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The Application of Data-Driven Financial Risk Management in Multinational Enterprises

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Abstract: With the intensification of global economic integration and market complexity, the financial risks of multinational enterprises will face severe challenges. The financial risk management system based on big data helps multinational enterprises track, predict and handle financial risks in advance. This article mainly introduces the basic concepts and core technical system of data-driven financial risk management, and elaborates on the specific implementation of key technologies such as data collection, risk prediction and assessment, and data visualization in multinational enterprises. The utilization of advanced big data technologies such as machine learning and statistics helps multinational enterprises identify risk points more accurately and improve decision-making efficiency. The main purpose of this article is to propose a scientific and comprehensive financial risk management system to multinational enterprises, helping them manage financial risks better in the complex and changeable global market and promoting their sustainable and stable development.

Keywords: multinational enterprises; financial risk management; big data technology; risk prediction; data-driven decision-making

1. Introduction

With the continuous and in-depth development of economic globalization, the financial risks faced by multinational enterprises have become increasingly complex and diverse, covering multiple aspects such as exchange rate fluctuations, credit risks, market price fluctuations and financial fraud. These risks have posed huge challenges to the financial stability and operating performance of enterprises. Most traditional technical methods rely on static data and empirical induction, making it difficult to adapt to the changes in the market environment in a timely manner. The processing of financial risk management based on technologies such as big data, artificial intelligence and machine learning developed in recent years is gradually becoming an important way to solve financial risks. Enterprises can collect, analyze and predict their financial risks in real time, optimize decisions and reduce potential financial risks. Big data-driven risk management methods provide multinational enterprises with more accurate and effective ways to identify and respond to financial risks [1].

2. The Theoretical Basis of Data-Driven Financial Risk Management

2.1. Modern Theories of Risk Management

Modern risk management thought emphasizes taking risk management as an overall strategy of an enterprise and addressing the problems that may be encountered in work practice in a more comprehensive and systematic way. It mainly includes five steps: risk identification, risk measurement, risk control, risk monitoring and risk transfer. By means of quantitative and systematic risk control measures, potential risks of various channels

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(such as market risks, credit risks, operational risks, etc.) are identified. In terms of risk control, the modern perspective uses diversified hedging methods, insurance and some financial products to mitigate the harm caused by risks. On the other hand, with the changes in the market, the traditional risk management system is also unable to meet the needs of modern enterprises. Therefore, a new perspective proposes a dynamic risk monitoring and intelligent decision-making. This makes risk management no longer a process of solving existing risk problems, but also a process of anticipating and preventing potential risks.

2.2. Theory of Data Science and Financial Engineering

In financial risk management, both data science and financial engineering theories have played significant roles. Data science can summarize and extract useful information from a large amount of information data through methods such as statistics, machine learning, and data mining to assist in risk prediction and decision-making [2]. Data science can identify potential financial risks of enterprises and conduct quantitative analysis by studying their financial data. Financial engineering mainly applies the knowledge of mathematics, statistics, computer science and other disciplines to construct a set of quantitative models and solutions in the financial field to solve complex financial problems. For financial risk management, financial engineering mainly improves the efficiency of risk management through risk management models, valuation models and risk hedging. Commonly used ones, such as the Value at Risk (VaR) model and the option pricing model, provide efficient risk management techniques for enterprises based on quantitative risk analysis.

3. Data-Driven Financial Risk Management Technology Framework

3.1. Data Collection and Integration Technology

Data acquisition and integration technology mainly consists of two major parts: On the one hand, it is for data sources and collection, that is, the capture of data from various systems both inside and outside the enterprise, including but not limited to ERP, CRM, and accounting software, the integration of external data sets (accomplished using API and WebCrawler technology), and real-time data streams [3]. For example, using Kafka and AWSKinesis to complete impromptu transaction data streams or sensor data readings; On the other hand, for data cleaning and integration, that is, the process of data deduplication, denoising and normalization, to ensure the accuracy and consistency of the data, ETL integrates data sets from different sources into a single platform (or database). Through these technologies, enterprises can collect, organize and integrate information from various channels in real time and effectively, providing effective and stable data for subsequent analysis and decision-making. (See Figure 1).

