

Application and Empirical Evidence of Financial Mathematics in Financial Markets

Sining Hu

The Affiliated International School of Shenzhen University, Shenzhen, Guangdong Province,
518000, China

Abstract. Financial mathematics is very closely related to financial markets, and in real life, financial mathematics has a wide range of applications in financial markets. This paper discusses the specific application of financial mathematics in financial markets through case analysis, entropy weight method, multivariate statistical regression analysis, etc., and measures the development index of China's financial market and evaluates the development factors of China's financial market. Finally, based on the conclusions, some suggestions were made, hoping to help promote the more coordinated development of financial mathematics and financial markets.

Keywords: Financial mathematics; Financial markets; Entropy law; Multivariate statistical regression analysis.

1. Introduction

In the modern economy, the importance of financial mathematics for financial development is self-evident, as one of the important driving forces of economic growth, it can be said that it is the lifeblood of the real economy. Financial mathematics is a combination of a series of financial models and traditional mathematical statistical tools, resulting in interdisciplinary disciplines and methods derived. With the development and improvement of modern financial markets, some new characteristics and risks have been alluded to, which requires us to analyze the changes in the internal mechanism and external characteristics of financial markets in more depth. In order for us to better understand the development trend of finance, so as to reflect the increasingly important role of financial mathematics in the development of financial markets. In terms of life, financial mathematics helps us to recognize the laws of economic development and the problems we face in real life from a more scientific perspective, as well as to help guide us in work and study.

There may be some closer relationship between financial mathematics and financial markets, and financial mathematics may promote financial markets at the same time, financial markets in turn will affect the development of financial mathematics. At the macro level, financial mathematics as an analytical tool for mathematics and statistics, it can provide some quantitative statistical methods and mathematical models, provide the necessary reference and support for financial policies and laws and regulations, so that we can better understand the internal characteristics of financial markets, so that we can better formulate financial policies; For individuals, learning the knowledge of financial mathematics can play a helpful role in personal finance, investment and calculation of personal income. It can be seen that financial mathematics is an important support for the development of financial markets.

On the other hand, financial markets can provide more realistic basis for the development of financial mathematics. The financial development of a country may produce many more typical cases and facts, and the analysis of these cases may put forward some new requirements in terms of tools and technologies, and the application of financial mathematics in financial markets can be inferred whether it meets market demand, thus further driving the development of financial mathematics. Therefore, it can be seen that financial mathematics and financial markets are complementary and mutually reinforcing.

Through theoretical and applied perspectives, this paper analyzes the impact of financial mathematics on the development of financial markets, so as to provide us with a meaningful analysis of the relationship between financial mathematics and financial markets. Compared with previous studies, most of them study the application of financial mathematics in financial markets through

quantitative analysis and forecasting, which lacks certain qualitative descriptions, evidence of typical cases and specific application analysis. This paper makes a corresponding supplementary study in its aspect, filling the gap in the relevant research. The research results and process of this paper provide some valuable enlightenment for the development of financial mathematics and the fact that financial mathematics can be better applied to economic finance, so as to be in the process of a new round of scientific and technological revolution and economic development of financial mathematics. We can better apply the methods and techniques of financial mathematics in real life and economic life.

2. Typical factual analysis of financial mathematics to promote the development of financial market

With the development of the digital economy and the advancement of Internet technology, the trend of financial digital transformation is becoming more and more obvious. More mathematical techniques and information technology are combined with traditional financial markets to derive a variety of development models, and derivatives have been widely used. Therefore, the article will start with three main derivatives that combine financial mathematics with the development of financial markets: Numerical Finance, Fintech and quantitative finance, the products of which provide a lot of technical support and support for the high-quality development of finance, further prove that financial mathematics is indeed widely used in the financial market and promote the development of the financial market.

