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Graduate School of Management

Master in Corporate Finance

FINANCIAL PERFORMANCE OF CHINESE SUPPLY CHAIN FINANCE UNDER THE IMPACT OF "THE BELT AND ROAD" INITIATIVE

Master's Thesis by the 2nd year student

Concentration — Corporate Finance

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彭妍 (Подпись студента)

24.05.2018 (Дата)

ABSTRACT

Master Student's Name	Peng Yan
Master Thesis Title	Financial Performance of Chinese Supply Chain Finance Under the Impact of "The Belt and Road" Initiative
Faculty	Graduate School of Management
Main field of study	38.04.02 —Management (specialization: Master of Corporate Finance)
Year	2018
Academic Advisor's Name	Alexander V. Bukhvalov
Description of the goal, tasks and main results	This paper is an empirical analysis of the market risk faced by the implementation of railway supply chain finance business (the case of Chinese Z Aluminum Industry Co.,Ltd). Because of the fluctuation of market risk, took Shanghai A00 Aluminum as an example,financial time series analysis method was used and GARCH(1,1) model was established to describe characterize matter of yield kurtosis and heteroskedasticity, and on this basis,the Monte Carlo simulation was improved to calculate long-term market risk VaR. Furthermore, in the case of the comprehensive considerations of risk-free capital cost, a risk management index of dynamic pledge rate was designed. As a result, there is a significant positive correlation between the dynamic pledge rate and the aluminum price under different holding periods.The models built in this paper can actually help Z company reduce the market risk according to different dynamic pledge rates.
Keywords	Railway supply chain finance, market risk, dynamic pledge rate, “The Belt and Road” initiative

АННОТАЦИЯ

Автор	Пэн Янь
Название ВКР	Финансовая результативность китайских цепочек поставок под влиянием инициативы «Один пояс-один путь»
Факультет	Высшая Школа Менеджмента
Направление подготовки	38.04.02 —Менеджмент (Профиль:Корпоративные финансы)
Год	2018
Научный руководитель	профессор А.В. Бухвалов
Описание цели, задач и основных результатов	Данная работа является эмпирическим исследованием риска, возникающего при реализации бизнеса по финансированию цепей поставок железной дороги (случай Chinese Z Aluminum Industry Co., Ltd). Из-за колебания рыночного риска, например, в случае Shanghai A00 Aluminum, финансовые временные ряды были использованы для анализа, GARCH(1,1) была построена для описания характера сущности коэффициента эксцесса и гетероскедастичности, и на основе этого модель симуляции Монтекало была улучшена для подсчета долгосрочного рыночного риска VaR. Далее индекс управления риском для динамической ставки залога был разработан для случая комплексного рассмотрения безрисковой стоимости капитала. В результате была выявлена значительная положительная корреляция между динамической ставкой залога и ценой алюминия в разные периоды времени. Построенные в работе модели могут помочь компании Z уменьшить рыночный риск в соответствии с различными динамическими ставками залога.
Ключевые слова	финансирование цепей поставок железной дороги, рыночный риск, динамическая ставка залога, «Один пояс-один путь»

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Introduction

With the advancement of information technology and transportation technology, the Chinese economy has integrated into the world markets, supply chain is replacing vertical integration and becoming the mainstream mode of international industrial organizations. In the supply chain, capital flow is a top priority and runs through all the activities in the supply chain. Thus, supply chain finance ,as a new financing service, is a systematic financial solution provided to coordinate the capital flow of the supply chain and reduce the overall financial cost of the supply chain.

At the same time, the proposal of the “The Belt and Road” initiative has brought tremendous opportunities to China's logistics industry. Rail transport, as a window to the logistics and transport corridor, is showing more and more Chinese enterprises and starting to make business overseas and expanding new geographical areas. Commodities are more dependent on railway transportation, while 90% of rail freight is bulk commodities and most of them have no financial infiltration. It can be said that railway supply chain finance has become the “blue ocean market” for new supply chain finance.

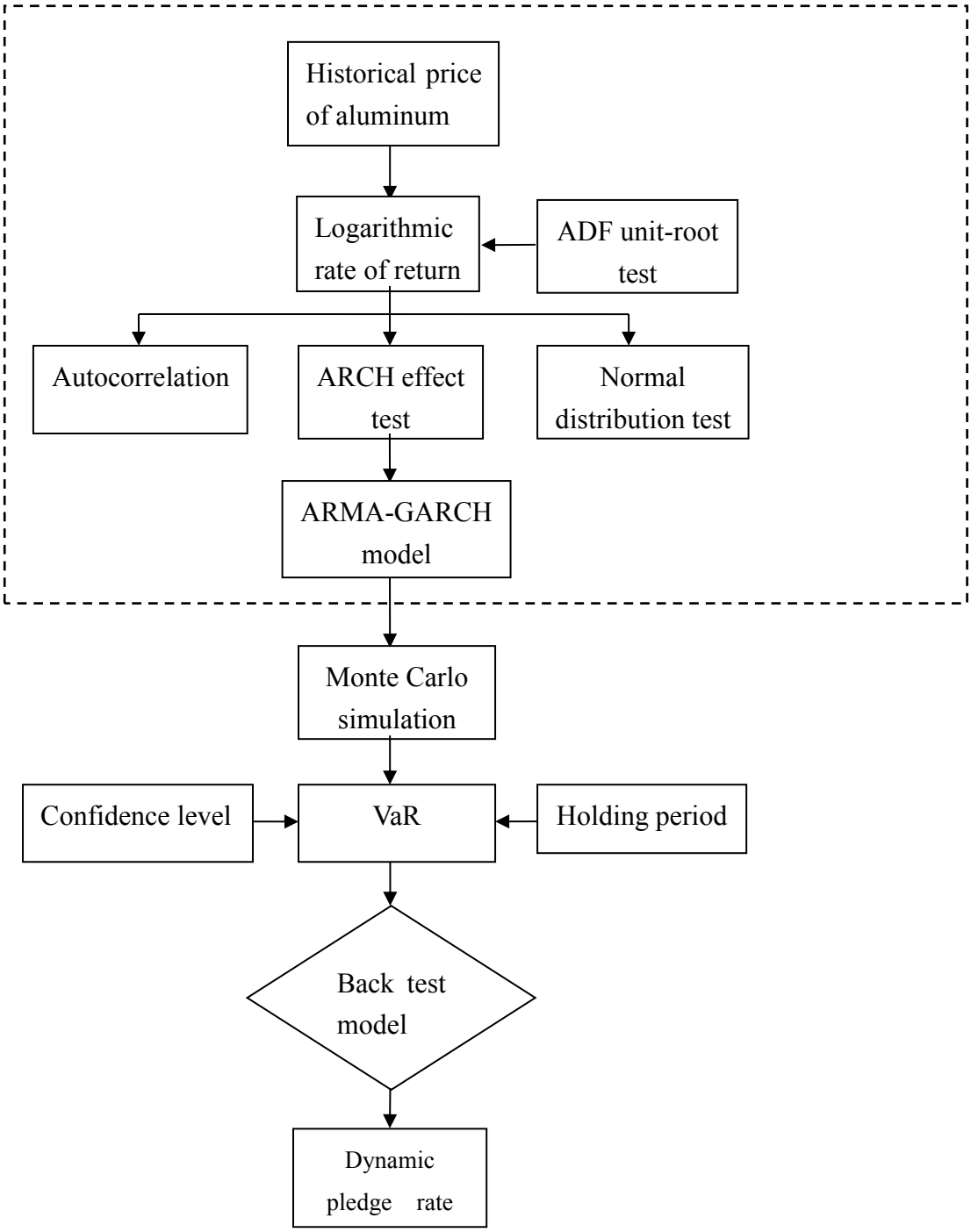
It is worth mentioning that due to the existence of financial leverage, supply chain finance business has high-risk characteristics. In this situation, it is necessary to carry out the main risks quantified estimation faced in the process of railway supply chain finance and design the corresponding risk control methods based on the current actual production of railway transportation.

The main research goal of this paper is to quantify and do an empirical analysis of the market risk faced by the implementation of railway supply chain finance business: the case of Tianjin Zhong Wang Aluminum Co.,Ltd (“Z” was used for an abbreviation of company full name in the following)

The research questions that have to be answered are following: How does the railway transportation develop supply chain finance business and how to reduce the market risk of railway transportation?

In order to achieve the goal mentioned above empirical study of Tianjin Z Aluminum Co., Ltd is chosen. The AR(1)-GARCH(1,1) volatility model is established to characterize the characteristics of the spike-heavy tail and heteroscedasticity of the return on the quality of

pledges, and the Monte Carlo simulation method is used to estimate the long-term risk VaR. Finally, the dynamic pledge rate is calculated under the condition that the comprehensive consideration of risk-free capital cost. The average market price of Shanghai A00 aluminum was taken as a sample for empirical analysis, and EVIEWS8.0 and Matlab2017 was used to conduct statistical analysis of financial time series and Monte Carlo simulation. The technology road map is shown below.