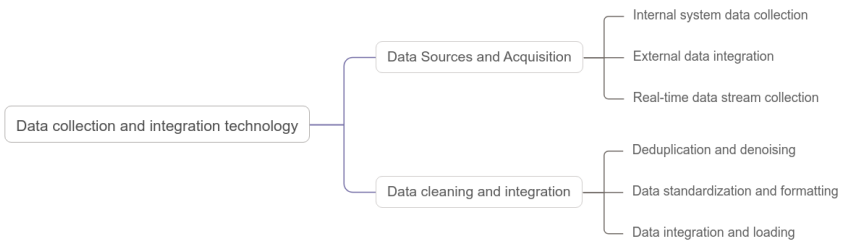

Figure 1. Data collection and integration Technology.

Based on these technologies and methods, enterprises can enhance the stability and practicality of data when integrating and managing it, and better optimize the decision-making process.

3.2. Risk Prediction and Assessment Model

Risk prediction and assessment models are a crucial part of data-driven financial risk management. They aim to accurately identify potential risks and quantify them through the analysis and modeling of historical data. Risk prediction models are usually based on statistical methods, machine learning algorithms and deep learning techniques to improve the accuracy and real-time performance of predictions [4]. Common risk prediction models include VaR , stress testing models and credit scoring models. Firstly, the VaR model helps enterprises assess their risk exposure within a specific time frame by quantifying the maximum potential loss of financial assets. The formula is:

$$VaR = \mu - z_{\alpha} \cdot \sigma \quad (1)$$

μ is the average rate of return of the investment portfolio, z_{α} is the quantile of the normal distribution corresponding to the confidence level α, σ is the standard deviation of the investment portfolio. VaR is a powerful risk measurement tool, especially suitable for assessing potential losses in the short term. Secondly, the stress testing model simulates the impact of different economic scenarios on the financial situation of enterprises and assesses the risk tolerance in extreme circumstances. In addition, the credit scoring model uses statistical and machine learning algorithms to predict the default risk of customers based on factors such as their financial status and credit history. In recent years, the application of machine learning technology in risk prediction has gradually increased. These models can discover potential risk patterns through training on massive historical data, thereby predicting risk changes. The formula is:

$$p(Default) = \frac{1}{1+exp(-(\beta_0+\beta_1 x_1+\beta_2 x_2+\ldots+\beta_n x_n))} \quad (2)$$

P(Default) is the probability of the customer's default, $x_1, x_2, \ldots x_n$is the different characteristics that affect the probability of the default (such as income, debt, historical credit, etc.) $\beta_0, \beta_1, \ldots, \beta_n$ is the regression coefficient of the model. Credit scoring models play a crucial role in credit risk management. Finally, deep learning realizes the modeling of complex nonlinear relationships through a multi-layer neural network structure, further improving the accuracy of risk prediction [5]. The application of real-time prediction models enables enterprises to dynamically adjust their risk management strategies. Through the input of real-time data streams, the risk assessment model can predict and feedback risk changes in real time, thereby providing enterprises with rapid response plans.

3.3. Data Visualization and Reporting System

The application of data visualization and reporting systems is a fundamental part of financial risk management. It can transform complex data into straightforward and clear diagrams, patterns and tables, enabling top management to quickly obtain important financial information and possible changes in financial risks. The data processed through images and patterns itself enhances the intuitive perception of the data parsing process and strengthens the interaction process, enabling the company's managers to respond immediately. Commonly used data visualization software includes Tableau, PowerBI, D3.js, etc. They can display real-time financial data and risk monitoring results in the form of dashboards, interactive charts and maps (see Table 1).

Table 1. Data Visualization and Reporting System.