2.1 Numerical Finance

Digital finance is a technical means of mathematical statistics and a new development model that combines the development of information technology with traditional financial services. Through the use of this information technology, the development of convenient mobile payment, credit, investment and other new financial business models, while a series of related application tools, such as Ant Financial, Alipay, Balance Treasure and other applications. It can be seen that digital finance has a very significant role in the process of promoting financial markets. It breaks the time and space distance between financial institutions, and can provide a more accurate implementation plan in the allocation efficiency of financial resources and improve the quality of financial services, thereby optimizing the ecology of financial products and financial institutions.

2.2 Fintech

It is a development model based on the use of financial mathematical methods such as big data, cloud computing and statistics. This technology is fully used to make scientific and accurate predictions in the financial fields such as bank credit and risk management, and provides a practical basis for the investment and operation of enterprises. At the same time, fintech can use cloud computing to simulate the current internal framework and future development trend of the financial market, so that people can better understand the development of the financial market and conduct research and judgment. Therefore, for products that are becoming more and more digital, the disappearance of spatial distance makes the relevance of financial services stronger, and the efficiency of capital circulation is higher (Chen, 2022). To achieve timely grasp and accurate analysis of information, and help financial institutions maximize their income, some effective financial policies can be formulated to promote the development of financial markets and strengthen risk prevention awareness by using financial technology means.

2.3 Quantitative Finance

In the face of a large amount of complex financial information, computer technology is more efficient and accurate for quantitative analysis than manual analysis and operation. Therefore, the mode of quantitative finance is used to quantitatively analyze the historical data of financial information in a quantitative way, and finally to be converted into intuitive information for display.

At the same time, quantitative finance is a typical investment method combining financial mathematics and traditional financial enterprises, which can predict and obtain profits with such technologies. From the Angle of investment decision-making mode, programmed investment model with advanced mathematical model instead of artificial subjective judgment, using computer technology from the huge historical data audition can bring excess returns of a variety of "large probability" events to develop strategies, help investors get much higher returns in the financial market (Qiao Z, 2019).

3. The empirical case of financial mathematics in the financial market

3.1 Construction of the index system

China's financial market mainly includes: banking, securities, and insurance. This paper mainly from the three main dimensions of financial market search data, subdivided into banking financial institutions loan balance and deposit balance, financial added value, the number of listed companies, stock market value, social financing scale increment and stock, insurance company capital balance and total assets, to calculate China's financial market development index. The data in this paper are all obtained from China Statistical Yearbook and China Financial Statistical Yearbook.

3.2 Model introduction

This paper uses the entropy weight method to conduct empirical research, which calculates the objective empowerment of variables and standardizes the data, so as to avoid unit inconsistency. If the information entropy of the index is smaller, the larger the information provided by the index is, the greater the role in the comprehensive evaluation is, and the weight should also be higher. In statistical measurement, economics and finance, computer science and other disciplines are widely used, and in many financial research, previous literature using this method to evaluate the risk index of financial market, measure the quality of financial industry development, at the same time in life, measure the level of urbanization development, and the quality of life, in public management, used to study the level of public services and social security. The calculation of entropy weight is as follows:

Build the original matrix of indicators: there are m years, n -item indicators, which can be built into a matrix of m rows and n columns. Let any data in the matrix be, representing the actual value of the year i indicator j .

Data is dimensionless. The specific method is

$$\text{Positive indicators } X_{ij} = \frac{X_{ij} - \min\{X_j\}}{\max\{X_j\} - \min\{X_j\}}$$

$$\text{Negative indicators } X_{ij} = \frac{\max\{X_j\} - X_{ij}}{\max\{X_j\} - \min\{X_j\}}$$

