of stress test, based on the principles of statistics and economics, the top-down method is to establish the connection between GDP, M2 and 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 specific modeling data are shown in Table 5-4.

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:

$$\begin{aligned} \ln \frac{NPR}{1 - NPR} = & -0.0668 \times R_{M2} - 0.1197 \times R_{GDP} \\ & -0.4703 \times \exp(R_H) + e(t) \end{aligned} \quad (5-3)$$

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%.

Table 5-5 Macro Variable statistics

Time Window	Year-on-year growth rate of GDP (%)	Year-on-year growth rate of M2 (%)	Growth rate of house price/year (%)	Central bank lending rate (%)
2007Q2	14.5	17.1	14.77	6.57
2007Q3	14.4	18.5	14.77	7.05
2007Q4	14.2	16.7	14.77	7.47
2008Q1	11.3	16.2	-1.65	7.41
2008Q2	11	17.4	-1.65	7.46
2008Q3	10.6	15.3	-1.65	7.2
2008Q4	9.6	17.8	-1.65	6.53
2009Q1	6.6	25.5	23.18	5.31
2009Q2	7.5	28.5	23.18	5.31
2009Q3	8.2	29.3	23.18	5.31
2009Q4	9.2	27.7	23.18	5.31
2010Q1	12.1	22.5	7.5	5.31
2010Q2	11.2	18.5	7.5	5.31
2010Q3	10.7	19	7.5	5.56
2010Q4	10.4	19.7	7.5	5.81
2011Q1	9.8	16.6	6.46	6.06
2011Q2	9.7	15.9	6.46	6.31
2011Q3	9.5	13	6.46	6.56
2011Q4	9.3	13.6	6.46	6.56
2012Q1	7.9	13.4	8.1	6.56
2012Q2	7.7	13.6	8.1	6.31
2012Q3	7.6	14.8	8.1	6.0
2012Q4	7.7	13.8	8.1	6.0
2013Q1	7.7	15.7	7.77	6.0
2013Q2	7.6	14	7.7	6.0
2013Q3	7.7	14.2	7.7	6.0
2013Q4	7.7	13.6	7.7	6.0
2014Q1	7.4	12.1	7.7	6.0
2014Q2	7.6	12.2	7.7	6.0
2014Q3	7.2	12.9	7.7	6.0
2014Q4	7.3	12.2	7.7	5.6
2015Q1	7.1	12	7.7	5.6
2015Q2	7.1	11.4	7.7	5.35
2015Q3	7.0	13.1	7.7	5.35
2015Q4	6.9	13.3	7.7	5.35
2016Q1	6.9	13.4	7.7	5.1

5.3.4 Discussion

By using the final 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 5-6 and Table 5-7 show the detailed results of stress testing.

Table 5-6 Results of stress testing (State-owned Enterprises /Non-state-owned Enterprises)

Scenario	Item	Amount of A1	Amount of A2
Benchmark scenario	Non-Performing Loan(NPL) balance	200.77	233.16
	Total loans	22000.15	19600.16
	Loss rate of NPL	40.45%	54.23%
	Capital adequacy ratio	10.00%	10.66%
Mild pressure	Total loans	22000.15	19600.16
	Loss rate of NPL	1.1%	1.8%
	Capital adequacy ratio	10.03%	10.00%
Moderate pressure	Total loans	22000.15	19600.16
	Loss rate of NPL	3.37%	4.5%
	Capital adequacy ratio	9.88%	7.66%
Severe pressure	Total loans	22000.15	19600.16
	Loss rate of NPL	5.39%	9.12%
	Capital adequacy ratio	8.17%	5.01%

In order to deal with the possible impact, logistics banks should be strengthened in the following aspects. On the one hand, logistics banks should adhere to the sound concept of risk, and strengthen the management and control. One is to balance the business structure, disperse risks and reduce the impact of economic cycle fluctuation on banks. Secondly, the profit structure is optimized, the focal point of business is adjusted to the ones with low capital consumption, and the resources are allocated to the business with less economic capital and less risk. The third is to maintain a reasonable credit leverage ratio and deposit loan ratio, and not to excessively expand

asset leverage due to the pursuit of business scale. On the other hand, during the transition to standard period, logistics banks will actively launch the issuance of subordinated debt and capital long-term instruments to supplement the capital of logistics banks.