Technology Roadmap

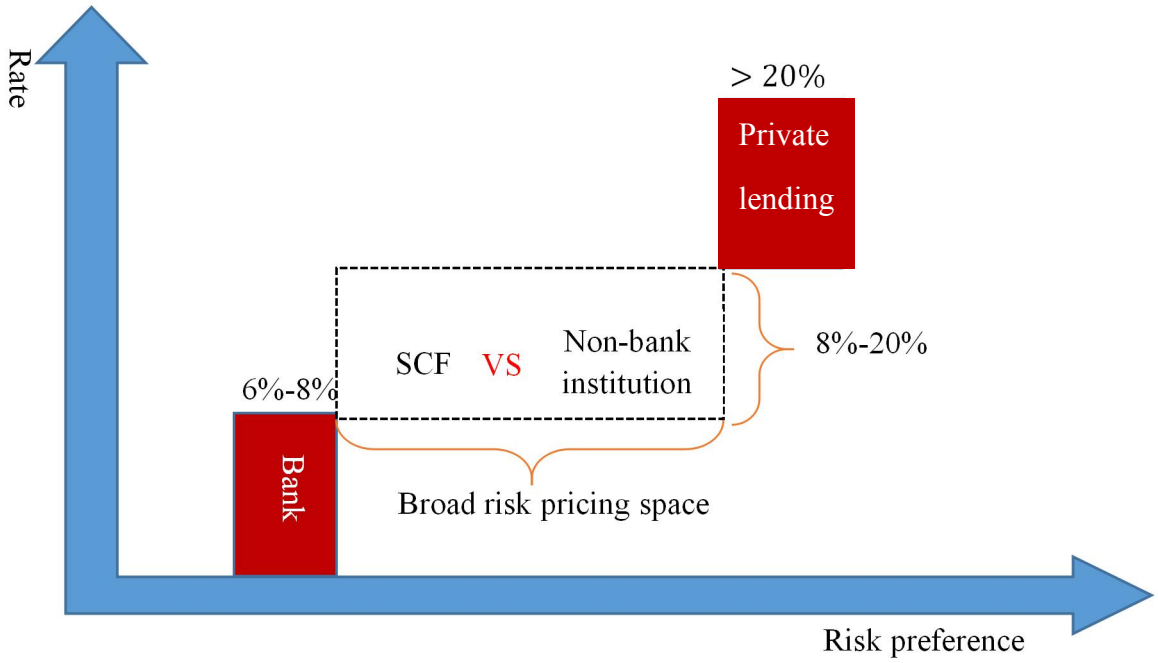
Chapter 1 Supply chain finance and railway transportation

1.1 Chinese supply chain finance overview

Supply chain refers to the functional network chain structure in which the core enterprise is the center and through the control of information flow, logistics and capital flow, the suppliers, manufacturers, distributors and retailers are integrated into the end user as a whole (Hu Yuefei, 2009). Supply chain finance is a bank revolves around the core companies to manage the capital flow and logistics of the upstream and downstream SMEs, and transforms the uncontrollable risks of the individual companies into controllable risks for the supply chain enterprises as a whole. Through the three-dimensional access to various types of information, the risk is controlled to the lowest financial services. In general, supply chain management refers to activities and processes that plan, coordinate, operate, control and optimize the entire supply chain system. So, among these it is worth mentioning that financial products and financing models that are more flexible, less costly, more efficient and more controllable risks appear to be particularly important. Under this background, supply chain finance has emerged and developed.

In recent years, the management of cash flow in the supply chain has also been increasingly concerned by all walks of life in China. Yang Shaohui (2005) believes that supply chain finance is a new type of financing model tailored for SMEs. It effectively integrates capital flows into supply chain management and provides not only commercial trade funding services for companies in all aspects of the supply chain, but also provides new loan financing services for vulnerable companies in the supply chain. Hu Yuefei (2008) believes that supply chain finance refers to the use of a credit model for self-reimbursable trade financing on the basis of analysis of the transaction structure within the supply chain, the introduction of new risk control variables such as core companies, logistics regulatory companies, capital flow guidance tools, etc. Also, it provides closed credit support and other settlement, wealth management and other comprehensive financial services to different nodes of the supply chain. Song Hua (2015) pointed out that, generally speaking, the current domestic view is that supply chain finance refers to “relying on core customers, based on the real trade background, using self-reimbursed trade financing, through accounts receivable pledge registration, third-party supervision and other professional means to close capital flows or control property rights and provide integrated financial products and services to upstream and downstream companies in the supply chain.”

The natural evolution of supply chain finance as an industry model upgrade essentially compensates for the gap of 8% to 20% in SME annual financing costs and gives SMEs a new financing tool. It has a strong living space in the context of SME financing. Also, it satisfies the demands of the transformation and upgrading of core enterprise industries and realizes the long-term value of its industrial chain through financial services.



Source: Cnii.com.cn

It is estimated that at present, the accounts receivable of Chinese companies are more than 20 trillion yuan. If these accounts receivables are used as potential collateral for bank loans, it can be predicted that the development of Chinese supply chain finance market has great potential. By 2020, the market scale of Chinese supply chain finance will reach 14.98 trillion yuan.

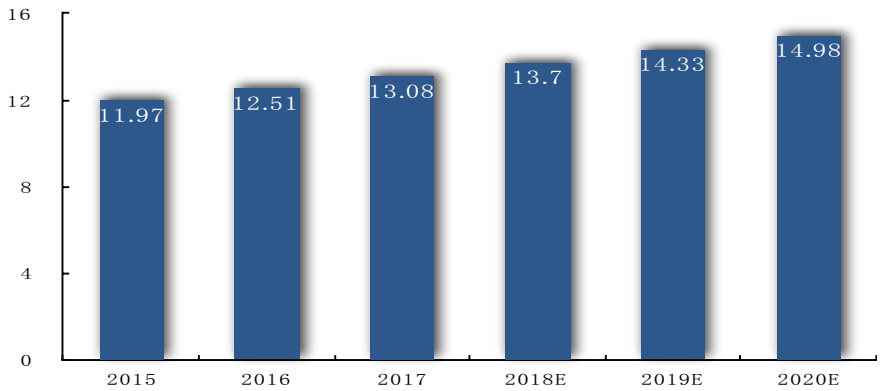


Figure 1.1 Forecast of scale of China's supply chain financial market 2015-1020 (unit: trillion) (Source:http://www.chyxx.com/industry/201704/513111.html)

1.2 Supply chain finance in logistics industry —as the example of railway transportation

1.2.1 Different roles and functions of third-party logistics enterprises in supply chain finance

In the traditional model, the third-party logistics are actually less relevant to the supply chain finance. The buyers and sellers just hope that the logistics activities can be carried out smoothly, and the third-party logistics only aim to obtain timely returns and funds through its own services. Although third-party logistics can know the status of both parties' transactions and the status, value, inventory and other information of the items, it cannot be delivered to financial institutions in a timely manner, thus creating an island of information. In the new supply chain finance model, third-party logistics have played an important role. According to the role of third-party logistics companies in supply chain finance, these roles are mainly reflected in the following aspects.

(1) Third-party logistics companies as trading platform providers

As a link connecting various companies in the supply chain, logistics companies can effectively understand the nature of goods, master the real information of business flows and logistics, and have professional advantages when analyzing the production of upstream and downstream companies and relationship between commerce and trade in the supply chain. In the process of developing credit financing services for small and medium-sized enterprises, financial institutions have adopted complex and high financing costs to reduce credit risks. Because of the nature of basic logistics services, third-party logistics companies have a certain understanding of the actual conditions of the goods, their purchase channels, sales channels, production and sales conditions. They can obtain more detailed and reliable information and use electronic information technology to delivery to related companies timely. At the same time, third-party logistics companies can also provide guarantees for customers or use their own credit advantages to seek indirect bank credits for their customers if they have a certain scale and credit degree.

(2) Third-party logistics companies as transaction risk managers

As a bridge between companies in the supply chain, third-party logistics companies hold trade information in many industries, such as cargo inventory, inventory time, sales volume, etc., and thus have a clearer grasp of market information than other companies such as banks. Third-party logistics companies can perform differentiated management according to different pledges, monitor real-time information, effectively evaluate the market value of pledges, reduce

information asymmetry risks and transaction costs in supply chain financial services. The transfer of regulatory functions has effectively reduced management costs and operational risks for banking financial institutions. Third-party logistics companies are responsible for collateral pledge supervision. Bank financial institutions focus on financial risk management. Effective market division of labor promotes the development of supply chain financial services.

(3) Third-party logistics companies as liquidity providers (risk undertakers)

A third-party logistics company with a certain scale can use its own capital advantages to provide customers with financial services such as advance payment and agent procurement. Even financial institutions such as banks grant the credit quotas of logistics companies according to the operation scale, operation status, debt ratio and credit degree of third-party logistics companies. Third-party logistics companies can directly use these credit lines to provide flexible pledge services to related companies. It will help companies obtain financing more easily and reduce some of the tedious aspects of the original pledged loan. At the same time, banks are equivalent to directional loans to third-party logistics companies, which improves the monitoring ability of the entire process of pledged loans, helps optimize the business process and work links of their pledged loans and reduces loan risks.

