Research on the Practical Path of Investment Risk Management Course from the Perspective of the Intersection of Mathematics and Finance

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Abstract: *With the increasing complexity and uncertainty of financial markets, investment risk management has become a core component of financial talent development. This paper, based on the interdisciplinary perspective of mathematics and finance, explores the practical teaching reform path of the investment risk management course. The study analyzes existing issues in current teaching, such as the disconnection between theory and practice and the insufficient application of mathematical tools. It systematically elaborates on the application paths of mathematical models and financial theories in areas such as risk measurement and quantitative analysis, and proposes strategies focusing on course reconstruction, practical platform development, and faculty optimization. Practical results show that the deep integration of mathematics and finance not only strengthens students' theoretical foundation in risk management but also cultivates their ability to solve complex financial problems across disciplines, providing a new paradigm for investment risk management teaching reform.*

Keywords: *Investment Risk Management; Interdisciplinary Integration; Practical Teaching*

1. Introduction

Driven by both financial innovation and digital transformation, the connotation and extension of investment risk management are undergoing profound changes. The traditional teaching model, which focuses mainly on theoretical lectures, is no longer sufficient to meet the market's demand for interdisciplinary talents. Mathematics, as the cornerstone of modern finance, is increasingly demonstrating its instrumental, intellectual, and methodological value. The interdisciplinary integration of mathematics and finance in investment risk management teaching is not only a fusion at the technical level but also a deep transformation of teaching models. It aims to cultivate students' abilities in quantitative analysis, model construction, and risk identification through the integration of interdisciplinary resources [1,2]. This paper, based on the interdisciplinary perspective, explores the organic integration of mathematical methods and financial theories, with the aim of providing theoretical support and practical references for the reform of investment risk management teaching.

2. Current Situation Analysis

Currently, there are still significant disciplinary barriers in the content and methods of investment risk management courses in universities. Most institutions focus on theoretical teaching, while interdisciplinary content related to mathematics and statistics accounts for less than 20%. This phenomenon leads to a narrow knowledge structure for students, making them feel ill-equipped when faced with emerging fields such as financial technology and quantitative risk management. At the same time, the teaching method remains teacher-centered, lacking practical components such as case-based teaching and experimental simulations, making it difficult for students to apply theory to practice. However, some universities have begun actively exploring reforms. For example, some universities have introduced courses such as "Financial Risk Management" and "Quantitative Risk Control Analysis" to promote the integration of mathematics and finance; others have built experimental teaching systems to enhance the application of mathematical tools in risk measurement and stress testing. These practices indicate that the interdisciplinary integration of mathematics and finance has become an important direction for teaching reform.

Table 1: Comparison between the Traditional Investment Risk Management Teaching Model and the Interdisciplinary Model

Comparison Dimensions	Traditional Teaching	Interdisciplinary Model
Course Design	Focuses on macro-level theories, with clear disciplinary boundaries.	Emphasizes the integration of mathematics, computer science, and finance, with the addition of quantitative courses.
Teaching Methods	Teachers lecture, and students passively receive information.	Case-based teaching, experimental simulations, and project-driven approaches.
Practical Components	Low proportion (<15%), with limited content.	Higher proportion (>30%), integrating mathematical modeling and software operation.
Competency Development	Emphasizes theoretical memorization and understanding.	Focuses on model construction, data analysis, and innovative problem-solving.

3. Existing Problems

3.1 Rigid Course Design and Insufficient Interdisciplinary Integration

The structure of investment risk management courses has long been characterized by a tendency to prioritize theory over practical applications. Mathematics courses are typically offered as public foundational courses, with content that is disconnected from the needs of finance majors. For example, statistics courses rarely cover financial time series analysis, risk models, or other application scenarios, resulting in students' difficulty in transferring mathematical tools to solve financial problems. Additionally, core courses lack modules on programming and mathematical modeling, leaving students less competitive when faced with roles in quantitative risk management, financial technology, and similar fields [1,3].

