

# Application of Financial Engineering in Supply Chain Risk Management

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**Abstract:** *With the continuous development of supply chains, managing risk management is expected to become a high ground in the field of financial engineering applications. With the increasing scale and complex structure of the supply chain, how to strengthen the risk management of the supply chain and promote its benign operation is particularly important and necessary. This paper firstly explains the significance of financial engineering and the role of financial engineering in risk management. Then it explains supply chain risk management from two perspectives: supply chain risk mechanism and supply chain risk characteristics. Finally, the measures of integrating financial engineering into risk management are analyzed from the two aspects of the role of financial derivatives and the specific application of financial derivatives. In this paper, the research direction of financial engineering in supply chain risk is prospected from two aspects of application exploration and theoretical research, with a view to help the research development of cross-cutting fields and make new insights for supply chain risk management practice.*

**Keywords:** *Financial engineering; risk management; supply chain*

## 1. Introduction

The term "financial engineering" was introduced in the twentieth century. Financial engineering encompasses many elements and relies heavily on the concept of engineering management. It mainly utilizes various engineering techniques to design, develop and implement new financial products. It can be said that financial innovation is specialized in solving problems in financial management <sup>[1]</sup>. In terms of its specific content, it includes not only the overall design, pricing and trading content of the product, but also the management of financial risk. In a narrow sense, financial engineering mainly includes the design, development and implementation of innovative financial instruments and financial instruments, as well as creative solutions to the resulting financial problems. As far as the characteristics of financial engineering are concerned, the most obvious one is innovation, which can be used as a technical support for financial innovation <sup>[2]</sup>. This can not only better solve the problem of investment and financing in the financial field, but also better solve the problem of risk management. Therefore, financial engineering, as an important aspect of modern development, has a very important role in promoting the development of enterprises <sup>[3]</sup>.

From the perspective of financial engineering development and management, enterprises bearing certain risks can not only obtain more effective equity through capital market management and innovative means, but also utilize the capital market as a platform to transfer part of the risk to investors <sup>[4]</sup>. Therefore, from this perspective and aspect, the role of financial engineering in risk management is increasing and expanding. As for the link and relationship between risk management and financial engineering, both fields are comprehensive. As far as understanding the concept of risk is concerned, it mainly implies that one is able to clearly understand the likelihood of consequences and how this likelihood manifests itself before something happens <sup>[5]</sup>. Financial engineering allows one to develop and take appropriate measures to avoid risks by understanding the trends in risk assessment.

It can be seen that the most essential characteristic of financial engineering is innovation, which is the technical support for financial innovation, and its purpose is to solve financial problems such as investment and financing problems, risk management problems and so on. Its "innovative" has three meanings: first, it refers to the financial field of the idea of the leap forward, the highest degree of innovation, such as the first options contract generation; second, it refers to the existing concepts for the re-understanding and application, such as in the commodities exchange to launch the financial futures as

a new species; third, it refers to the decomposition of the existing financial products and re-combination. The creation of endless new financial instruments is mostly based on this combination of decomposition techniques<sup>[6]</sup>. Currently financial engineering focuses more on the creation of products, from the design, development and implementation of new financial instruments to the financial design of mergers, acquisitions and reorganizations of enterprises, which are more directly oriented to financing decisions and investment decisions<sup>[7]</sup>.

In the development of society and market, scientific and reasonable management and operation is the goal that every enterprise constantly pursues. As far as the current economic development and enterprise management methods are concerned, supply chain is currently a more scientific and modernized management mode<sup>[8]</sup>. In this era of rapid development of science and technology, effective avoidance of potential risks has become one of the problems that many enterprises need to solve, both in terms of enterprise management and capital management<sup>[9]</sup>. In addition, by designing and developing a number of relatively new financial products as well as applying relatively advanced financial methods, financial engineering must comprehensively promote a variety of technological approaches. This includes the ability to effectively manage financial issues<sup>[10]</sup>. In addition, many firms have benefited from this approach in financial engineering and supply chain management. Therefore, this paper specifically analyzes the application of financial engineering in supply chain risk management<sup>[11]</sup>.