1.2.2 The prospect of railway supply chain finance under the background of "The Belt and Road"

With the increasingly fierce competition in the logistics market, third-party logistics companies are gradually turning to newer service areas to expand profit margins. Today, with the refinement of the social division of labor, logistics companies continue to reduce the cost of logistics through various advantages such as transportation and warehousing, in order to gain greater market competitive advantage, but the reduction in costs will inevitably lead to a decline in the profits of traditional logistics services. Under this contradiction, third-party logistics companies have to open up new service areas and expand their profit margins. As an emerging field, on the one hand, supply chain financial services have expanded the level and depth of service of logistics suppliers. On the other hand, it has also eased the problem of customers' capital flows. By providing supply chain financial services, it not only improves the market competitiveness of logistics companies, attracts more customers, but also deepens cooperation

with customers in the process of service development, laying the foundation for deeper and broader cooperation. It is worth mentioning that because of the high threshold of the supply chain financial services industry and the higher requirements for capital, information, management and corporate qualifications, the competition within the industry is weaker and the profit space is also broader.

As the lifeline of the national economy, railways are one of the important engines that drive the country's economic growth. Railway enterprises have undertaken large-scale infrastructure construction tasks, but traditional methods of financing cannot meet funding needs. Today, the launch of the railway supply chain financial services platform can solve this problem.

The strategy of blue ocean challenges companies to break out of the red ocean of bloody competition by creating uncontested market space that makes the competition irrelevant. Instead of dividing up existing - and often shrinking - demand and benchmarking competitors, blue ocean strategy is about growing demand and breaking away from the competition (Kim and Mauborgne, 2005).Commodities rely on rail transport, while 90% of rail freight is bulk commodities, and most of them have no financial penetration. So, railway supply chain finance becomes blue ocean market for new supply chain finance and the application of railway supply chain finance can allow companies to break form the competition, find their own special market and open up blue oceans of uncontested market space.

In the era of globalization, market competition, companies seek greater interest to seek a broader space for development, considering the long term, on the basis of common interests between enterprises to establish strategic cooperative relations and realize the depth of cooperation. From supply chain perspective, the long-term stable supply chain is based on mutual cooperation between enterprises from the chain, the result of mutual trust. In the process of developing supply chain finance, railways not only improve their own business capabilities, but also more importantly integrate into the customer's production and sales links, and establish strategic cooperative relationships with each other.

One of the core contents of the "The Belt and Road" initiative currently being implemented is "Investment and Trade Cooperation". It aims to drive China's large number of advantageous production capacity and its competitive products to "go abroad" and form a win-win strategy. Therefore, through theoretical and empirical analysis, it is very important to

help Chinese dominant manufacturing companies construct a sound supply chain finance model, promote their global supply chain efficiency and enhance global competitiveness.

In this case, as the third-party logistics company, the core business of the railway should be transformed from basic logistics transportation to integrated management of customer supply chain, that is, to provide customers with various resources related to procurement, manufacturing organization and sales channel integration business. On the basis of supply chain management, the effective embedding of financial resources contributes to the construction and smooth implementation of its business processes, stabilizing the upstream and downstream businesses and operating systems through the use of financial resources. At the same time, it will continue to expand its business activities, accelerate the turnover of accounts receivable and obtain higher capital gains further.

1.2.3 Analysis of railway supply chain financial business model based on chattel mortgage

As a traditional third-party transportation company, the railway business should focus on transport services and use pledge control as a breakthrough. The supervision of movable property is based on the cooperation of third-party logistics companies and banking financial institutions, the pledged supervision of movable assets owned by a financing company or a third party recognized by a bank and assists the banking financial institution in controlling financial risks.

In the process of supply chain finance, first of all, railways can use self-managed stocks and existing transportation networks to assist bank financial institutions in supervising in-transit goods and inventories and carry out chattel mortgage-related services (see Figure 1.2). At the same time, on the basis of consultation between banks and financing companies, the use of the railway logistics center warehouse as a third-party mortgage warehouse to carry out the corresponding mortgage financing business, which is not only conducive to the bank's supervision of collateral, but also the use of railway transport network financing companies can also conveniently achieve transportation or distribution of goods or products. Secondly, after accumulating relevant experience, under the commission of the banking financial institution, the logistics extension business of supervision will be implemented for the storage process. Under the condition that the mortgage supervision does not take possession or custody, the customer’s work warehouse or third-party warehouses are supervised.

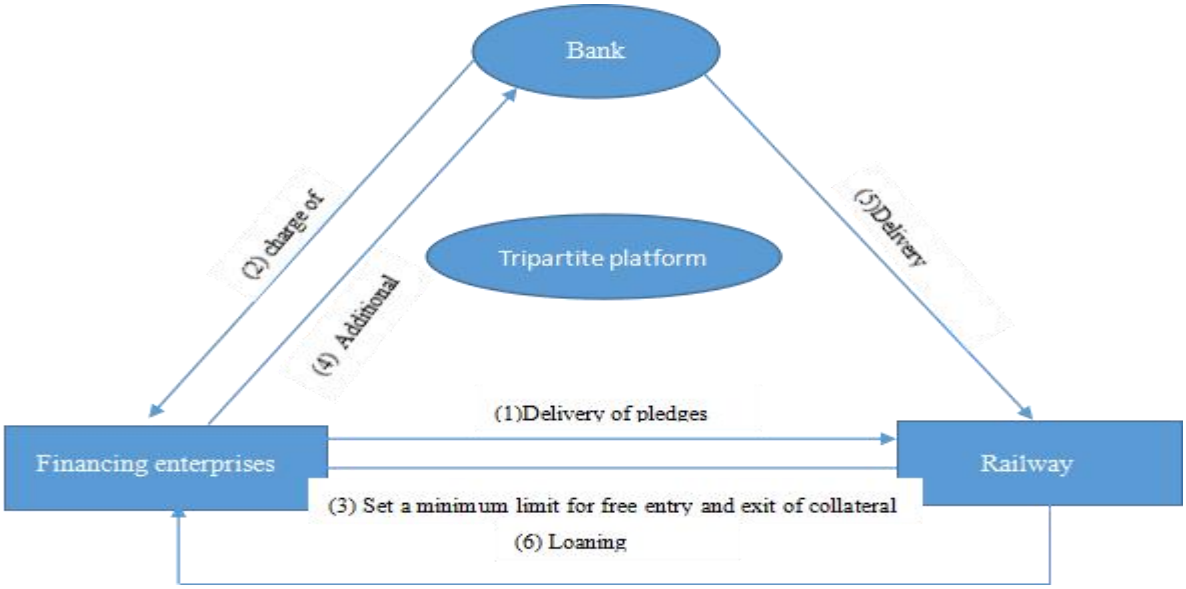


Figure 1.2 Dynamic production supervision modes in railway supply chain finance

1.3 Previous research on supply chain finance

1.3.1 Research on business models and technical methods of supply chain finance

The research on supply chain finance started earlier in Western countries. In the middle of the 20th century, Albert, Raymand and Dunham [1948] systematically reviewed inventory financing and receivables financing involved in supply chain finance. In recent years, researches on supply chain finance have also become more diversified and the focuses of researches are also different. It can be summarized from two aspects.

On the one hand, it summarizes and advocates the practice of the supply chain finance business model. Shawnee K Vickeryr[2003] systematically analyzed the laws, regulations, business forms, management methods and operational procedures of the supply chain finance business in developed countries such as Europe and the United States. Allen N Berger [2004] first proposed the idea of using supply chain finance to solve the financing difficulties of SMEs based on the development of SMEs. Leora Kapper [2004] analyzed the mechanism and operation of supply chain finance inventory financing based on issues of SME financing. Gonzalo [2006] proposed eight elements for the survival of SMEs in the process of researching the inventory financing business, and pointed out that liquidity, as the most important factor, directly affects the survival and development of the enterprise. M Badell[2007] and Guoming Lai[2009] analyzed the supply chain finance business model based on financial institutions of commercial banks from two perspectives: the development trend of supply chain financial services and the

operation technology of supply chain finance.

On the other hand, previous researches are more focused on the use of technical means to optimize the supply chain capital flow and reduce the supply chain financial costs. Hofmann [2003] combines supply chain management with financial tools, noting that operational asset management aims to reduce fixed assets, including inventory and in-transit goods and improve transit time by improving the interaction of logistics and information flow, such as order processing, debt and liability management. Pfall [2004] proposed order cycle management to optimize the supply chain financial service process, including activities in orders, bills, payments and IT systems. Michael [2007] emphasizes the role played by core companies in supply chain finance and uses it as a guide to rationally embed cost analysis, cost management and various financing instruments to systematically optimize the availability of funds and their costs.

When we pay attention to the development of China's supply chain, we can see that China's research on supply chain finance began with the concept of "financing storehouses" in 2000 proposed by Zhu Daoli, who provided a theoretical basis for later supply chain finance. Guo Tao [2005] gave a detailed discussion on the financing role and impact of accounts receivable. Yang Shaohui [2005] from the perspective of commercial banks, defined supply chain finance as a new financing model tailored for small and medium-sized enterprises and effectively embedded capital flows into supply chain management, which provides strong financial support for companies in the chain. At the same time, it also solved the financial problems faced by the weaker companies. Hu Yuefei [2007] pointed out that supply chain finance should be established on the basis of analysis of the internal transaction structure of the supply chain and use core enterprise credit ratings to provide credit financing for upstream and downstream enterprises. Lian Ziying [2013] proposed to expand the existing "1+N"model into "M+l+N"model, which relying on a core enterprise to provide "M"suppliers and "N"distributors or customers with supply financial services.