Table 5-7 Results of stress testing (All Enterprises)

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, under 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 we conducted a stress test under different scenarios. In this test, we set the GDP growth rate as the main factor of change, and also set three scenarios: mild stress scenario, the GDP growth rate dropped; In the severe stress scenario, the GDP growth rate dropped; Under the extreme pressure scenario, the GDP growth rate dropped.

The interest rate for a one-year loan is set as the only change factor and there is

no interaction relationship with other macroeconomic variables. We can also understand this relationship as that when the interest rate for a one-year loan changes in a very short period of time, other macroeconomic variables have no time to make corresponding changes. Therefore, this is a short-term change, which is suitable for point estimation. Compared with the first method, the second method obviously focuses on the analysis over a longer period of time. It reflects the trend of macro-economy in a year, and the macroeconomic variables will interact and influence each other.

The relationship between macroeconomic variables is set differently. In the sensitivity stress test, we did not consider the interaction between macroeconomic variables, which is obviously not consistent with the actual situation. However, this method is more direct, convenient and simple in testing the short-term impact caused by the rapid change of a macroeconomic factor in a short time; In situational stress tests, macroeconomic variables interact with each other.

5.4 Summary

This chapter mainly studies in the New Basel Accord's framework the measurement of macro factors in the credit risk stress testing of commercial banks. Based on macro factors, the scenario stress testing is to investigate the adverse effects of macroeconomic downturn on the quality of commercial banks' credit assets. According to the different characteristics of credit assets of commercial banks, they are divided into corporate bank credit assets and retail bank credit assets in this chapter, and then respectively examines the transmission mechanism of the macro factor impact in the credit risk stress testing and finally comprehensively examines the measurement of macro factors in the credit asset stress testing of commercial banks as

a whole.

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 under pressure scenario 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.

Taking the relevant data of logistics banking business of commercial banks in China as samples, an empirical analysis of the 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.

It shows that there have been risks from credit investigation to post-loan management, and it should strengthen risk control. 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.

6. Conclusions

6.1 *Summary of the Research*

This research has targeted questions and improvements in the following aspects:

In the studies, the research investigates the credit risks in the logistics banking business by different empirical models. PSTR model is used to solve the mismatch deviation of the model, and the asymmetric effect of monetary policy on bank risks is studied from the perspective of intermediate target of monetary policy (broad money). The empirical results demonstrate that throughout periods of monetary policy expansion and contraction, monetary policy (represented in money supply) has a nonlinear impact on bank risks.

To study the measurement of non-systematic risk caused by the operation condition in loan, it analyzes the optimal mode of enterprise operation in risk control in establishing the risk-return model to measure the risk of the core enterprise based on VaR theory. This part extends it to the logistics banking chain level, and obtains the value range of credit risks.

The final research explored at how long-term effects of macro-factors on logistics banking system, the research uses the stress testing of credit risk. The result shows that the banks' capital-to-capital ratio under the three kinds of stress scenarios is lower than the minimum regulatory requirements. The profit structure is optimized, the focal point of business is adjusted to the ones with low capital consumption, and the resources are allocated to the business with less economic capital and less risk.

To sum up, based on the prior research, this study further provides empirical

proof that macro-policy has a nonlinear effect on logistics banks' risk. This research is also different from the research of Molodtsova (2008) and Molodtsova & Papell (2009) who take Taylor rule (Taylor, 1993) as an exogenous determinant of monetary policy. Although Taylor rule is the mainstream method for evaluating monetary policy in the United States (Kahn et al., 2012; Taylor, 2012), but there is no strong relevant evidence to show that this rule is also used in China.