Computing the entropy value e_j of the index j :

$$e_j = -k \times \sum_{i=1}^m [p_{ij} \times \ln(p_{ij})]$$

$$k = 1 / \ln m, p_{ij} = y_{ij} / \sum_{i=1}^m y_{ij}$$

Calculate the weight W_j of the index j :

$$W_j = (1 - e_j) / \sum_{j=1}^n (1 - e_j)$$

Calculating the quality value of China's financial market development u_j :

$$u_j = \sum_{j=1}^n (y_{ij} \times w_j)$$

Results analysis

This paper uses the entropy right method to synthesize the financial market index system to obtain the development degree of China's financial market, and it is drawn into Figure 1 according to the year, and thus shows that the development degree of China's financial market is increasing year by

year, showing an increasing trend, indicating that the development of China's financial market is constantly improving. From the graph, the development trend of China's financial market mainly changed significantly in 2008 and 2014, and its impact has accelerated in the subsequent years, indicating that these two years may be a turning point for the development of China's financial market. The reason is that during the financial crisis in 2008, the government has issued a series of policies for macro-control, thus vigorously promoting the development of China's financial market, and laying a solid foundation for the development of China's financial market. In recent years, as China's economy gradually turned to high quality development, economic development demand for financial market is higher and higher, the financial market has made obvious improvement, for insurance, banking, securities and other industries, due to the policy constraints and the market active, obtained more capital security, thus greatly improve and prompted the development of China's financial market. Its chart shows an average growth rate of 4.4% per year. Through the scientific evaluation of China's financial market by the entropy right method, it can be preliminarily believed that some traditional mathematical statistical methods are widely used in the theory and practice of finance, and can be used to measure the development of China's financial industry or the specific financial industry, so as to lay a foundation for the scientific formulation of relevant policies.

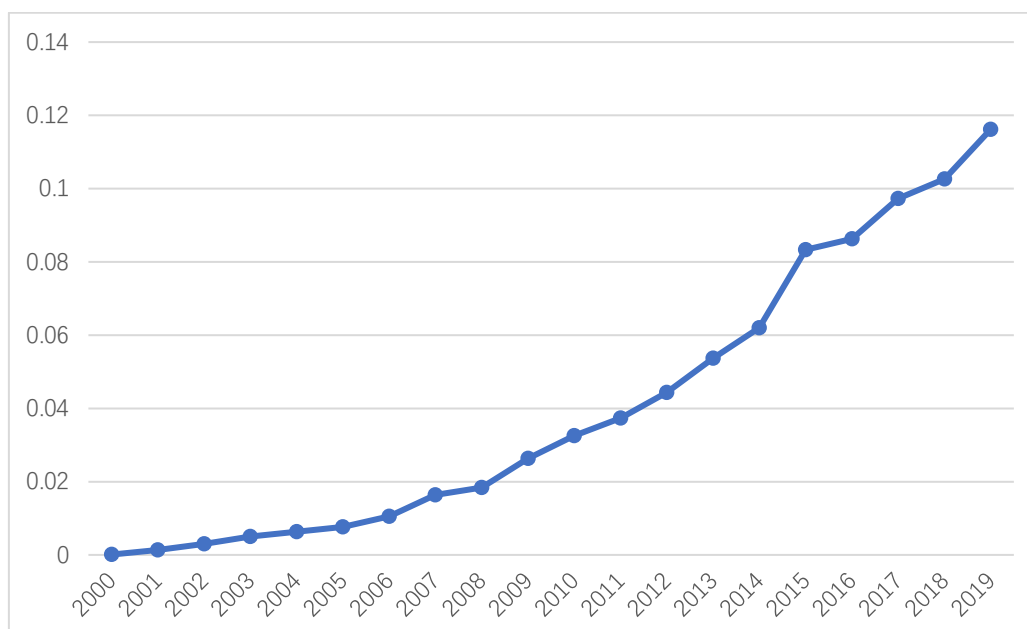


Figure 1. Development degree of China's financial market

4. Multiple statistical regression analysis of the development quality of China's financial market

4.1 Model construction

This paper studies the development and changes of China's financial market from the empirical methods of measurement and measurement. As shown in Figure 2, a multiple statistical regression model is constructed to help test the factors influencing the development of the financial market. The specific forms are as follows:

