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Application and Optimization of Data Analysis in Investment Risk Assessment

Chenyang An [1,*]

[1] Economics and Finance, Queen Mary University of London, London, E1 4NS, United Kingdom
* Correspondence: Chenyang An, Economics and Finance, Queen Mary University of London, London, E1 4NS, United Kingdom

Abstract: With the rapid development of financial market, investment risk assessment has become more and more complex, and traditional risk assessment methods are gradually difficult to meet the needs of efficient and accurate prediction. As a core tool in the modern financial field, data analysis can effectively improve the accuracy and timeliness of investment risk assessment. This paper first classifies investment risks, including market risk, credit risk, liquidity risk and operational risk. Then it discusses the specific application of data analysis in various risk assessment, such as market data analysis, big data and sentiment analysis. Finally, it focuses on how to optimize the risk assessment process through a multi-factor model, machine learning and other technologies, so as to improve the scientific rigor and effectiveness of investment decisions.

Keywords: data analysis; investment risk assessment; application and optimization

1. Introduction

In today's globalized financial market, the traditional risk assessment methods usually rely on historical data and static models to deal with the changes of market dynamics. However, with the rapid development of data analysis technology, especially the wide application of big data, artificial intelligence and machine learning, investment risk assessment has gradually become more accurate and efficient. Through in-depth mining of market data, macroeconomic indicators, industry dynamics and other information, data analytics provides investors with new perspectives and tools to identify and measure various types of risk, and optimize investment decisions and risk management strategies. Data-driven assessment methods are changing the risk control model in the financial field, improving the accuracy and timeliness of risk prediction.

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2. Classification of Investment Risks

2.1. Market Risk

Market risk refers to the risk that the price of investment assets fluctuates due to changes in the market environment, thus affecting the return on investment. It includes but is not limited to stock market price fluctuations, interest rate changes, foreign exchange fluctuations and commodity price fluctuations. Market risk is typically influenced by macroeconomic variables — such as economic growth and inflation — as well as political developments. For investors, the unpredictable and systemic nature of market risk means that even diversification cannot completely avoid its impact [1]. For example, an overall decline in the stock market or an important economic event (such as a central bank interest rate increase, a change in the international situation) can cause large-scale market volatility, affecting the prices of all underlying assets. Therefore, market risk is one of the main risks that all investors must pay attention to.

2.2. Credit Risk

Credit risk refers to the risk that the borrower fails to fulfill the debt repayment obligation on time, resulting in the creditor being unable to recover the principal or pay interest, and thus suffering losses. In the field of investment, credit risk is often seen in debt-type investment instruments, such as bonds and loans. The root cause is the change of the borrower's credit status, which may result in the decline or loss of its solvency due to poor management, financial problems or the impact of external economic environment. Credit risk is not only limited to debt default, but also includes credit rating reduction, debt restructuring and other situations. The amount of credit risk generally depends on the borrower's credit history, financial stability, industry outlook, and macroeconomic environment. Investors need to evaluate these factors in order to predict potential credit risks and carry out corresponding risk control and coping strategies [2].

2.3. Liquidity Risk

Liquidity risk refers to the risk of loss due to the failure to trade at the expected price in the event that market conditions change or individual assets cannot be quickly bought or sold at a reasonable price. Liquidity risk is usually divided into two categories: market liquidity risk and fund liquidity risk. Market liquidity risk refers to the fact that under certain market conditions, the bid-ask spread of an asset transaction increases or the trading volume decreases sharply, which makes it difficult to realize the asset quickly. The liquidity risk refers to the inability of enterprises or financial institutions to obtain sufficient funds in time when the capital demand peaks. Liquidity risk usually manifests in market instability, economic downturn or unexpected events, especially in the case of insufficient liquidity in the capital market, investors may not be able to sell their assets or obtain financing in a timely manner, resulting in a significant decline in the value of the investment [3].

2.4. Operational Risks

Operational risk is the risk of loss due to internal processes, people, systems, or external events. It includes risks caused by operational error, system failure, human error, fraud, or external disasters. This risk is usually manifested in technical failure, information disclosure, personnel negligence, compliance failures, or supply chain disruptions. Unlike other types of risk, operational risk is generally difficult to quantify and predict, so it is usually necessary to establish a sound internal control mechanism, audit procedures and emergency plans to deal with. With the improvement of informatization and automation, the impact of operational risk on financial institutions and enterprises is gradually increasing, especially in the fields of complex systems and high-frequency trading. An operational error is highly likely to cause serious financial losses or reputation risks [4,5].