## **2. Risk Management Issues in Supply Chain**

### ***2.1 Mechanism of supply chain risk***

What is a supply chain, that is, around the core enterprise, through the control of information flow, logistics, capital flow, starting from the procurement of raw materials, made into intermediate products as well as final products, and finally by the sales network to deliver the products to customers<sup>[12]</sup>. Supply chain contains joined node enterprises, which links suppliers, manufacturers, distributors, retailers and customers into a network chain structure business model. It can be seen that the supply chain is a kind of virtual enterprise system between the enterprise and the market, which does not change the independent legal person attribute of each node enterprise in the market, and does not really eliminate its potential conflict of interest, i.e. supply chain risk<sup>[13]</sup>. Specifically supply chain risk refers to the supply chain enterprises in the production process, due to a variety of pre-predictable uncertainties brought about by the impact of the supply chain enterprise actual returns and expected returns deviation, so that the risk and possibility of damage. That is, in the process of cooperation between supply chain enterprises, there are various factors that generate endogenous uncertainty and exogenous uncertainty. For example, the selection of enterprise partners is uncertain, for example, if the partners are not selected properly, the partner has a strong sense of "moral failure", which will lead to a greater risk in the supply chain operation, which is what is known as moral hazard. For example, there is uncertainty about the appropriateness of the contract formed between the principal and the agent; there is uncertainty about the result of the bargaining and negotiation between the two partners; there is uncertainty about the delivery status of the supplier, and there is uncertainty about the ever-changing market demand. Further, the natural and social environments faced by enterprises always have uncertainties<sup>[14]</sup>.

Supply chain risk refers to the actual production and management process in a supply chain company when certain unpredictable factors that cannot be foreseen inside or outside the system may occur. According to the general situation, the risks that supply chain companies usually face can be divided into two categories: exogenous risks comparable to the risks of the natural environment and endogenous risks comparable to market and moral risks. In addition, the partners of the company face greater uncertainty regarding the specific development of the company. This can lead to supply chain problems if the partner fails to take responsibility or if there are problems with the internal management of the partner company. There may be some risks in the supply chain due to changes in the natural and social environment faced by the company or product quality and price problems of suppliers and partners.

### ***2.2 Characteristics of supply chain risks***

Every company in the supply chain tries to avoid the risk in different ways when they face the uncertainties that arise in the society. And the characteristics of the risks faced by the enterprises in the supply chain are:

- (1) Interaction and gaming

Although supply chain companies must participate in certain projects and risks to serve the interests of the company, their interests are oriented differently because these companies exist as independent individuals in the market. Therefore, without a scientific and complete monitoring mechanism, each firm may lead to intense competition and gaming to pursue its own maximum interests. Since companies in the supply chain need to keep abreast of market information, proper cooperation is needed to ensure the full operation of the supply chain.

(2) Transmissibility.

For the operation and development of enterprises, internal scientific management may have a certain role in promoting the development of the enterprise itself. However, when it is put on the market, several companies must be involved in the product development, production and final dissemination process. During the sequential development and management of the product, potential risks accumulate at each stage, and when risks accumulate, they are passed on to the next manufacturer and the next company. In this process of continuous transmission and accumulation, the security of the entire supply chain is also affected to some extent. Therefore, this transmissible risk state directly affects the overall operation and risk level of the supply chain.

### ***2.3 Difficulties of supply chain risk management***

Existing research on supply chain risk management is mainly from two perspectives: one is procurement, the other is sales and marketing, but both are only from the perspective of how to optimize the supply chain structure to reduce costs to manage risk. Research has shown that supply chain risk can be managed not only from an operational perspective but also from a financial perspective. From the operation point of view, enterprises can reduce risks by changing the degree of vertical integration, product strategy, procurement strategy, storage strategy, etc. From the financial point of view, enterprises can reduce risks by purchasing insurance, modifying the terms of the supply contract, and also reduce risks by utilizing derivatives such as futures, options and forwards to hedge.

Supply chain is not just the operation of individual enterprises, but a systematic management mode, i.e. a virtualized system between the market and enterprises. Members of the system often have their own positions and interests and therefore regard some information as trade secrets that need to be protected and preserved. As there is a degree of selfishness in companies, this also leads to some information and resources not being truly shared. As a result, there can be some discrepancy between the price of a product and its actual value, which can also lead to difficulties in risk management. In addition, there are many companies and suppliers that manage the supply chain. This situation, as well as the involvement of other government administrations, also leads to the expansion of supply chain risks.

## **3. Measures to integrate financial engineering into risk management**

### ***3.1 Applicability of the use of financial derivatives in supply chain risk management***

If there is a large difference between the market price and the expected price of a product in a company's supply chain, there is a risk that will significantly reduce the company's operating profit. Therefore, the power of financial derivatives can be used to manage risks in the supply chain. By using financial derivatives, product trading can become more flexible. In volatile financial markets, even if the product price fluctuates significantly, financial derivatives can transfer the corresponding risk, allowing the company to have a higher risk tolerance. This can be an effective way to hedge the risks of small businesses as well as a profitable opportunity for large corporations. Companies should get the right kind of talented people to hedge risks and make profits through the judicious use of financial derivatives. This is very important for a company to operate as it has its core competencies without being dominated by risks. In a supply chain, the issue of risk arises when there is a huge difference between the price of a product in the market and the expected price, which pushes up the actual transaction and administrative costs and reduces the profits that can be earned. Due to their inherent timeliness, accuracy, managerial flexibility and cost advantages, financial derivatives can effectively reduce not only the actual management and operational costs, but also the actual risks in the supply chain. As a result, they have become an important option for risk avoidance today.