as shown in the graph,

$$FIN = 934.95 + a_1 * GDP + a_2 * TRA + a_3 * POP + a_4 * THR + a_5 * FP$$

a_1 is 27.58, a_2 is 6.18, a_3 is -91.09, a_4 is 9.22, a_5 is 25.90

The explained variables are financial market (FIN), and the main explanatory variables are per capita GDP (GDP), import and export trade (TRA), total population (POP), added value of the tertiary industry (THR), and fiscal expenditure (FP).

Table 1. Regression results

Variables	Data
GDP	27.58**(2.27)
TRA	6.18*** (5.13)
POP	-91.09(-1.38)
THR	9.22*** (4.19)
FP	25.90** (2.47)
Cons	934.95(1.29)

***, **, * indicates 1%, 5%, and 10% of statistical significance, respectively. The t-values are shown in parentheses

4.2 Results analysis

This paper selects the main reasons is divided into the following aspects: financial market is expressed according to the proposed financial market index, economic growth in per capita GDP, the government's macro-control in fiscal spending, opening to the outside world depends on the import and export trade, demographic factors determined by the total population, the final industrial structure for the added value of the tertiary industry. The above data are mainly from the China Statistical Yearbook. In order to eliminate the bias caused by the dispersion between scalars, all the data results are logarithmically treated and avoid the data maxima and minima. It can be seen from the data that it is basically in line with expectations, in which the import and export trade and the added value of the tertiary industry have a very significant impact on the development of the financial market, followed by per capita GDP and government fiscal expenditure, while the total population has no significant impact on the development of the financial market.

In order to estimate the coefficients of each parameter in the model, multiple statistical regression analysis is used to estimate, and the results are shown in Table 1. From the results, we find that economic development is significantly positive, indicating that economic development promotes the development of the financial market, the reason may be: economic growth has brought a lot of capital demand, promoted the activity of economic activities, thus providing economic support for the development of the financial market. Opening to the outside world helps to introduce new technology and experience from abroad, and also attracts investment from overseas companies, thus increasing the import and export trade. As can be seen from the table the population growth has not had a significant impact on the development of the financial market, which may bring the growth of the financial market from the demand for capital, while the densely populated areas do not necessarily have a high capital demand, so the change of the total population will not have a great impact on the development of the financial market. However, the government's macro-control is conducive to the development of the financial market. A series of policies are conducive to drive economic development and bring more investment opportunities to the financial market, which shows that the development of the financial market cannot be separated from the support of the government. At the same time, the development of the tertiary industry also plays an important role in promoting the development of the financial market. For example, expanding employment and ensuring social stability can improve people's living standards and quality of life, and effectively promote the process of China's industrialization and modernization.

5. Suggestions for applying mathematics in financial markets

This paper will discuss how financial mathematics can be better used in China's financial market, and put forward the following suggestions:

5.1 Strengthen the research in basic science and develop more financial mathematical mode

The current traditional models and methods have not been improved and developed in a long period of time. Although these methods are still effective in specific research, their repeated

applications rely on changing the data. These mathematical models do not have much innovation and cannot be further applied to the market. Financial mathematics is built based on basic disciplines such as mathematics, statistics and computer science, which play a supporting role for subsequent applications and specific practices in the financial market. On the contrary, without the support of these basic disciplines, the measurement, prediction of financial markets and analysis will be impossible, so it is of great significance to improve the research of basic science. At the same time, it is also necessary to strengthen the financial support and provide the relevant technical support, so that the development and development of financial mathematics can obtain an external guarantee. Universities, research institutes, and research institutions should play a leading role to lay the foundation for developing more mathematical models. This paper uses the entropy weight method and multiple statistical regression method to measure the development trend of financial market and influencing factors, although these methods and models have irreplaceable advantages and advantages, but for the development and innovation of these models is necessary, contribute to the future rely on these basic methods of research more accurate.