3. Application of Data Analysis in Investment Risk Assessment

3.1. Market Data Analysis and Risk Assessment

In the modern investment field, market data analysis has become one of the core tools to evaluate investment risk. Through in-depth analysis of historical data, real-time trading data, and macroeconomic data in financial markets, investors are able to identify potential risk factors, optimize their portfolios, and make more rational decisions. Market data analysis can help investors identify market trends and volatility. Statistical methods, such as regression analysis and time series analysis, can be used to model the price fluctuations of stocks, bonds and other assets to predict future risks. Through the calculation of volatility, investors can judge the uncertainty of the market, so as to adjust investment strategies and avoid potential risks. At the same time, market data analysis can also assess the overall systemic risk of the market through multi-dimensional factors. For example, macroeconomic data is often closely related to market risks, and by quantifying these data, investors can better judge the stability of the market. On the other hand, based on big data

analysis technology, investors can also dig deep into the subdivision data within the industry, identify the risk sources affecting specific asset classes, and achieve accurate risk early warning [6]. In general, market data analysis can not only provide investors with effective risk assessment tools, but also help them better grasp the market dynamics and realize the scientific and digital investment decisions.

3.2. Macroeconomic and Industry Data Analysis

In the investment risk assessment, macroeconomic and industry data analysis is an important link that cannot be ignored. Macroeconomic data can reflect the general trend of the economic environment and directly affect the direction of capital market. The industry data reflects the economic conditions and development potential of a specific industry, helping investors to judge the development prospects of the industry and related risks. Through the analysis of macroeconomic and industry data, investors can accurately grasp and evaluate the risk factors in the market changes, and make accurate investment decisions. Among the macroeconomic data, GDP growth rate, consumer price index (CPI), unemployment rate and interest rate are the most common indicators. Investors can use these data to understand the overall health of the economy, and thus predict market trends. At the same time, industry data can also reflect the competitive situation of various industries, technological innovation and market demand changes, and provide a basis for risk assessment within the industry. Table 1 below presents an analysis of the latest macroeconomic data and industry trends provided by the World Bank, the International Monetary Fund (IMF), and the National Bureau of Statistics of China.

Table 1. Analysis of Macroeconomic Indicators and Industry Trends in 2022-2024.

Index	2022	2023	2024(forecast)	Data source
GDP Growth rate (%)	3.0	4.0	4.5	International Monetary Fund (IMF)
CPI (Inflation rate)	2.1	3.2	2.4	National Bureau of Statistics of China (NBS)
Unemployment rate (%)	5.5	5.3	5.0	National Bureau of Statistics of China (NBS)
Interest rate (%)	3.7	3.8	4.0	People's Bank of China (PBOC)
Industry Growth Rate (%)	6.5	5.2	5.0	CCID Consultants
Market demand growth (%)	3.2	2.8	3.0	National Bureau of Statistics of China (NBS)

These changes in macroeconomic and industry data provide investors with investment references under the current economic situation. By combining these data, investors can better understand the potential risks in the market and make corresponding adjustments in asset allocation to reduce portfolio risks.

3.3. Big Data and Sentiment Analysis

In investment risk assessment, the combination of big data and sentiment analysis provides investors with more accurate decision support. Big data technology can process large amounts of information from a variety of sources, including stock market data, news reports, social media activity, consumer behaviors, etc., to provide investors with a more comprehensive view of the market. Sentiment analysis is to identify changes in market sentiment through the analysis of text, voice and other information to help investors predict market trends and possible risks. Sentiment analysis mainly uses natural language processing technology to process text data such as news reports, social media comments, and financial analysis to identify emotional tendencies (such as positive, negative, or neutral). Through sentiment analysis, investors can find out the market's reaction to a certain

event in advance and adjust their investment strategy in time. For example, when a company releases a negative financial report, sentiment analysis can help investors gauge the market's emotional reaction to the company's future performance and optimize investment decisions. Table 2 below shows how big data and sentiment analysis are used in investment risk assessment.