3.2 Teaching Content Lags Behind Technological Development

The pace of innovation in financial markets far exceeds the textbook update cycle. Currently, most textbooks still focus on qualitative descriptions, with insufficient coverage of quantitative analysis methods in cutting-edge fields such as risk measurement and algorithmic trading. For example, the VaR model mostly remains at the theoretical derivation stage, lacking numerical experiments and simulation analysis based on Python or MATLAB. This lag results in students finding it difficult to apply what they have learned to real-world work, leading to a significant gap between their knowledge and industry demands [4].

3.3 Weak Practical Components and Insufficient Application of Mathematical Tools

Although most universities have financial laboratories, the experimental content is often limited to basic operations, such as securities trading simulations and financial statement analysis, without deeply integrating mathematical modeling and data analysis. In practical teaching, the application of mathematical tools is often regarded as an auxiliary method rather than a core competency, leading to students being unable to independently perform quantitative analysis of complex financial problems. Furthermore, the depth of university-industry collaboration is insufficient, and students lack opportunities to apply mathematical methods to solve financial problems in real-world scenarios [6].

3.4 Need for Improvement in Teachers' Interdisciplinary Competence

Most finance faculty members graduate from economics-related disciplines, with their knowledge structure primarily focused on theoretical finance, and limited ability to apply mathematical tools. This background makes it difficult for teachers to effectively integrate mathematical methods into their teaching, also restricting the depth and breadth of course content. Meanwhile, universities' mechanisms for introducing and training interdisciplinary faculty are inadequate, further hindering the progress of teaching reform.

Table 2: Main Issues and Impacts in Investment Risk Management Teaching

Problem Types	Specific Manifestations	Impact on Student Abilities
Rigid Course Design	Mathematics and finance courses are separated, with a lack of interdisciplinary courses.	Weak quantitative analysis skills, difficulty in knowledge transfer.
Outdated Content	Textbooks are updated slowly, with insufficient introduction of cutting-edge technologies.	Lack of innovation ability, slow adaptation to job roles.
Weak Practical Components	Experimental content is simple, with inadequate application of mathematical tools.	Poor hands-on skills, inadequate ability to solve real-world problems.
Limited Faculty Expertise	Teachers have a weak interdisciplinary background, and teaching methods are traditional.	Limited learning outcomes, slow improvement in overall competence.

4. Application of Mathematics and Finance in Investment Risk Management Courses

4.1 Mathematical Methods Provide Fundamental Tools for Financial Modeling

Many areas of modern investment risk management rely on the support of mathematical methods. Probability theory and mathematical statistics provide the theoretical foundation for risk measurement and asset pricing. For example, in portfolio management, the Markowitz model quantifies risk through the variance-covariance matrix and uses optimization methods to solve the efficient frontier. Differential equations play a core role in derivative pricing, with the Black-Scholes model using partial differential equations to characterize the dynamics of option prices and provide a basis for hedging strategies. Furthermore, stochastic processes are widely applied in interest rate models, credit risk modeling, and other areas, greatly enriching the methodological system of financial analysis.

4.2 Mathematical Software and Programming for Financial Computation and Visualization

With the expansion of financial data, mathematical software and programming tools have become indispensable support platforms. Excel, as a basic tool, can perform tasks such as cash flow discounting and bond duration calculations. MATLAB, with its powerful numerical computation capabilities, is widely used in complex modeling such as portfolio optimization and option pricing. In recent years, Python, with its open-source ecosystem and library support (e.g., Pandas, NumPy, Scipy), has dominated financial data analysis, enabling end-to-end analysis from data acquisition to model construction. For example, Python can be used to write programs that automatically fetch stock data, calculate its return volatility, and visualize price trends and correlation matrices [3].

4.3 Mathematical Thinking Enhances Financial Problem-Solving Ability

Mathematics not only provides tools but also cultivates a rigorous mode of thinking. The uncertainty in financial decision-making requires practitioners to have logical reasoning and quantitative analysis skills, and mathematical training helps to strengthen this aspect of competence. For example, in risk management, mathematical thinking helps students understand the statistical assumptions and limitations of the VaR (Value at Risk) model, enabling them to apply the model more cautiously. At the same time, optimization theory teaches students to seek optimal solutions under multiple constraints, such as the return-risk balance strategy in asset allocation [5].