It is not difficult to observe from the above research papers that the initial combination of supply chain and finance started from the perspective of supply chain financing. It can be said that the financing function is the basic function of supply chain finance. Moreover, the supply chain finance business development model is basically the same, mainly based on accounts receivable financing, inventory financing and prepayment financing.

1.3.2 Research on risk identification and measurement of supply chain finance

In terms of risk identification of supply chain finance, Matthew [1997] considered that supply chain finance should be a special form of banking financial credit services, except for basic credit characteristics, which has other unique attributes. Therefore, he focused on information sharing by analyzing its advantages and disadvantages in the supply chain finance and put forward the corresponding solutions. Hallikas[2002] analyzed the financial risk of supply chain based on Pater's external risk uncertainty conditions, considering the possibility of the risk being amplified. Zhao Li [2010] systematically analyzed the three major supply chain finance models and proposed solutions according to each model.

The quantitative analysis of supply chain financial market risk mainly refers to the means of risk management of financial assets, of which VaR method is the most mainstream. J. E Morgan [1996] and Alexander C [1996] introduced the theoretical method of VaR in detail. However, it is not easy to measure accurately in practical operations, because when calculating the VaR by using the parametric method, we not only consider the distribution characteristics of the yield, but also take the fluctuation characteristics of the yield in account. Empirical research shows that under the volatility of the return of rate does not satisfy the assumption of an effective financial market, that is, it shows a sharp peak and thick tail. In order to reflect the heteroskedasticity of volatility, Engle [1982] proposed an autoregressive conditional heteroskedasticity (ARCH) model, and Bollerslev [1986] improved it to propose a generalized autoregressive conditional heteroskedasticity model (GARCH). These two models show good advantages demonstrating the time-varying characteristics of the market and appeals widespread attention. Ricardo [2012] used the GARCH model to predict and analyze the VaR of assets under the thick-tailed feature. Wei Yu [2010] combined the scroll time window method with VaR, predicted the data outside the sample in GARCH model and calculated VaR in combination with China's gold spot market. Liu Qingfu[2011] and Shao Yanping [2007] analyzed the futures copper market and proved that the model has good performance in predicting market risk effectively.

1.4 Risk identification of railway supply chain finance business-- three different categories

Through the analysis of the railway supply chain financial business model, it can be seen

that there are more participants and more involved industries in supply chain finance, compared with the traditional loan business. Especially in the practical application process, different service products are integrated with each other and involve many links and operation methods.

Therefore, in the risk management process, in addition to considering the credit risk management of financing companies involved in the traditional credit business, it is necessary to pay more attention to the credit information carried by the relevant collateral in the financing process, such as the relationship between the supply and demand of the goods and the security The status of value fluctuations, the actual situation of the transaction background, and sometimes even the market development of the supply chain where the financing companies are located. At this time, it is impractical to rely solely on bank financial institutions to assess and manage risks. Thus, it is necessary for the railways to exert their professional expertise and manage business risks from the perspective of logistics supply chain.

Based on previous studies, this paper divides the risks pf supply chain finance into three different categories: macro-industry risk, corporate credit risk and supply chain system risk.

1.4.1 Macro- industrial Risk

As participants in the market economy, all parties involved in supply chain finance will be affected more or less by the macroeconomic environment or the overall development of the industry. Specifically, the macro-industry risk can be subdivided into macro-environmental risk and industry development risk.

(1) Macro-environmental risks. The trend of macroeconomic development, changes in the political environment, and the degree of perfection of the legal and regulatory system are all incentives for such risks. Compared with other risks, macroeconomic effects are more widespread and have far-reaching effects, which may have a major impact on the national economy over a period of time. However, such risks are difficult to control effectively. In the actual process, the possible losses can only be minimized.

(2)Industry development risks. When investigating the credit company's background in financing companies, situation analysis of the industry in which the company located is an important step because the trend of the industry as a whole has the most profound impact on companies. In terms of China's economic trends in recent years, the transformation of the

industrial structure has led to a sharp decline in the previous strong commercial commodity market. Companies based on block transactions have been hit in this process, and the industry's development status is not optimistic in the short term. In addition, from the perspective of the industry, to consider the business situation is more comparable and can get more objective observation data. In general, the development of the industry can be considered from the perspective of the industry's average profitability, transaction frequency, technological change and future development potential. It is worth mentioning that different industries have different sensitivities in the face of changes in the macroeconomic environment.

1.4.2 Corporate credit risk

Credit risk assessment is the core business of traditional credit risk management. It focuses on the investigation and analysis of the company itself. The goal is to prevent the financing needs or affiliates from taking opportunistic actions in the supply chain financial activities, so that the organizers of financial activity may suffer huge losses. Generally speaking, it mainly involves the financial analysis of financing companies', historical status of creditworthiness, business status analysis and analysis of compliance capabilities.

(1) Corporate financial analysis. In supply chain finance, although the foundation of finance is the trade process and logistics process in supply chain operations, it is not completely based on the company's financial statements and financial indicators. It is usually difficult for many small and medium-sized enterprises to rely on their financial statements to judge and manage risks, but financial position risk analysis is still necessary. One of the key tasks in financial analysis is to conduct a comprehensive analysis of the assets of the client company, understand the assets of the company, and determine the liquidity of each asset, especially the contents of the liquid assets.

(2) Integrity history. Integrity is the basis and prerequisite for carrying out supply chain finance. If there is no good credit history for supply chain participants or financial organizers, supply chain financial activities will have a huge crisis. However, this problem is also the biggest obstacle facing China's supply chain finance. On the one hand, there is currently no perfect credit information management system in the asset market. On the other hand, the implementation of policies has a low price for breach of contract and cannot compensate for the

actual losses. It is because of this that historical analysis of integrity has become particularly important.

(3) Analysis of business conditions. The object of operation analysis in the perspective of the supply chain is not only the operation status of the financing demand side, but also the operation status of the upstream and downstream companies, as well as the understanding and mastery of the entire supply chain operation by the financial organizer, especially the supply chain. Business flow and logistics in operation.

(4)Analysis of performance capabilities. Corporate performance capabilities can reflect the level of business risk, but also reflect the company's ability to use liabilities to engage in business activities. Supply chain financing serves the growing SMEs in various channels of the supply chain. The performance ability of these companies directly determines whether they can provide qualified products and services according to the requirements of the companies in the channel, thus affecting the smooth circulation of funds repayment. Judgment on corporate performance capabilities can be analyzed from the aspects of the company's profitability, product technology maturity, product quality and reliability.

1.4.3 Supply chain system risk

Supply chain system risk is a potential instability factor that may arise in the process of collaborative competition between companies in the supply chain. Compared with general credit financing, the biggest characteristic of supply chain finance is the self-repayment nature of the trade process. This kind of self-repayment may be manifested as the realization of the self-value of the pledges, or it may be expressed as the future refund of the transferred bill. However, self-compensation is based on the supply chain and is closely related to the upstream and downstream companies. Specifically, supply chain system risks can be divided into supply chain management risks, upstream and downstream trade risks, and trading market risks.

(1) Supply chain management risk

The smoothness of supply chain operation levels and processes is closely related to the supply chain's organizational and management capabilities. The stronger the organizational management capabilities, the stronger the stability of the supply chain, and the higher quality of operations.

It can be said that whether the supply chain or not is stable has a direct impact on the development of companies in the chain, especially for small and medium-sized enterprises. In the case of low supply chain operation efficiency, corporate profitability will certainly be affected. At this time,the probability of breaching contract will be higher.

Therefore, the analysis of supply chain management factors is the key to measuring the stability of the supply chain. In the process of consideration, on the one hand, it measures the efficiency of the use of materials and technologies; on the other hand, it evaluates the effectiveness of management and behavior. Compared with the former, the latter is intangible, which is more difficult to measure and evaluate, but it is more important for the coordination and stability of the supply chain. Secondly, in the performance evaluation system, interest distribution mechanism, etc., it may also be detrimental to the future development of the supply chain and stable operation, resulting in the entire chain of competition in the industry to fall under the wind.

(2) Upstream and downstream trade risks

As a part of the supply chain, modern enterprises are inevitably not isolated. The trade relationship with upstream and downstream companies is one of the basic relationships between enterprises. Essentially, the core of supply chain finance business is to solve the problem of capital flow in the production and operation process. The fundamental cause of this problem is the asymmetry of the financing companies in trade with the upstream and downstream companies. For example, if the company may need to prepay the purchase price during the procurement process, it will need to obtain the payment after the sales period expires. The company's large amount of assets will exist in the form of inventory or accounts receivable, and the liquidity of the assets will decline.

In the financing process, the upstream and downstream trade risks often manifest themselves as the authenticity of trade background and the the risk of converting pledges into cash.