Tools	Function	Advantages	Disadvantages	Applicable scenarios
Tableau	It supports rich data visualization capabilities, can obtain information	Humanized design, strong operational convenience,	It has certain constraints on complex data to a certain extent and	Support the decision-making of senior management of

	from multiple data sources, and supports real-time generation of interactive dashboards and reports.	highly visible graphics and instrument diagrams, and powerful data connection capabilities.	the cost is relatively high	enterprises, sales data analysis, and financial data analysis reports.
Power BI	Microsoft is capable of connecting various data sources, providing diverse charts, and enabling cloud and desktop applications.	Seamlessly integrated with Excel and Microsoft products, it is rich in information visualization and has a relatively low price	The custom advanced functions are relatively low, which may lead to performance bottlenecks in large-scale data applications.	Financial information analysis, internal reporting and external decision support, information sharing and collaboration among departments.
D3.js	Open-source libraries use javascript to generate dynamic and interactive web charts and can also support the exchange of complex data.	Highly customizable, capable of supporting complex animations and interactive functions, and open source and free.	The threshold for coding is high, the learning curve is steep, and a foundation in website development knowledge is required.	User-defined reports, web-based analysis, interactive graphics, and queries.
QlikView	Under the self-service data detection and analysis function, the dashboard can be quickly output, which is suitable for the processing of big data.	Realize the connection and analysis functions of data, with fast data processing speed and the ability to handle massive amounts of data	There are many operation steps and the cost is relatively high.	Data analysis, highly participatory reports
Google Data Studio	The free tools provided by Google allow the content of other data sources to be integrated into the report.	It is free to use and seamlessly integrates with Google products	It is used in the preliminary analysis of small-scale projects.	Analyze small business reports and conduct analysis through online marketing data, as well as display data of google products.

Ultimately, enterprises consider their own business needs, budgets, technical foundations, and the complexity of the data to be processed, and decide whether to apply which tools.

3.4. Integration and Collaboration of Risk Management Systems

An integrated and collaborative risk management system is an important measure to ensure cross-field cooperation and comprehensively control financial risks. The financial risk control of group enterprises is not limited to a certain business unit or a single program software. It relies more on the close communication and mutual information sharing among various departments and systems. The integrated risk management system can integrate all financial data, prediction models, and the results of risk monitoring on one platform. It enables each business department to understand the main contents of economic risk information in the first place, and can further improve the response speed and decision-making quality. Common integration modes include API integration, data centers, enterprise resource planning ERP system integration, etc. By integrating all the technical equipment within the enterprise, financial risk management can observe problems from a macro perspective and promptly identify risk factors that may involve multiple fields. Furthermore, the significance of cross-border cooperation and data sharing in enhancing the efficiency of risk management is self-evident. Establishing a cooperative network enables seamless information communication and cooperation among various departments.

4. Application of Data-Driven Financial Risk Management in Multinational Enterprises

4.1. Real-Time Monitoring and Management of Exchange Rate Fluctuation Risks

Exchange rate fluctuations pose significant financial risks to multinational enterprises. As these enterprises operate cross-currency businesses, they will have a huge impact on their profits and losses as well as balance sheets. To effectively deal with this risk, it is necessary to establish an effective monitoring system. By setting up a real-time monitoring system and using the latest information data of the foreign exchange market, statistical and machine learning algorithm models are adopted to predict the direction of exchange rate fluctuations and issue risk warnings. Based on real-time monitoring of market changes, historical fluctuation data of key currency exchange rates and macroeconomic indices, models are established to predict exchange rate fluctuations, achieving automatic adjustment of exchange rate exposure risks and risk avoidance according to market conditions. On the other hand, this data-driven risk supervision system can also understand the financial impact of exchange rate fluctuations in various situations through scenario analysis. Help senior management of enterprises formulate sensitive exchange rate risk aversion strategies for decision-making, such as foreign exchange futures, options or currency swaps, etc.