5.2 Combine theory and practice to apply more financial mathematical models in the financial market.

Most financial mathematical models only stay at the level of theoretical research and lack some necessary practical applications, so the practical effect, estimation accuracy, goodness of fit and other aspects of these models have not been verified by practice. In order to lay the foundation for optimizing and adjusting these models and promote the continuous development of existing mathematical models and statistical methods, we should combine more financial mathematical models with data and apply them to the financial market, and give full play to the role of financial mathematical models in the financial market and conduct further testing. At the same time, we can take some ways to promote and strengthen the application of financial mathematics in the financial market, such as the establishment of financial market laboratory construction. So that the existing financial mathematical models and newly developed mathematical methods can be quickly put into practice in a short term, so that they can be tested, so as to improve the application level of financial mathematics. At the same time, the cooperation between enterprises and governments can be strengthened, and these models can be fully played and applied through specific data, cases and situations.

5.3 Cultivate more financial and mathematics talents and improve the level of human capital

In China, the talent in financial mathematics is still relatively lacking, we can learn from foreign experience and actively explore professional talents in financial mathematics, undergraduate, master's and doctoral study system should open more related majors. It helps to strengthen the level of specialization and improve students' understanding and application of financial mathematics knowledge, so that education plays a decisive role in cultivating talents in this field. Take most universities that have already offered relevant courses. The content of the lectures only stays at the theoretical level, lacks the necessary practical opportunities, and students have no way to apply their knowledge well in the financial market. For the cultivation of financial mathematics talents, it is necessary to formulate a professional overall plan, comprehensively consider the similarities and differences between finance and mathematics majors, and form a representative and application level of measures, so as to provide a professional foundation for the cultivation of financial mathematics talents and play a supporting role.

6. Conclusion and discussion

This paper analyzes the theory and application of financial mathematics in financial markets in depth. Through the analysis of financial models such as digital finance, financial technology and quantitative finance, we will explore the specific embodiment of financial mathematics in financial

markets. The practical application of financial mathematics in financial markets is demonstrated through case studies. This paper uses the entropy weight method and constructs its index system to calculate the development degree of China's financial market, and uses multivariate statistical regression analysis to analyze the impact of factors such as opening up, economic growth, and industrial structure on the development of China's financial market, and finds that there are differences in the influence of different factors, and concludes that China's financial market development index is rising, according to which it is proposed to actively develop mathematical models and cultivate financial mathematical talents.

This paper only analyzes the application of financial mathematics from the macro level, and uses specific financial mathematical models and methods to calculate the degree of development of China's financial market. The results show that in reality, it is found that financial mathematics has a wide range of applications in macroeconomics, which is also of great significance for the future development and further promotion of economic finance. However, not only at the macro level, but also at the corporate level and at the individual level, there are also wide applications, such as personal investment, financial management and credit, etc. there will be different degrees of contact and use of financial mathematical methods. At the same time, there are still certain limitations in this paper, the data in this paper mainly comes from the macro level, and the future can try to explore the city, so it is necessary to increase the openness of data. This paper studies the development trend of the financial market from the perspective of case analysis and data analysis, but in the future, it is still possible to conduct field research on specific enterprises, questionnaire surveys and other methods to study how enterprises use financial mathematics in investment, credit, risk control and other aspects.

References

- [1] Chen Z. Financial technological innovation strengthens digital supervision [J]. China Financialyst, 2022 (05) :87-88.
- [2] Qiao Z. The investment model of technological innovation: the application of quantitative investment in the financial market [J]. China Journal of Commerce, 2019(06):26-28.
- [3] Noja G G, Cristea M, Jurcut C N, et al. Management Financial Incentives and Firm Performance in a Sustainable Development Framework: Empirical Evidence from European Companies[J]. Sustainability, 2020, 12.