It was mentioned that self-reimbursement is the most prominent feature of supply chain finance, and the fundamental basis for self-payment is the authenticity behind trade. Once the authenticity of the transaction background does not exist, the bank rashly grants credit to the financing enterprise when there is a contract fraud, a problem with the legality of the receivables,

or a problem with the ownership or quality of the security, and the payment will not be guaranteed , which will face great risks. The risk of realization also involves upstream and downstream companies, specifically whether the collateral is easily discounted at the time of default, i.e whether the downstream company's ability to purchase collateral or the level of repurchase of collateral by upstream companies is related to the risks faced by lenders. The gap is consistent. In particular, for certain specific collateral, if they are not guaranteed by the upstream or downstream companies, the collateral may be difficult to realize, thereby losing the effect of reducing the losses when the risks occur.

(3) Market risk

The market risk of collateral mainly refers to the uncertainty of the future market price, which has an adverse effect on the financial business of the railway supply chain. Since the price of collateral is always fluctuating, if in the repayment period borrowing companies are unable or unwilling to repay the loan, and the overall price of the collateral is just below the corporate loan value, financial institutions will face the risk of loan losses. In particular, for some SMEs with a relatively single structure, the price fluctuations of the main sales products may even affect their development. In the process of adverse market fluctuations, they may even lead to bankruptcy.

At present, banking financial institutions have relatively mature research on market risks such as stocks, securities and futures. However, compared with the on-the-spot market, commodity trading prices, transaction volumes, trading habits, etc. in the spot trading market are very different, bank financial institutions are often unable to do anything. Therefore, it is necessary for third-party logistics companies to proceed from their operational management data and to measure the actual value of the collateral in combination with professional experience.

In summary, in addition to focusing on macro-environmental risks and the credit risk involved in traditional financial credit business, railway supply chain finance should focus on the consideration of the supply chain system itself. The practical trade background, reasonable selection of collateral and effective assessment of the market risk of collateral are the key factors of the railway supply chain financial business. Compared with the other two, there are more aspects involved in the market risk of the collateral and it is more difficult to make a reasonable quantitative estimate. The following analysis will focus on this issue.

Chapter 2 Empirical market risk analysis of railway supply chain finance business based on VaR method

According to the analysis above, previous scholars have studied risks of stocks, bonds, and commodities based on the VaR-GARCH model. These transaction types already have relatively sound risk control measures, such as margin system. Therefore, the vast majority researches on risk measurement based on the VaR-GARCH model are short-term risks within two weeks (especially one day), that is, using the serial data of the past as a sample to predict the daily risk value in the future day. In contrast, spot control methods based on over-the-counter transactions are relatively scarce, so the setting of the dynamic pledge rate is particularly important.

Due to the inverse relationship between liquidity and risk, unlike financial assets such as stocks, bond and futures, the liquidity of inventory pledge business is weaker, the risk is greater than the former and the time for risk discovery to risk disposal is also poor, leading to a longer period of risk holding of the bank,

Therefore, under the current conditions, the core of the financial risk management of the railway supply chain is to measure and control the market risk of the pledges and to predict its long-term price risk, that is, to use the serial samples of the past period of time to predict the value at risk of the future N months or more.

In response to the industry competition, the competition between enterprises is transformed into the competition between supply chains. Supply chain finance has emerged as the times require. It is regarded as a kind of "integrated financial and logistics innovation service" proposed by banks and logistics companies. Its essence is a kind of pledge guarantee business under the participation of logistics companies. Despite the huge potential of the supply chain financial market, concerns about the supply chain's financial risk have been restricting the prosperity of dynamic pledge financing business. The stock pledge loan as the main business model is to reduce and evade the credit risk of the loan by using the stock as a pledge. During the evaluation of pledged loans, the valuation of pledged assets is to judge whether the value of the pledged goods can maintain the ability to guarantee loans in the future loan period. The pledge ability of pledges is reflected by pledge rate.

2.1 Assumption of model

Aluminum, which has good liquidity, strong liquidity and easy preservation, has always been regarded by the banks as an ideal product in the stock pledge business. The paper will use time series of aluminum as a model sample.

The market price of aluminum is dynamic and fluctuate. It has similar characteristics with financial asset prices. The model is based on the following assumptions:

(1) During the pledge period, banks choose different risk windows according to their own risk preferences, the credit status of supply chain financial counterparties, the liquidity of their own assets and the supply chain operation condition, pledge rate will vary accordingly.

(2) The price of aluminum fluctuates randomly, under different macroeconomic environments and the rate of pledge will be different.

(3) The stock pledge business is a short-term financing activity (less than one year), so it is assumed that the bank-lending rate will remain unchanged during the pledge period.

2.2 Research method - Monte Carlo Simulation based on GARCH model

The concept of value at risk (VaR) was first proposed by Till Guldimann, head of JP Morgan's global research department, who developed into one of the main indicators of global financial market analysis.

Combining with the financial practice of the railway supply chain, VaR as a measure of market risk in the process of pledge of movables was defined. The most unfavorable situation in the price of pledges may occur during certain pledge periods and certain levels of confidence. From a statistical point of view, VaR can be described as a quantile where expected returns are distributed at a certain confidence level within a certain target time. Assume that P is the value of the asset, Pt is the initial value of the asset portfolio and c is the confidence level needed for the risk metric, then VaR_{1-c} means that the loss will exceed critical value only when the probability is 1-c, i.e.

$$Pr(P—Pt > -VaR_{1-c}) = c$$

Or $$Pr(Pt—P > VaR_{1-c}) = 1-c$$

The VaR method is used to estimate the market value risk of the collateral involved in the company's mortgage financing process and to reduce the credit risk exposure through the

dynamic pledge rate. In order to calculate VaR, there are two important parameters: holding period and confidence level, only when these two parameters are determined, the VaR calculation makes sense.

(1) Holding period

According to the nature of the asset, the selection of the holding period is different. Assets, with good liquidity, such as stocks, bonds, futures, the holding period is shorter, generally one day or one week. As for the off-the-spot cash transactions involved in the pledge of movables business in railway supply chain finance, its liquidity is relatively poor, so the holding period is longer, generally measured monthly, quarterly or annually. In this paper, monthly holding period is chosen.

(2) Confidence level

The differences in confidence level reflect the degree of bank financial institutions' risk aversion. A lower level of confidence means that there is a relatively high probability of experiencing extreme losses that exceed VaR and the risk may be underestimated. Whereas, if the confidence level is too high, it will increase the risk reserve of financial institutions and reduce the efficiency of capital utilization. In general, the confidence level of bank is set between 95%-99%.

Assume that the market price of aluminum on day t is P, the market price on day t-1 is P_{t-1}, the daily rate of return of pledged aluminum adopted a logarithmic return rate can be defined as

$$R_t = \ln P_t - \ln P_{t-1}$$

It is not difficult to see that when the rate of return is the smallest possible value, it means that the loss of asset is the greatest, that is, the minimum value of the asset price. Therefore, according to the definition of VaR, VaR can be obtained when the minimum price or the lowest yield is found. In the case where the confidence level is c and the duration is T, the risk of price VaR_P can be represented by the VaR of the logarithmic rate of return, that is

$$VaR_P = Pt\,(e^{VaR(T)} - 1) = Pt\,(e^{Rt} - 1)$$

From the practical application process, it was found that the traditional Monte Carlo simulation is not very effective for small-probability events. To solve this problem, this paper introduces the GARCH model into the simulation process. The GARCH model can effectively describe the time-varying characteristics of thick tails and agglomerations existing in the

financial time series. According to previous studies, the first-order GARCH model can effectively characterize the above features, and thus the GARCH (1, 1) model is established to build conditional mean and conditional variance equations:

$$Rt= \mu R_{t-1} +\varepsilon_t =\mu_t +\sigma_t z_{t;}$$

$$\sigma^2_t = \alpha_0 +\alpha_1\varepsilon^2_{t-1} +\beta_1+\sigma^2_{t-1}$$

Rt: yield of t trading days;

μ_t: average condition of the yield of t trading days;

ε_t, ε_{t-1}: residual items of t and t-1 trading days respectively;

$\sigma^2_{t,}$ $\sigma^2_{t-1:}$ conditional variance of t and t-1 trading days respectively;

Zt : the newborn variable, that is, the residual term

In order to better characterize the peak-thickness and tail-tail characteristic of the yield, suppose that Zt obeys the t-distribution; α_0 is a constant term and $\alpha_0>0$; α_1 is ARCH parameter estimates, $\alpha_1>0$; β_1 is an estimate of the GARCH parameter, $\beta_1>0$.

In this way, the mean μ and standard deviation σ in the original Monte Carlo simulation can be replaced by the conditional mean μt and the conditional variance σt in the GARCH (1, 1) model.

Pledge rate calculation

The pledge rate is the ratio of the maximum credit of bank financial institutions to the actual value of the assets. Assume that the quantity of pledge is Q, and the cost of loan is $C=P_tQw(e^{rt} -1)$, where r is interest rate of loan. To calculate the cost of capital, continuous compounding method is chosen in this paper. The amount of loan equals to the current value minus the risk value and the cost of capital of risk-free value.

$$P_tQw = P_tQ - P_tQ (eVaR^{(T)} -1) - P_tQw(e^{rT} -1)$$

So, the rate of pledge is

$$W = \frac{2 - e^{VaR(T)}}{e^{rT}} \qquad (2.2)$$

From the above formula, it is not difficult to see that there is a negative correlation between loan interest rate and pledge rate, which also shows that with the increase of loan risk the cost of financial borrowing will increase, and the pledge rate will also decrease. The risk-free

price Ps=PtQ - PtQ (eVaR $^{(T)}$ -1), i.e, the initial price minuses the price risk VaR and the amount of loan, P_L is the free-risk price deducts the cost capital of loan.