### ***3.2 Specific application of financial engineering***

After studying the causes of risk in the supply chain, it is not difficult to find that the most direct

reason for the formation of enterprise risk in the supply chain is the volatility of the actual price and expected price of the product, price fluctuations will lead to changes in profits, and changes in profits will turn to affect the cost of how much. Therefore, it is this volatility that ultimately leads to the creation of risk in the supply chain. After some research, it has been shown that financial derivatives are exactly the kind of risk avoidance tools that people have created. They have great timeliness and accuracy, and they can avoid the risks in the supply chain in a timely manner. Financial derivatives because of its unique hedging mechanism, its own powerful financial leverage, so that the cost of the whole industrial chain can be controlled. Moreover, the unique two-way position of financial derivatives can also make investors' buying and selling transactions become more flexible and changeable. In this way, no matter how the market price of the product changes, some enterprises in the industry chain can take corresponding measures in time to make timely and effective response, which will obviously be able to protect the small and medium-sized enterprises with weaker risk-bearing ability. The specific application of financial engineering in supply chain risk is as follows:

Hedging realizes the cost commitment of the futures market. Supply chains are closely interconnected, so in practice, profits in one market can be hedged by losses in another. In this process, a wholesaler, manufacturer or operator can use either the spot market or the futures market for reverse trading. In this way, profits and costs can be effectively controlled and managed. In a supply chain, manufacturing equipment companies can naturally make full use of hedging to avoid risks. In addition, the supply chain facilitates the company's products, enabling the company to fully utilize the relationships and commitments between upstream and downstream companies to complete the sale of product quantities. By sharing the risk among related companies, the risk factors associated with internal price changes can be effectively avoided, thus better ensuring stability and continuity of production. The first link in the supply chain (commodity producer) can hedge the risk of commodity price fluctuations in the futures market. At the same time, it can enter into physical futures contracts between upstream and downstream companies and sell short through futures contracts, which commits the upstream companies in the supply chain to purchase a certain amount of product in a future period, or it can purchase options from suppliers and deliver through options.

Options and futures contracts are created to hedge risk. The so-called option is actually a right of first refusal and agreement. In exchange for the payment of a certain fee, the buyer can trade at a pre-set and negotiated price for a period of time in the future. In this procedure, the buyer can buy or sell at the agreed price, but does not have to buy or sell the agreed party's own product. As a result, the investor has more choices in this process in the face of dramatic market changes. After a certain time and date, the option contract loses its limitations and advantages and can no longer bind the parties. At the same time, purchase options with opposite price expectations can reduce the risk of supply chain companies to a certain extent.

In the face of huge price fluctuations, option trading can provide investors with more choices. Regardless of whether the futures price is rising or falling, as long as the fluctuation reaches a certain level, the risk can be avoided and profits can be made. If a trader predicts that the price will rise in the future, he will also buy puts on the corresponding options along with the futures contract. If the price of the futures contract moves in an unfavorable direction and falls, the put option is exercised to purchase the futures contract at a lower price in order to make a profit and reduce the loss of holding a long futures position. If the futures price actually rises and moves in the investor's favor, the investor can sell the futures contract at a higher price in the futures market to hedge and close out the position while giving up the put option. The only loss to the investor is a limited premium, but they can minimize their risk. By depositing a certain amount of margin (royalty) between supply chain companies, they have the right to buy or sell a certain amount of a specific product (futures contract) at an agreed-upon price at some time in the future, while purchasing the opposite option and accepting the expected price fluctuations, minimizing the supply chain company's risk and realizing profitability.

#### **4. Conclusion**

Through the comprehensive analysis of the above, we can have a deeper understanding of financial engineering and risk management in supply chain. The combination of financial engineering and enterprise risk management is of great help to the development of enterprises. The current international and domestic situation is complicated. Enterprises must learn to reasonably avoid risks in order to realize stable operation. The application of financial engineering is very important for enterprises.

Although financial engineering plays a very important role in supply chain risk management, it must

be noted that financial engineering is manufactured due to the immature development of capital markets in some developing countries and the inability of financial prices to be fully balanced. The functions of derivatives in risk avoidance and price discovery cannot be fully utilized, especially as the use of certain financial derivatives is restricted by the system and relevant laws and regulations, such as the lack of a short-selling mechanism. The development of basic financial instruments in emerging economies is also insufficient, lacking a large number of financial derivatives, as well as the development of the derivatives market and related laws and regulations are still far from mature. All these limit the application of financial engineering in supply chain risk management in China. Although financial engineering has brought revolutionary changes to risk management, it is still not a "solution" to risk management.

Therefore, enterprises need to think comprehensively, continuously enhance their own strength, improve labor productivity, advocate scientific management and decision-making, establish efficient operation mechanism, etc., and silently face all kinds of risks and challenges in order to continue to grow and expand in the fierce market competition.

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