5. The Effect of Mathematical and Financial Integration on Teaching Reform

5.1 Enhancing Students' Quantitative Analysis Ability

The introduction of mathematical tools has significantly enhanced students' ability to quantitatively analyze financial problems. By incorporating mathematical experiments into the curriculum, students can operate models themselves and understand the impact of parameter changes on results. For example, in the "Financial Risk Management" course, students use Python to build VaR models and intuitively understand model behavior by adjusting parameters such as confidence level and holding period. This teaching method, which combines theory with practice, allows students to interact with models, adjust parameters, and observe changes in results, thus gaining a deeper understanding of the statistical assumptions and limitations behind the models. For example, when analyzing the risk of a stock portfolio, students can calculate return volatility, covariance matrices, and visualize risk distribution. This training significantly improves their data processing abilities and model debugging skills, deepens their theoretical understanding, and also cultivates their skills in numerical computation and model adjustment.

5.2 Strengthening the Integration of Theory and Practice

Mathematical tools serve as a bridge between financial theory and practice. In case studies, students use statistical software to perform regression analysis on market data, validating the effectiveness of the Capital Asset Pricing Model (CAPM); through simulated trading, they apply knowledge of stochastic processes to generate asset price paths and evaluate the effectiveness of hedging strategies. This problem-oriented learning approach breaks the abstraction of traditional teaching, making knowledge tangible and accessible.

5.3 Cultivating Innovative Thinking and Interdisciplinary Perspectives

The integration of mathematics and finance has sparked students' innovative thinking. In the quantitative investment course, student teams are required to design trading strategies based on mathematical models and test their effectiveness through backtesting. Such projects not only develop technical skills but also cultivate teamwork and communication abilities. Some students have even transformed their research results into competition projects, winning awards in financial modeling competitions, demonstrating the practical outcomes of the teaching reform. In terms of interdisciplinary project practice, student teams may combine machine learning algorithms (such as random forests) with time series analysis to predict value-at-risk under extreme market conditions. These projects encourage students to break free from a single disciplinary framework, integrating mathematics, computer science, and finance knowledge to solve complex problems. Regarding the transformation of competition and research outcomes, many students have turned their course research into competition entries, winning awards in financial modeling contests. For example, students from the Department of Financial Mathematics at Peking University, by participating in the "Quantitative Investment Strategy" project, not only won national-level awards but also applied their findings in real trading tests, showcasing the practical success of the teaching reform.

Table 3: Key Outcomes of Empowering Investment Risk Management Teaching with Mathematics and Finance

Empowerment Dimensions	Specific Outcomes	Case Examples
Quantitative Analysis Ability	Mastering model construction and data processing skills	Students are able to independently perform statistical analysis and visualization of stock data.
Integration of Theory and Practice	Ability to translate abstract theories into actionable solutions	Implementing VaR model testing and parameter optimization through Python.
Cultivation of Innovative Thinking	Possessing the ability to solve complex problems across disciplines	Designing trading strategies based on machine learning and time series analysis.
Enhancement of Employment Competitiveness	Adapting to the demands of financial technology positions	The proportion of graduates entering fields such as quantitative investment and risk management has increased.

6. Strategies and Suggestions

6.1 Restructure the Curriculum System and Strengthen Interdisciplinary Integration

Universities should break down disciplinary boundaries and build a modular interdisciplinary curriculum system. In the investment risk management course, additional courses such as "Financial Mathematics" and "Quantitative Risk Control Analysis" can be introduced to integrate mathematical tools into the core teaching content. At the same time, traditional courses should include mathematical application modules, such as incorporating Excel and MATLAB experiments in "Investment Science" and integrating statistical analysis and Python programming in "Securities Investment." The course structure should follow a step-by-step principle, gradually advancing from basic mathematical methods to comprehensive applications, ensuring the coherence of students' knowledge system.