Table 2. Applications of Big Data and Sentiment Analysis.

Data source	Application mode	Risk identification	Sentiment analysis tool
Stock market data	Stock price, trading volume change	Identify the risk of price fluctuations	Stock sentiment analysis
News report	News content, financial reports	Identify potential risks in the company/industry	Sentiment analysis
Social media feed	Social platform comments, tweets, etc.	Identify public sentiment and market expectations	Public opinion monitoring, emotional tendency analysis
Financial report analysis	Company reports, financial indicators	Identify financial health	Financial analysis and sentiment scoring

By combining big data and sentiment analytics, investors can more fully assess potential risks in the market, identify subtle changes, and optimize investment decisions to reduce uncertainty and risk in investment.

4. Data Analysis Methods for Optimizing Investment Risk Assessment

4.1. Multi-Factor Model Optimization

Multi-factor model is a common investment risk assessment method, which can measure investment risk more accurately by considering the influence of multiple variables on asset return. On the basis of the traditional single factor model (such as CAPM), the multi-factor model introduces more economic, industry and company-specific factors to build a more comprehensive risk assessment system. Suppose the return on asset R_i is subject to multiple risk factors F_1, F_2, $\cdots$, F_k the influence of, it can be expressed by the following formula:

$$R_i = \alpha + \beta_1 F_1 + \beta_2 F_2 + \cdots + \beta_k F_k + \in_i \quad (1)$$

Among them, R_i is an asset i the rate of return of, α Constant term, represents the rate of return without the influence of factors, β_1, β_2, $\cdots$, β_k are the coefficient of each factor, reflects the sensitivity of each factor to asset returns, F_1, F_2, $\cdots$, F_k are different risk factors, ϵ_i Is the error term, represents parts that are not explained by the model. In order to optimize this multi-factor model, it is usually necessary to optimize the estimation of factor weights. Using historical data for regression analysis, the least squares method (OLS) can be used to estimate the coefficients of each factor. The goal of least squares is to minimize the error term ϵ_i Sum of squares of. To wit:

$$\hat{\beta} = \arg\min_{\beta} \sum_{i=1}^{n} \left(R_i - \alpha - \sum_{j=1}^{k} \beta_j F_{ij}\right)^2 \quad (2)$$

Among them, $\hat{\beta}$ is the coefficient estimated by the least square method, F_{ij} is the i sample the value of the j factor, the goal is to adjust β_j to minimize the error between the predicted value of the model and the actual return. In this way, multi-factor models can be optimized to provide a more accurate assessment of investment risk.

4.2. Machine Learning Optimizes Risk Prediction

As a powerful data analysis tool, machine learning can optimize the predictive accuracy of investment risk assessment by learning patterns and regularities in historical data. By building an appropriate machine learning model, it can effectively capture the nonlinear relationship in the financial market, identify complex investment risk factors, and im-

prove the efficiency of risk prediction. Common machine learning algorithms include support vector machines, decision trees, random forests and neural networks. By learning from a large amount of historical data, these algorithms can automatically discover potential risk factors and rules without relying on traditional financial theories, helping investors assess risks more accurately. Take support vector machine as an example, its basic principle is to find a hyperplane in the high-dimensional space, distinguish different categories of data, maximize the interval between categories, so as to improve the classification accuracy. In risk assessment, support vector machines can be used to predict the risk profile of a portfolio. Suppose that the risk prediction model of a financial product is:

$$f(x) = w_i \cdot x_1 + w_2 \cdot x_2 + \cdots + w_n \cdot x_n + b \quad (3)$$

Among them, x_i represents each feature, w_i is the weight of the feature, b is the offset term, $f(x)$ is the risk prediction result. Through machine learning optimization algorithms, you can adjust the weight parameters w_i, thus, the risk of financial products can be predicted more accurately. Through continuous training and optimization of models, machine learning can significantly improve the accuracy of risk predictions, reducing uncertainty and potential losses in investment decisions.