Back test model

In the process of modeling and estimating VaR, the accuracy of the model must be tested, that is, the degree of coverage of the price risk of VaR is detected. At present, the most popular test method is based on Kupiec's failure rate theory, such as the back testing model specified in the Basel protocol. This method mainly examines the numbers VaR exceeded in the test sample. In the general financial market risk calculation, the market price data at each moment is collected using the mark-to-market method and the daily risk value is examined. However, this paper is a measure of long-term market risk and the data is based on the average of the price on the trading day. Therefore, to improve this back testing model, numbers of the long-term risk value VaR exceeded in the holding period or numbers of risk free prices Ps exceed are calculated, which can be expressed as:

$$\text{Over} \begin{cases} 1, & P_{t+i} - P_t < VaR \\ 0, & orelse \end{cases}$$

Or

$$\text{Over} \begin{cases} 1, & P_{t+i} < P_S \\ 0, & orelse \end{cases}$$

If the number of samples detected is N, f is the number of Ps exceed, then the accuracy of the model can be expressed by f/N. When it tends to 1-c, it means that the model accuracy is reasonable. If it is too large or too small, it proves that the model is invalid.

2.3 VaR-GARCH modelling and back testing

As a traditional state-owned large-scale transport enterprise, the railway basically covers the major cities and most of the cities and towns in the country. In the process of transitioning to modern logistics, combined with its own advantages in transport resources, it has a strong market competitive advantage in terms of transportation of bulk raw materials. According to the current

situation of the railway, select a more typical enterprise as a case for analysis. Z Aluminum Industry Co., Ltd. was established in June 2011. It is located in Wuqing District, Tianjin. It is mainly engaged in the research and development of aluminum extrusion products. The products mainly involve transportation, mechanical equipment and electric power engineering. In order to adapt to the current domestic and international situation, the company has gradually transformed itself into a modern, high-tech, high-precision hard aluminum alloys production line, introducing the most advanced product lines and currently the company's cash flow has been strained. According to this situation, the railway can use the supply chain finance business to find a breakthrough for customer companies from supply chain scheme innovation and financing settlement services.

The core of the financial risk management of railway supply chain under current conditions is to measure and control the market risk of the quality of goods. This article uses the most current market risk estimation method VaR to measure the market risk faced by railway supply chain finance and control it on this basis.

2.3.1 Dynamic pledge rate sample interval selection

Select Shanghai A00 aluminum as a sample and use the average transaction price from January 04, 2007 to December 30, 2016 as an estimation sample, totaling 2469 sample points. Select the estimated sample outside interval from January 03, 2017 to March 16, 2018. The average transaction price in this period was taken as the sample point for testing, with a total of 300 sample points. Assume that March 16, 2017 is the effective period of the pledge contract and the longest pledge period is 12 months to determine the market risk VaR and the different dynamic pledge rate during this period. A00 Aluminum price time series in the sample is shown in Figure 2.3.1.

Figure 2.3.1. A00 Aluminum price time series (abscissa: Year ; ordinate: Market price of Aluminum) (Source: EViews output by author)

2.3.2 A00 Aluminum Statistical Characteristics in the Sample Range

Based on the logarithmic yield rate (see Figure 2.3.2 and Figure 2.3.3), logarithmic rate of return of A00 Aluminum have a significant concentration and agglomeration effect, followed by a large series of large fluctuations. The performance of small fluctuations are often more stable, which means that there may be an ARCH effect on the residual items of the return sequence.

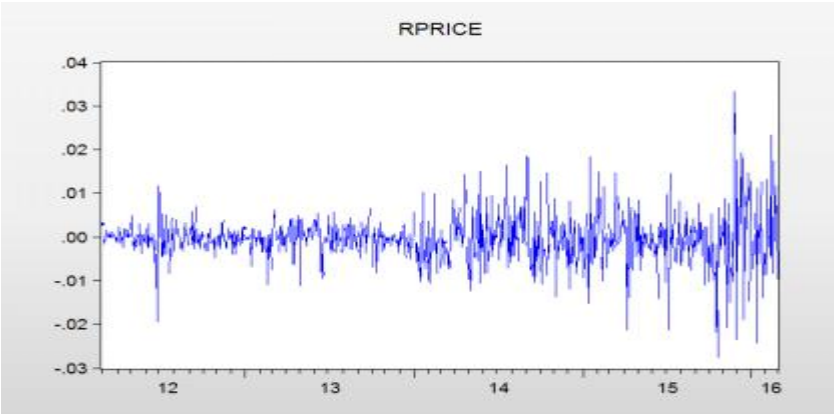


Figure2.3.2. A00 Aluminum log return time series

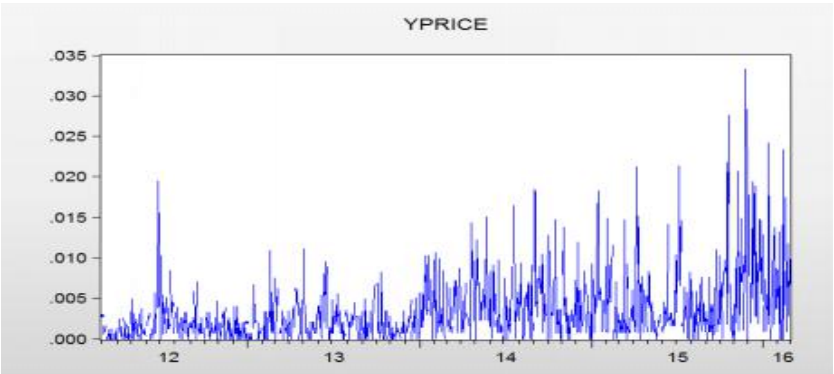


Figure 2.3.3.A00 Aluminum logarithmic yield absolute value

Before modeling the rate of return, firstly ADF test on the rate of return sequence is performed, that is, the unit root test in order to examine whether there is a unit root in the test sequence, if it exists, the sequence is non-stationary and only if the sequence is stable, the GARCH model can be used. The test results are shown in Table 2.3.4.

Table 2.3.4.Yield sequence ADF test

Null Hypothesis: RPRICE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=21)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-26.80448	0.0000
Test critical values:	1% level	-3.436696	
	5% level	-2.864230	
	10% level	-2.568255	

It can be seen from 2.3.4.that the ADF test t statistic is- 26.80448, which is far less than the test statistic threshold of 1%, 5% and 10%, and the probability of the t statistic is very close to 0, so the rate sequence is smooth.

The A00 aluminum yield series was tested with a lag of 28 autocorrelation tests. The test results are shown in Figure 2.3.5. As can be seen from the results, the values of the first-order autocorrelation and partial autocorrelation function obviously exceed the confidence interval, indicating that there is a first-order autocorrelation of the rate of return sequence. It can be assumed that the conditional yield is $Rt= pR_{t-1} +\varepsilon_t$.

Correlogram of RPRICE

Date: 03/18/18 Time: 18:54
Sample: 3/01/2012 3/01/2016
Included observations: 997

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.159	0.159	25.268	0.000
		2	-0.051	-0.078	27.895	0.000
		3	0.052	0.075	30.584	0.000
		4	0.059	0.034	34.065	0.000
		5	0.050	0.044	36.597	0.000
		6	0.005	-0.008	36.627	0.000
		7	-0.048	-0.049	38.986	0.000
		8	0.030	0.041	39.895	0.000
		9	0.082	0.062	46.695	0.000
		10	0.048	0.034	48.990	0.000
		11	0.008	0.005	49.058	0.000
		12	0.008	0.004	49.122	0.000
		13	0.004	-0.011	49.137	0.000
		14	0.013	0.003	49.309	0.000
		15	-0.020	-0.025	49.697	0.000
		16	0.024	0.040	50.296	0.000
		17	0.027	0.013	51.057	0.000
		18	-0.013	-0.021	51.231	0.000
		19	0.094	0.100	60.141	0.000
		20	0.127	0.091	76.634	0.000
		21	-0.044	-0.074	78.634	0.000
		22	-0.052	-0.034	81.416	0.000
		23	-0.056	-0.070	84.589	0.000
		24	-0.023	-0.016	85.126	0.000
		25	-0.006	-0.012	85.159	0.000
		26	-0.055	-0.037	88.218	0.000
		27	-0.044	-0.011	90.172	0.000
		28	-0.028	-0.044	90.987	0.000

Figure 2.3.5 Yield sequence autocorrelation

According to the correlation test results, ARMA (1,1) econometric model is established for the rate of return series to eliminate the linear dependence existing in the sequence. Based on this, the ARCH test is performed on the residual items of the mean equation. If the test result is statistically significant, it means that there exists an ARCH effect in the return sequence and the ARCH model is needed to eliminate the influence of the heteroscedasticity of the autoregressive condition. Using the Lagrange multiplier test proposed by Engle, the ARCH effect of aluminum yield series residual items in the sample is tested. The test results are shown in Table 2.3.6.

