

# An Overview of the Development of Mathematics in Economics

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## Abstract

**With the development of economics research, mathematics as the main analytical tool is more and more widely used in economics. The degree of application of mathematical tools has become an important measure of the quality of economics research. This article combs the history of the application of mathematics in economics, expounds the differences and connections between economic statistics, economic theory and econometrics, and finally points out the future opportunities of mathematics in economics research and the realistic risks that should be guarded against.**

## Keywords

**Mathematics; Economics; Econometrics.**

## 1. INTRODUCTION

As an analytical tool for economic research, mathematics has always played an important role in economic research. The quantitative analysis of economics research using mathematical tools is a manifestation of the continuous efforts of generations of economists to make economics a rigorous science like natural science. Take the Nobel Prize in Economics as an example. During the period from 1969 to 2016, the Nobel Prize in Economics was issued 48 times, and a total of 78 people were awarded. Among them, 32 people have a degree in mathematics, accounting for 40% of the total. More than half of the award-winning results have used mathematical methods, and the importance of mathematics in economics research is self-evident.

The introduction of mathematical tools in economic research is an irreversible development trend. On the one hand, the mathematical symbol system gives economic theory a unified discourse system, which can effectively avoid ambiguities in the understanding of economic concepts and simplify the complex logical analysis of economics. Thinking, it can be said that the establishment of mathematical models is the key to the theorization of economics. On the other hand, the rapid development of statistical inference methodology based on econometrics has made extraordinary achievements in the field of economic theory testing and predictive economic model application.

The application of mathematics in economics can be analyzed from several aspects. At present, it is mainly divided into three parts: economic statistics, economic theory and econometrics. Economic statistics and economic theory are the foundation of econometrics, and econometrics and The effective combination of economic theory forms a perfect closed loop of empirical research in economics.

In the following part, this article first reviews the history of the introduction of mathematics in economics research, and then elaborates on the connections and differences between the subdivisions of mathematics applied to economics research; finally, the status quo and actual development of applied mathematics in economics Make a summary of the situation.

## 2. DEVELOPMENT HISTORY

For the first time to introduce mathematics to economic analysis, the French mathematician and economist Cournot published "Study on Mathematical Principles of Wealth Theory" in 1838, which has a history of more than 180 years. At that time, the economics community did not recognize the use of this form of analysis of economic phenomena. It was not until Walras and Jevons et al. discovered that the concepts such as "marginal" in the theory of marginal utility actually corresponded to the "derivative" or "partial derivative" in mathematics, did the economics community recognize and begin to use calculus and other advanced mathematics. Subsequently, the mathematical economist Walras used equations to propose a general equilibrium theory in "The Essentials of Pure Political Economy", but in mathematics, Walras did not strictly prove its existence. It was not until 1954, 80 years later, that Arrow and Debreu used the "Kakutani Fixed Point Theorem" to give a rigorous proof of the existence of general equilibrium. During these 80 years, many economists have used mathematical tools to promote the development of economics as a whole. For example, Morgenstein and von Neumann published "Game Theory and Economic Behavior" in 1944, which created The branch of game theory; Samuelson combines the principle of maximization with the principle of equilibrium, so that the main content of neoclassical economics has a classic mathematical expression.

"Econometrics" was first proposed by Norwegian economist Frisch in 1926 to imitate the term "biometrics". It is generally believed that econometrics is divided into classic econometrics and modern econometrics based on the 1970s, while modern econometrics is divided into time series econometrics, micro-econometrics, and non-parametric econometrics And panel data econometrics. Representatives of classic econometrics include Frisch, Tinbergen, and Klein, etc., who laid the foundation for the essence, probability theory, functions, and research procedures of econometrics. On this basis, modern econometrics has developed its own model theory system based on different data characteristics, based on research questions, and more economic research topics can use econometric methods for empirical research. Modern time series econometrics solves the contradiction between the non-stationarity of macroeconomic time series and the mathematical foundation of classical econometrics models; microeconometrics adapts to the data characteristics of microscopic individuals; nonparametric econometrics overcomes the parameter model design The difficulty of setting and setting errors; panel data econometrics makes full use of empirical information reflecting the two dimensions of space and time.

## 3. ECONOMIC STATISTICS, ECONOMIC THEORY AND ECONOMETRICS

The intersection of mathematics and economics has derived several new terms. Economic statistics is a quantitative description of various subjects, sectors, variables and various economic phenomena in the economic system, and its essence is economic measurement. Economic theory is a discipline that systematically uses advanced mathematics to express, research and demonstrate economic theory. Econometrics is based on certain economic theories and statistics, using mathematics, statistical methods, and computer technology to establish econometric models as the main means to identify the causal relationship between economic variables and reveal the law of economic operation Economics discipline.

In economics, economic statistics and econometrics, due to their close integration with economic theory, play an important role in quantitatively describing economic phenomena and revealing internal economic laws through phenomena. Together, they constitute economic research, especially Empirical research has a complete methodology, but economic statistics and econometrics have different research objects and research categories. Economic statistics is a quantitative description of various economic phenomena, economic behaviors and economic entities, and its essence is economic measurement. Econometrics, on the basis of

observational economic data, is guided by economic theory to conduct econometric modeling and statistical inference, thereby testing the validity and correctness of economic theories and economic hypotheses, and revealing the causality and intrinsic relationship of economic variables The law of economic operation. Obviously, economic statistics is an important premise and foundation of econometrics. On the other hand, the setting of econometric models requires the guidance of economic theory, such as which economic explanatory variables to choose, etc. However, considering the particularity of economic data, some methodologies of economic theory cannot be directly used for statistical inference of economic data. Finally, the empirical results of econometrics can in turn adjust economic theory to make it more realistic.

#### 4. CONCLUSION

As a means of perfecting methodology, mathematics plays a major role in vigorously developing economics. On the one hand, the introduction of mathematics can enable economics to have a complete and rigorous theoretical system. On the other hand, the rapid development of econometrics allows us to test the applicability of economic theory through models and data and predict future economic trends. At present, with the rapid development of computer technology, the availability and quality of data have greatly improved, and there is still room for further development of the integration of mathematics and economics in the future. But we must also see the limitations of mathematics in the application of economics, and cannot blindly exaggerate the contribution of mathematics to economic research. The limitations of mathematics in economics research are mainly reflected in two aspects. First, a model is an abstract summary and summary of complex social and economic reality. When it is used to explain or predict reality, it is often not as accurate as natural science. One of the main reasons is that the economic behavior we observe is the result of many factors. We rarely find all the factors and put them into the model. These factors that are not put into the model affect the accuracy of the model's predictions. So far, the economics community has not had a good way to solve this problem. Second, the statistical relationship described by the model is different from the actual causal relationship. Due to the non-experimental characteristics of economic data, econometric models reflect the statistical relationships between economic variables. Through econometric models, we can only get conclusions about explanatory variables and explained variables. At present, we often rely on economic theory. And economic hypothesis interprets the correlation between economic variables as causality, which poses a huge challenge for identifying economic causality through empirical research.

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