Therefore, this research does not explicitly assume that banks follow any loss function when monetary policy decisions are made, nor does it assume that interest rate is an exogenous variable of banks. This hypothesis is only based on the current market economy model of our government.

The main innovation feature of this research is that in the the existing theoretical frameworks and models, the single factor model and CPV model mentioned here are models to measure enterprise credit risk according to a macroeconomic factor. However, the first test is controlled by many factors, which is not widely used in commercial banks in China, and is used even less in the practice of logistics banking. At present, the main characteristics of the project research already carried out in China are that it is mainly focused on accurately analyzing and effectively measuring the downward pressure situation in China's macro-economy and the adverse economic impact on China's non-performing loan owners through the practical application of relatively simple economic model analysis methods and tools and the relevant provisions of the Basel Accord is not taken into account. Through the above research, this study mainly demonstrates the relevant measurement of macro factors in stress testing based on the relevant provisions of Basel Accord and the current situation of stress measurement carried out by logistics banks in China. At the same time, the

income model is designed to judge the restriction of macro factors on credit risk. It has been proved to be greatly effective, and it is of more practical significance to carry out stress test for logistics banking business.

The New Basel Capital Accord has been gradually implemented all over the world. It has become a trend to increase risk's capacity control and promote the development of risk assessment from single qualitative research to both qualitative and quantitative research. At present, domestic logistics banks have made great achievements in internal rating management, but their internal risk management ability is still low. Especially in the process of implementing the internal rating method, most banks' internal risk management is still in the scoring stage, and the technology for credit risk management still uses conventional measurement techniques. Since the measurement of credit risk in domestic The financial sector is still in learning and exploration, the study of credit risk measurement model is of benefits to China's logistics banks to measure credit risk and implement international strategy by using internationally leading concepts, technologies and methods.

The research on credit risk measurement is helpful to promote the strategic transformation of logistics banks. At present, the domestic banking industry is accelerating the transformation of the business strategy focusing on asset light and capital light. Quantifying the value of enterprise credit risk cost is helpful to accurately analyze the company's operation and management cost, capital use cost, other enterprise credit risk management cost, tax risk cost and capital cost in the process of operating business, and finally determine a reasonable loan interest rate. Strengthening the in-depth study of credit risk measurement can promote banks to reduce credit risk and strive to improve operation and management efficiency. On the

other hand, asset and liability structures are optimized, and capital occupation is decreased.

6.2 Implications of the Research

6.2.1 Implications on Research

The significance of this thesis is divided into four parts.

1. The research on the risk of logistics bank in China mainly includes concept description, theoretical analysis and case study. However, there is little research on systematically quantifying the risk of logistics banks. In addition, expert analysis and questionnaire survey are mostly used in the research of risk measurement. Different from other research fields, questionnaire survey has certain advantages in other research fields. In the research on the risk of logistics bank, the evaluation of experts and the judgment of investors are subjective, and have the tendency to evaluate by virtue of past investment memory. The usage of the data is from the National Bureau of statistics and RRESET to process, and basically eliminates the impact of unreasonable evaluation.

2. The standard method - linear quadratic framework is improved to analyze optimal monetary policy. The financial sector should be included in the model for making macroeconomic decisions and the monetary policy's nonlinear influence on bank risks should be taken into account by the monetary authorities' reaction function. Thus, a foundation for further research is laid.

3. Qualitative analysis was the main method to study the risk of logistics banks

in the past. From the perspective of banks, this thesis takes the credit risk faced by banks as the research object, and establishes and perfects a new research model based on the real financial data of banks and enterprises. This is a breakthrough and innovation in the risk research of logistics bank.

4. Most studies analyze the relationship between enterprises in the logistics banking chain to determine the risk. Due to the difference between China's macroeconomic and political environment and the market environment of developed countries, the particularity of logistics finance determines that the selection characteristics of research objectives are very special, so that it is necessary to rely on macro objectives to select research objectives. Therefore, the risk of logistics banking business can be calculated, which is rarely mentioned in the previous studies.