Table 2.3.6.Yield sequence residuals ARCH effect test

Heteroskedasticity Test: ARCH

F-statistic	70.12087	Prob. F(1,993)	0.0000
Obs*R-squared	65.62779	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 04/12/18 Time: 23:29
Sample (adjusted): 3/06/2012 3/01/2016
Included observations: 995 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.05E-05	2.39E-06	8.582539	0.0000
RESID^2(-1)	0.256966	0.030687	8.373821	0.0000

R-squared	0.065958	Mean dependent var	2.75E-05
Adjusted R-squared	0.065017	S.D. dependent var	7.29E-05
S.E. of regression	7.05E-05	Akaike info criterion	-16.28058
Sum squared resid	4.93E-06	Schwarz criterion	-16.27073
Log likelihood	8101.590	Hannan-Quinn criter.	-16.27684
F-statistic	70.12087	Durbin-Watson stat	2.112576
Prob(F-statistic)	0.000000		

The Lagrange multiplier test gives a test statistic value of 70.12087, which is much larger than the test critical value and the statistical probability is close to 0, indicating that the return sequence has a strong ARCH effect. Therefore, we need to establish a GARCH model for the return rate series.

Table 2.3.7.Yield sequence statistics and distribution

Yield sequence ststistics

Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera(probability)
-0.000362	0.000000	0.0332286	-0.027687	0.005340	0.137552	8.463041	1242.947(0.000000)

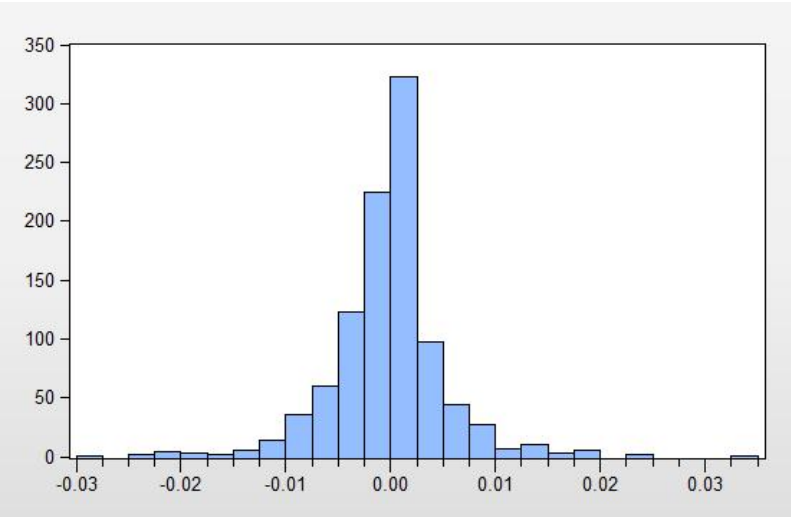


Figure2.3.8. Yield sequence distribution

According to Table 2.3.7.and Figure2.3.8, the skewness of the rate of return sequence is greater than 0 and the kurtosis is greater than 3 in the sample interval. The test quantity of J-B is 1242.947 and the probability is 0. It belongs to a typical thick-tailed distribution, which means that the probability of extreme events with price fluctuations is higher than the normal distribution. Therefore, the volatility is studied by using the GARCH (1, 1) model. At that time, it is reasonable to assume that the newborn variable z and obeys t student distribution.

2.3.3 Results and back test of model

According to the analysis above, AR (1)-GARCH (1, 1) model is established. The joint parameter estimation is performed on the mean value equation and the volatility equation, the results are shown in Table 2.3.9..

Table 2.3.9 Parameters fitting results

Indicators	c	rho	α_0	α_1	β_1	v
Numbers	1	0.010504	4.00485E-07	0.858809	0.14119	3.773448

From the estimation data, the degree of freedom v of t distribution is 3.773448, which is consistent with the description of the spike and thick tail of the yield series. The conditional mean constant term is close to 0, and the coefficient is not obviously negligible, so the conditional mean and conditional variance of the GARCH (1, 1) model under student t distribution are following:

$$Rt= 0.010504R_{t-1} +\varepsilon t$$

$$\sigma^2 t= 4.00485E-07+0.858809\varepsilon^2_{t-1} + 0.14119\sigma^2_{t-1}$$

Where $\alpha_1+\beta_1=0.999<1$, which satisfies the assumption of stable parameters for the GARCH (1, 1) model and can be used for variance prediction. According to banking practice, the holding period is set monthly and carry out Monte Carlo simulations for 100,000 times respectively, taking the lower quantile in the case of 95% confidence level as the logarithmic rate of return VaR for the holding period. The VaR calculated value is brought into equation 2.2 to find the corresponding pledge rate, where the loan interest rate is the current bank's annual interest rate of 4.5% from six months to one year. The calculation results are shown in Table 2.3.10.

Table 2.3.10 Calculation results of dynamic pledge rate under different holding periods

Period（Month）	1	2	3	4	5	6
T	21	42	63	84	105	126
Pt	12980	12980	12980	12980	12980	12980
VaR(T)	0.141756549	0.19375963	0.230739599	0.259399076	0.282973806	0.303389831
VaRp	1840	2515	2995	3367	3673	3938
PS	11140	10465	9985	9613	9307	9042
PL	11091	10368	9839	9418	9064	8750
w	0.844530977	0.780321104	0.732185195	0.693370089	0.660429723	0.631194777
Period（Month）	7	8	9	10	11	12
T	147	168	189	210	231	252
Pt	12980	12980	12980	12980	12980	12980
VaR(T)	0.327195686	0.340677966	0.357473035	0.37403698	0.386748844	0.397919877
VaRp	4247	4422	4640	4855	5020	5165

Table 2.3.10 Calculation results of dynamic pledge rate under different holding periods(cont.)

Period（Month）	7	8	9	10	11	12
PS	8733	8558	8340	8125	7960	7815
PL	8392	8169	7902	7638	7425	7231
w	0.597047119	0.576541284	0.55136194	0.526298192	0.506483947	0.488777858

From the calculation results, it can be seen that with the growth of the holding period, the market risk VaR gradually increases, while the pledge rate is also significantly reduced. It can be seen from the decrease in the pledge rate that only from the market price aspect, the market risk of A00 aluminum is significant, and the risk is obvious in the long-term holding situation. In order to test the accuracy of the model, a test was performed according to the collision model and the test sample from January 03, 2017 to March 16, 2018. The test results are shown in Table 2.3.11.

Table 2.3.11 Back test result

Period（Month）	1	2	3	4	5	6
T	21	42	63	84	105	126
Pt	12980	12980	12980	12980	12980	12980
VaR(T)	0.141756549	0.19375963	0.230739599	0.259399076	0.282973806	0.303389831
VaRp	1840	2515	2995	3367	3673	3938
PS	11140	10465	9985	9613	9307	9042
f	0	0	0	0	0	0
f/N	0	0	0	0	0	0
	7	8	9	10	11	12
T	147	168	189	210	231	252
Pt	12980	12980	12980	12980	12980	12980
VaR(T)	0.327195686	0.340677966	0.357473035	0.37403698	0.386748844	0.397919877

Table 2.3.11 Back test result(cont.)

Period （Month）	7	8	9	10	11	12
VaRp	4247	4422	4640	4855	5020	5165
PS	8733	8558	8340	8125	7960	7815
f	0	0	0	0	0	0
f/N	0	0	0	0	0	0

During the 12-month period of the simulated pledge period, there was no breakdown in the price of aluminum, which is entirely within the confidence level of VaR, showing that the VaR-GARCH (1, 1) model reasonably estimates the price risk faced by A00 Aluminum during the selected sample period.

2.4 Managerial implication

According to the analysis above, Z aluminum industry applied for a pledge loan from the bank at the beginning of each month. According to the 84% dynamic pledge rate for one month, the company only needs to pay 16% of the purchase price, and bank will be able to pay the remaining amount to the railway according to the contract. In order to ensure the authenticity of the trade background, Z Aluminum shall enter into a tripartite agreement with the railways and suppliers to apply for special funds for purchase through the supply chain of the railway, and the railways will pay the suppliers and manage the loans on behalf of Z Aluminum. After the Z aluminum industry applies for the redemption to the bank and pays the purchase price and related procedures, the railway will deliver the goods according to the company's requirements.

In order to further reduce losses caused by breach of contract, railways, banks, Z aluminum and its upstream suppliers should sign corresponding contracts. For example, if the supplier promises a certain repurchase, Z Aluminum can use the remaining goods when it cannot repay the loan or if the supplier fails to deliver the goods in accordance with the contract or the delivery volume is inconsistent, the supplier will refund of purchases to reduce business risks.

2.5 Deepening financial solutions of z aluminum company in railway supply chain finance under risk control

The use of supply chain financial instruments can help Z Aluminum reduce the liquidity difficulties caused by corporate procurement, but only financial tools are far from enough. The railway supply chain finance business needs to further tap potential customer needs and improve the degree of integration between companies.