6.2 Innovate Teaching Methods and Emphasize Practical Orientation

Teaching methods should shift from a "teacher-centered" approach to a "student-centered" one, promoting case-based teaching, project-based learning, and simulated experiments. For example, in the financial risk management course, instructors can guide students to collect market data, use the VaR model to calculate portfolio risk, and write analytical reports. At the same time, universities should strengthen the development of virtual simulation platforms to simulate real financial scenarios, allowing students to deepen their understanding of mathematical tools through hands-on operations. Additionally, students should be encouraged to participate in activities such as mathematical modeling competitions and financial innovation contests, using competitions to promote learning and enhance practical skills.

6.3 Strengthen Faculty Development and Enhance Interdisciplinary Teaching Capabilities

Universities should optimize faculty structures through a combination of recruitment and development. On one hand, they should recruit financial professionals with backgrounds in mathematics and computer science to enrich the teaching staff. On the other hand, they should strengthen training for existing faculty, organizing interdisciplinary workshops to enhance their ability to apply mathematical tools. Additionally, industry experts can be invited as adjunct professors to offer short-term courses or lectures, bringing the latest industry practices into the classroom.

6.4 Improve Practical Platforms and Deepen University-Industry Collaboration

Universities need to increase investment in building financial laboratories equipped with advanced software and databases to support teaching in mathematical modeling and data analysis. At the same time, they should collaborate with businesses to establish internship bases, arranging for students to intern in the quantitative and risk management departments of financial institutions and participate in real projects. Through university-industry collaboration, universities can gain timely insights into industry needs, adjust the curriculum, and ensure that talent development is targeted and relevant.

6.5 Optimize Assessment Methods and Focus on Process Evaluation

Reform the exam-based evaluation system and establish diversified assessment criteria. Increase the weight of practical assessments such as lab reports, project designs, and case analyses, focusing on students' ability to apply mathematical tools and their innovative thinking. In the evaluation process, emphasize periodic feedback, and assess learning outcomes through regular assignments, experimental performance, and other comprehensive evaluations, guiding students to value the learning process.

Table 4: Summary of Strategies for Empowering Investment Risk Management Teaching Reform with Mathematics and Finance

Strategic Directions	Specific Measures	Expected Outcomes
Curriculum Restructuring	Introduce quantitative finance courses and embed mathematical modules.	Break down disciplinary barriers and build a comprehensive knowledge system.
Innovation in Teaching Methods	Promote case-based teaching and project-based learning.	Enhance students' interest in learning and hands-on skills.
Faculty Development	Recruit interdisciplinary faculty and organize training.	Improve teachers' teaching abilities and ensure the implementation of reforms.
Improvement of Practical Platforms	Build high-level laboratories and deepen university-industry collaboration.	Provide a real training environment and bridge the gap between universities and industries.
Optimization of Assessment Methods	Increase the weight of practical assessments and focus on process evaluation.	Fully reflect students' abilities and guide their learning direction.

7. Conclusion and Outlook

The empowerment of mathematical methods, tools, and thinking is a key driving force behind the reform of investment risk management teaching. Through interdisciplinary integration, it is possible to address the disconnect between theory and practice in traditional teaching, while also cultivating versatile talent that meets the demands of the new financial era. In the future, as technologies such as artificial intelligence and big data are increasingly applied in the financial sector, the integration of mathematics and finance will become even closer. Universities need to further optimize the curriculum system, innovate teaching models, and strengthen faculty development to meet the challenges of the new era. At the same time, attention should be given to balancing ethical education with innovative thinking to ensure the comprehensive development of talent. The path of mathematical empowerment in financial education is long and challenging, but it is undoubtedly a crucial route to enhancing the quality of financial education.

Funded Project

Harbin Normal University Higher Education Teaching Reform Research Project: "Mathematics + Finance" Dual-Driven Investment Risk Management Course Restructuring Study, Project Number: XJGY202509

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