4.3. Real-Time Risk Monitoring and Adjustment

With the dynamic changes and increasing uncertainties in the financial market, investors' attention to risk has gradually shifted from the traditional static assessment to real-time monitoring and adjustment. At the heart of this shift is the ability to continuously track market movements through data analytics and make timely risk adjustments to portfolios on this basis. Real-time risk monitoring can not only help investors quickly identify potential risks, but also reduce investment losses through dynamic adjustment mechanisms and improve risk response capabilities.

The key to realize real-time risk monitoring is real-time data acquisition and analysis. First, investors need to rely on a variety of data sources (such as stock prices, trading volumes, macroeconomic data, etc.) for real-time information on market changes. Through techniques such as data mining and machine learning, analytical models can quickly identify risk signals in the market, such as abnormal phenomena and sharp price fluctuations and capital outflows. When these risk signals are triggered, the system will automatically start an early warning mechanism to remind investors to carry out risk assessment and adjust the investment portfolio if necessary. This adjustment includes not only the optimization of asset allocation, but may also involve the real-time control of risk exposure to prevent potential losses from escalating. The advantage of real-time risk monitoring is that it can reduce information lag and improve the timeliness of decision making. When unexpected events occur in the market, traditional risk assessment methods often cannot respond quickly, while real-time monitoring systems can respond to risk changes in the first time. By combining real-time data with predictive models, investors can obtain accurate risk assessment results in a short period of time, so that effective adjustment measures can be taken.

In order to realize efficient real-time risk monitoring, system architecture usually includes data acquisition layer, data processing layer and decision layer. The data acquisition layer is responsible for collecting market data in real time, the data processing layer carries out risk assessment through data analysis and modeling, and the decision layer makes portfolio adjustment according to the assessment results to ensure that the risk is controlled within an acceptable range (see Figure 1).

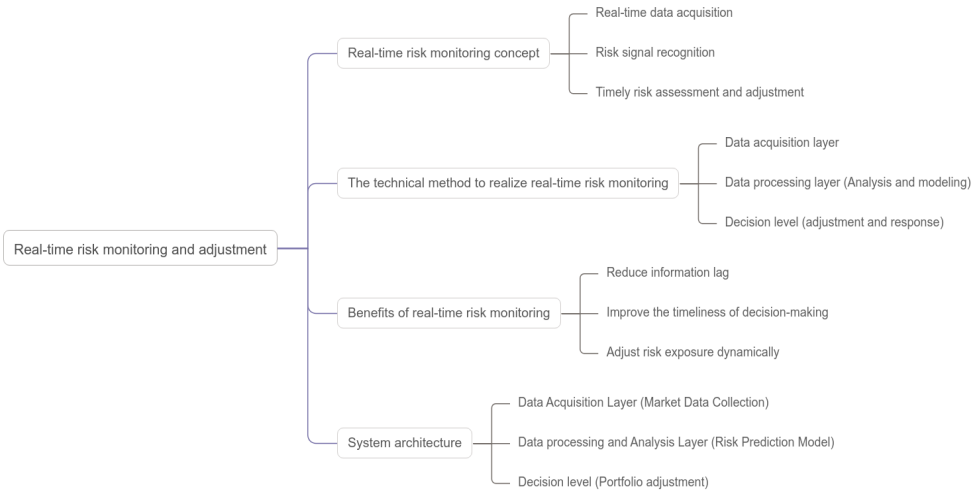

Figure 1. Real-Time Risk Monitoring and Adjustment Framework.

Through this process, investors can react to market changes in the first time, thereby effectively reducing potential losses and improving risk management capabilities. In practical applications, the technology combined with machine learning and artificial intelligence can further optimize the accuracy of risk prediction, enhance the adaptive ability of the system, and make investment decisions more accurate and efficient.

5. Conclusion

In the process of investment risk assessment, data analysis has become an indispensable tool. Through the classification and analysis of market, credit, liquidity and operational risks, investors can better identify and quantify potential risks. The application of market data, macroeconomic data and sentiment analysis make risk assessment more comprehensive and accurate. At the same time, the introduction of multi-factor model and machine learning technology has greatly improved the reliability and timeliness of risk prediction. Real-time risk monitoring and adjustment provides investors with a more flexible response strategy. Specifically, the continuous optimization of data analysis improves the scientific and practical nature of investment risk assessment, and also promotes the rationalization of financial decisions.

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