(1) By signing the procurement framework agreement, use the existing warehouse of the railway to move the enterprise warehouse forward. z Aluminum can enter into strategic purchase cooperation framework agreements with suppliers at the beginning of each quarter or at the beginning of each year according to the current year's production plan to lock in the purchase volume for the current quarter or year. Then, according to the company's production needs and suppliers' supply capacity, we formulate an elastic supply plan, which will supply the original one-time supply decentralized batch by month and reduce inventory backlog. And select the nearest railroad warehouse from the supplier as the joint delivery warehouse. Because the aluminum plant also needs to look for a warehouse for storage after the completion of production, transporting electrolytic aluminum to the delivery warehouse after production can reduce the cost of one-time warehouse operations and short-haul transportation costs. The electrolytic aluminum in stock before each delivery is owned by the aluminum plant, and it is owned by the Z aluminum industry after delivery, and the railway is used for pledge supervision. After the delivery of electrolytic aluminum, z aluminum can be redeemed immediately and transported by rail to the production plant, or it can be stored as a pledge.

(2) Railway stocks management , immediate delivery, extend the redemption period of the company. Through the inventory management plan and combined with accurate in-transit transportation control, Z aluminum industry can only maintain the production requirements for the next few days according to the production needs, and the railway can reasonably distribute according to the production plan submitted by the company and the current inventory situation. Arrangement and transportation of inventory, this aspect fully meets the needs of customers, reduces the production costs of customer companies, and on the other hand increases the flexibility of railway transportation, facilitating organization and management. Most importantly, instant delivery has delayed the redemption period of Z Aluminum. Once the company needs to

redeem the goods needed for production in the next few days, the remaining goods can continue to be pledged. And can establish a dynamic pledge warehouse, that is, set a minimum limit according to the market price risk, allow goods out of the above-limit amount of goods, and can barter, so that under a reasonable procurement plan and the use of materials plan, ensure the storage and delivery In the balance case, the company does not need to add any funds during the credit extension period, which further increases the liquidity of the company's funds.

Conclusions

For the traditional transport enterprise railways, under the dual pressures of the decline of traditional freight business and fierce competition in the modern logistics market, the transition to modern logistics is imminent. On the one hand, the railway needs to integrate and optimize its own transportation resources. On the other hand, it needs to expand the logistics market, improve customer experience and integrate into the logistics chain of the company. As a brand-new financing service model, supply chain finance integrates financial credit services on the basis of supply chain management. It not only solves the problem of liquidity of assets for customers, but also enhances the viscosity of logistics companies and customers. So, the objective of integrating railways into the logistics chain of enterprises is a feasible and effective way.

This paper is based on the actual production of railways, aims to explore the feasible road for the development of the railway supply chain financial business and quantify the risks faced during the development of the railway supply chain financial business. The main findings are as follows:

(1) The proposal of “The Belt and Road Initiative” has brought tremendous development opportunities to China’s logistics industry. Logistics and supply chain finance also need to be constantly revamped in terms of efficiency improvement and risk management under the participation of multiple parties. However, there is no doubt that supply chain finance has become an important field and direction of logistics innovation. The launch of the railway supply chain finance can be said to be another "ice-breaking" trip on the road of deepening the reform of the railway.

(2) The risks involved in the development of the railway supply chain finance business are summed up in three categories: macro-industry risk, supply chain system risk and corporate credit risk. In the study, it was found that due to the self-repaying nature of supply chain finance, supply chain system risks should be paid more attention to compared to traditional credit business, especially upstream and downstream trade risks and market risks. Market risks are more difficult to estimate in actual operations due to the involvement of market risks, which is the difficulty of risk control.

(3) For the problem that market risk is more difficult to grasp, this paper uses the AR (1)-GARCH (1,1) model to characterize the characteristics of peak-heavy tail and

heteroscedasticity of yield fluctuations. In order to provide thicker tail features during GARCH modeling, the t-distribution is used to describe the residual term. Based on the results of parameter fitting, the Monte Carlo simulation is improved to estimate the long-term value of risk VaR. Finally, a back test shows that the method can effectively estimate the market risk under long-term market fluctuations.

(4) Based on the study of financial credit business risk control tools, under the conditions of effective measurement of market risk using the VaR method, calculate the dynamic pledge rate under different holding periods, which will not only combine the risks faced by banks with their risk tolerance, but also help improve the financing efficiency of companies and promote the steady development of their businesses. Empirical analysis shows that the dynamic pledge rate obtained in the short-term is more efficient than the static empirical value method, but it is relatively conservative in the long-term.

It should be pointed out that the research on the risk of railway supply chain finance business is mainly aimed at quantifying the market risk. However, in the actual business development process, due to the large number of involved parties and the relatively complicated process, there are many risk factors and comprehensive considerations must be taken against the risks. Finally, this paper uses GARCH model to depict the fluctuation of yield and predicts long-term risk through Monte Carlo simulation. The empirical results show that due to the unavoidable model error, the error will be amplified in the case of multiple iterations. Although it can be increased by increasing the number of simulations to reduce the error interference, but in the case of long-term risk prediction, the risk estimation result is high and the calculation result of the dynamic pledge rate is conservative. Therefore, for long-term risk prediction, it is necessary to continue to explore in the follow-up work.

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Appendice

```
clc;

close all;
clear all;

r = 0.045;

T0 = datenum(2017,1,1);

[~,~,xlsdata] = xlsread('Data sample.xlsx');

datelist = xlsdata(7:end,1);

Price = cell2mat(xlsdata(7:end,2));

Return = [0;diff(log(cell2mat(xlsdata(7:end,2))))];

in_sample_sel = find(datenum(datelist)<T0);

InSample = Return(in_sample_sel);

PSample = Price(in_sample_sel(end));

out_sample_sel = find(datenum(datelist)>=T0);

OutSample = Return(out_sample_sel);

OutPsample = Price(out_sample_sel);

ARmdl = ar(OutSample,1);

rho = ARmdl.a(2);

u = rho*InSample(end)*252;

Params = ARmdl.a;

model = garch(1,1);

model.Distribution = 't';

EstMdl = estimate(model,InSample);

Params =[Params EstMdl.Constant EstMdl.GARCH{1} EstMdl.ARCH{1} EstMdl.Distribution.DoF];

ht = infer(EstMdl,InSample);

sigma = sqrt(ht(end))*sqrt(252);

ParamsResult = [{'c' 'rho' 'alpha0' 'alpha1' 'beta1' 'v'};num2cell(Params)];
```

```
xlswrite('VaR model results.xlsx',ParamsResult,'AR-Garch Params')


 #calculate VaR by using Monte Carlo Simulation method based on GARCH model
 VaRCalResult(1,:) = ['Period（Month）',num2cell(1:12)];
VaRCalResult(2:8,1) = {'T';'Pt';'VaR(T)';'VaRp';'PS';'PL';'w'};
for t = 1:12
    T = t/12;
    [VaRT,VaRp,PS,PL,W] = VaR_Calculate(PSample,T,u,sigma,r,K);
    VaRCalResult{2,t+1} = round(T*252);
    VaRCalResult{3,t+1} = PSample;
    VaRCalResult{4,t+1} = VaRT;
    VaRCalResult{5,t+1} = VaRp;
    VaRCalResult{6,t+1} = PS;
    VaRCalResult{7,t+1} = PL;
    VaRCalResult{8,t+1} = W;
end
xlswrite('VaR model results.xlsx',VaRCalResult,'VaR Estimated results')


#VaR backtest
VaRTestResult(1,:) = ['Period（Month）',num2cell(1:12)];
VaRTestResult(2:8,1) = {'T';'Pt';'VaR(T)';'VaRp';'PS';'f';'f/N'};
for t = 1:12
    T = VaRCalResult{1,t+1}/12;
    PS = VaRCalResult{6,t+1};
    [f,N] = VaRBackTest(VaRCalResult{6,t+1},OutPsample,T);
    VaRTestResult{2,t+1} = N;
    VaRTestResult{3,t+1} = VaRCalResult{3,t+1};
    VaRTestResult{4,t+1} = VaRCalResult{4,t+1};
```

```
    VaRTestResult{5,t+1} = VaRCalResult{5,t+1};
    VaRTestResult{6,t+1} = PS;
    VaRTestResult{7,t+1} = f;
    VaRTestResult{8,t+1} = f/N;
end
xlswrite('VaR model results.xlsx',VaRTestResult,'VaR Backtest results')

#function [VaRT,VaR,PS,PL,W] = VaR_Calculate(PSample,T,u,sigma,r,K)
c = 0.95;
dt = 1/252;
N = round(T/dt);
M = 100000;
Pt = PSample*ones(M,1);
for t = 1:N
    dwt = randn(M,1);
    Pt = Pt.*(1+u*dt+sigma*sqrt(dt)*dwt);
end
#calculate VaR and pledge rate
sort_rt = sort(Pt);
VaR = round(-(sort_rt(round(M*(1-c)))-PSample));
VaRT = VaR/PSample;
PS = PSample - VaR;
PL = round(PS-PSample*(r*T));
W = (2 - exp(VaR/PSample))/exp(r*T);

function    [f,N] = VaRBackTest(PS,Sample,T)
N = round(T*252);
OSample = Sample(1:N);
```

```
f = length(find(OSample<PS));
end
```