Specifically, monetary and fiscal policies are important tools for the government to stabilize the economy and counter economic cycle regulation. Some expansionary monetary policies, such as falling interest rates frequently result in increased credit. Increasing the investments of private sector, individual economy and enterprises is an effective way to boost GDP. One of the reasons may be the endogenous problems in empirical economic analysis. Owing to the difference from enterprises, commercial banks that develop logistics banking business are also an important part of monetary policy, and their effectiveness will inevitably enhance or weaken monetary policy. In the aspect of exploring the possible influence of monetary policy on bank risks, the conclusion is that as the critical level of money supply changes, bank risks is affected by monetary policy and other factors in a way that allows for a smooth and progressive shift from high to low. Under two different types of systems, the transition

flexible money supply has a favorable effect on bank risks. However, it is not statistically significant under the high system, but it is significant under the low system. The results show that, commercial bank samples also have asymmetric effects. The influence of control variables also has reference value. The PMI has a negative effect on bank risks, and it is statistically significant at both high and low levels. For the index of real estate price, it has a negative impact at a low level, and its coefficient is not statistically significant while at the high stage, it has a positive effect and great statistical significance.

The study infers that the monetary policy impact on bank risks is asymmetric, just like what happens in the stock market. Banks' risk-taking practices is sometimes subjective and irrational. Following the adoption of monetary policies, the changes of bank risks preference, risk perception and risk decision-making behavior show the characteristics of slow, gradual and non-discrete. Monetary policy correspondingly influences bank risks, which will change due to the different types of macro-environment and monetary policy, and is uncertain due to the interactive determinants. During the market downturn, the wealth of the whole economy has decreased sharply, and investors are in the invalid area of the utility function. Due to the loss aversion, the impact of monetary policy may be more significant on banks' risk. Therefore, a nonlinear route connection exists between monetary policy and bank risks, and its correlation is stronger in the market downturn.

6.2.2 Implications on Practices

In actual operation of logistics banking business the following elements require focus and improvement.

1. Business closure

In logistics banking business, the transmission of value in logistics banking chain operations should form a complete closed system. The closed system mainly refers to the early and young connection of activities. At the same time, value can be fully integrated and circulated, and the economic value of each link can be transmitted to the next link according to the set route and degree, generating new value. The main body is complete, the process is clear, and the elements are complete, which together can make risks be effectively avoided.

2. Transaction informatization

To achieve the goal of controllable financial risks, transactions should be informationized. Transaction informatization can not only obtain and analyze various types of information and data directly generated in logistics banking business, but also achieve full cycle management. The information governance of logistics banking business needs to ensure the authenticity of the business, logistics capabilities and quality, and clear and controllable financial analysis. Business authenticity not only includes the real existence of the business and the subject, but also the continuous and stable value generated. In addition, the logistics operation capability and inventory turnover rate in logistics banking business should meet transaction requirements. It is essential to ensure that the financial fund flow in the overall business system is clear and controllable.

3. Self compensation of income

The logistics banking chain revenue or future revenue of logistics banking business can cover all possible costs and risks in the business. Satisfying risk income self compensation can effectively mitigate risks. By analyzing the liquidity of

inventory goods and elements in logistics banking business, we can effectively control the risk of revenue coverage. In the networked state of financial business operations, the liquidity of goods and factors not only needs to be statically examined for returns, but also dynamically analyzed for spatiotemporal factors. The spatiotemporal elements mainly include temporal and spatial elements. The longer the financing cycle, the greater the potential risk. In the imperfect credit system in China, the credit of small-to-medium-sized enterprises is unstable, so try to borrow and repay as short as possible. Meanwhile, due to the various political and economic climates in different countries and regions, the risks generated are also different. This political risk can also be marketed to the credit of the trading entity, promoting transaction security.