4.2. Transnational Credit Risk Management and Optimization

Transnational credit risk management is another important financial risk faced by multinational enterprises. In terms of credit risk assessment and identification, the financial status and repayment ability of customers are analyzed first by using their credit ratings. Through the research on credit risk factors, such as macroeconomic factors and industry factors, potential risks can be revealed more effectively. The application of the default rate estimation model enables enterprises to accurately estimate the probability of customers defaulting. It is helpful for improving loan decisions. Enterprises can adopt diversified investment portfolios to reduce the adverse impact caused by the credit risk of individual customers. At the same time, they will also take measures such as requiring lenders to provide guarantees or collateral to lower credit risks. In addition, credit risks can be effectively shared and transferred through credit insurance, financial derivatives, etc. Finally, by establishing a dynamic monitoring system to improve credit risk management, the role of implementing a real-time monitoring system lies in enabling enterprises to closely monitor the changes in the credit status of borrowers and detect potential problems at the first moment. Regular preparation of credit risk reports can not

only be used to assess the current credit risk status, but also serve as fundamental data for predicting the credit risk of enterprises. Additionally, it is necessary to maintain flexible credit limits and strategies, and be able to respond promptly and improve management when market conditions change. (See Figure 2).

Figure 2. Transnational Credit Risk Management and Optimization.

This comprehensive measure provides companies around the world with a complete and flexible credit risk framework for risk management to ensure more effective risk identification, mitigation and monitoring in the global business process, and to ensure the stable operation of their finances.

4.3. Hedging against Market Fluctuations and Commodity Price Risks

For multinational companies, they are confronted with the volatile situation of the world economy. Among them, the fluctuation of commodity prices is one of the most significant factors that make the risks of multinational companies difficult to control. As the degree of turmoil in the global economic situation continues to rise, the impact of commodity price fluctuations on multinational companies is also becoming increasingly intense. In order to effectively and reasonably control the risk of price fluctuations of commodities, these enterprises may adopt market fluctuation hedging measures based on data. During this process, companies need to constantly monitor market conditions to adjust their own risk management and control measures. Data-driven market fluctuation risk management is mainly based on the prediction models of future commodity prices for prediction. In this process, the data on which these models are based include past market price data, supplier market information, climate and geographical political situation and many other data contents, and are used to predict future price and market changes. Then, based on such results, design the risk hedging strategy for one's own commodity prices, and adopt the scenario planning method to conduct scenario tests, such as the degree of impact of changes in commodity prices on the enterprise's finance under different market conditions.

4.4. Identification and Prevention of Financial Fraud in Cross-Border Operations

Financial fraud is one of the key risks for cross-border companies to conduct international operations. In business activities involving multiple regions, it poses more obstacles to the financial management and risk management of enterprises. Generally speaking, the traditional paper-based review and analysis method is time-consuming, labor-intensive and not timely enough, and is prone to lag behind the discovery of accounting fraud. The financial fraud supervision and early warning system based on data analysis, with advantages such as high real-time performance, strong intelligence, and high flexibility, can greatly enhance the speed and accuracy of early warning and detection of financial fraud transactions. Its main role after establishment is to fully utilize enterprise financial reports, transaction behaviors and employee behaviors to conduct

financial data mining technology and machine learning predictive analysis to find abnormal movement models. In this method, it is possible to automatically search for or discover special or abnormal transaction or capital flow transaction information of enterprises based on historical data and behavioral habits. It can also combine big data technology to simulate scenarios in advance for the prediction of potential financial fraud to analyze and discover the risk exposure environment under potential fraud situations.

5. Conclusion

Due to the increasingly complex and volatile international macro environment, the financial risks of multinational enterprises have become more complex, such as exchange rate fluctuations, credit risks, market risks and financial fraud, etc. Data-driven risk management and control methods are one of the effective and accurate solutions when facing the above problems. Through modern technologies such as big data analysis and artificial intelligence, multinational enterprises can perceive risks in real time and accurately, predict risks, and propose countermeasures and prevention strategies. Building a data-driven risk management process based on data can enable multinational enterprises to make better scientific decisions, improve economic benefits, and enhance their ability to resist market risks and unknown risks. However, risk control driven by big data still has certain risks and needs to be continuously improved in the subsequent practical operation process.

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