4. Management separation

Management systems should be separated from each other. In this case, the responsibility is clear and the process is controllable. The various activities of logistics banking business can be effectively managed, mutually constrained, and do not overlap. In detail, business approval and business operations are separated from each other. Separation of transaction operation and logistics supervision. The development and implementation of financial business, regulation, and separation of the three. Separate the supervision of specific enterprises and their senior management. At the same time, the management of logistics banking business needs to pay attention to clear concepts of structure and functions, clear responsibilities of each department, stable strategy, and complete management, in order to achieve a good cooperation mechanism.

5. Differences in risks

In logistics banking business, adopting effective methods and combinations can effectively prevent risks and uncertainties. There are differences in the means and approaches to reducing risks for different sources of risk. The risks faced by logistics banking business are the superposition of logistics banking risks and financial risks, therefore, different means are required to diversify risks. However, even so, the importance and risk diversification ability of different means are different, with a priority order. There are differences in the credit of different entities, and entities should choose different means to diversify risks based on their own attributes (such as corporate culture and history).

6. Reputation quantification

In terms of innovation in logistics banking business, corporate reputation represents a company's ability in financial activities. Corporate reputation is a vital component in ensuring the stability of financial business. Assessing the basic situation and solvency of enterprises can effectively avoid moral hazard. Assessing the innovation capability and development potential of enterprises can maintain and enhance their market competitiveness, especially for SMEs. An analysis of the market prospects for the sector where the business is located, as well as a favorable market and regulatory environment, can stimulate the potential of the enterprise and ensure sustainable development.

6.3 Limitations of the Research

1.SME

Owing to the special situation of financial market in China, there is limited transparency of financial data. Thus, what is able to get access to is only the data of

the listed enterprises and banks. As it is discussed in the previous parts, most of the enterprises with the strongest demand for loan are SMEs, which may not have enough assets to get into the market. As it was mentioned previously, banks have access to the core enterprises in the same logistics banking chain with the SME to obtain the credit data of the SME, but there is still information asymmetry between each other. Thus, what the study can learn is the general credit risks measured by open data. It is complicated to understand the real market story. However, in the future research, this research will keep on trying to further reveal more parts of the business process of logistics banking business through empirical analysis.

2. Micro factors

The micro factors (the qualifications, financial status, trade background, and contractual ability of logistics banking chain financing enterprises) also exist, and contribute significantly to the study of risks of logistics banking business. Analyzing relevant factors and understanding the impact mechanism of the factors on logistics bank risks can provide support for the operation of logistics banking business.

Enterprise qualifications refer to the resources, capabilities, and status of an enterprise. In logistics banking business, enterprise qualifications mainly involve resource and technological production capacity, enterprise's ability to respond to industry changes, and enterprise risk tolerance. When the enterprise qualification is poor, if the financing amount is too large or the cycle is too long, the risk of logistics banking business increases heavily.

The analysis of the enterprises' financial situation is also a means of risk prevention. Financial condition analysis analyzes the asset structure and asset

liquidity of a company by understanding its asset status, profitability, and fund operation efficiency, and determines whether it meets the conditions for enterprise operation and financing. The analysis of the financial situation of enterprises can prevent the risk of abnormal investment due to cash out. If the financing amount or period of a company exceeds the operational range that its financial level can maintain, timely risk prevention should be carried out.

Logistics banking business should assess the authenticity of the trade background between enterprises in the logistics banking chain. Analyzing the transaction background, transaction methods, and payment situation of a company to determine the rationality of its financing is beneficial for regulation and risk warning.

The capacity of an enterprise to carry out its commitments reflects its operational risks and determines whether it can provide products according to agreed requirements. In logistics banking business, enterprises on the logistics banking chain need to jointly fulfill contracts to ensure the smooth recovery of funds. Only by analyzing the profitability, risk tolerance, and market stability of enterprises can it effectively prevent and control risks.

Micro influencing factors will affect the financing volume, financing cycle, and financing rate of logistics banking business. These influencing factors collectively affect the magnitude of the risk. The research primarily examines role of macro influencing factors on the risk of logistics banking business, but there is a lack of discussion on micro influencing factors. Further research should include the analysis of micro factors and more comprehensive research on methods for controlling and managing the risks of logistics banking business.

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