Article

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# A critical study of the evolution of Mathematics in Economic Analysis

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**Abstract**

*Mathematical economics is an electrifying division of study in economics. It is helpful in model building and provides mathematical form of a descriptive theory in a simple as well as easily understandable way. Economics axiomatization can be embedded with mathematical formula to make it more scientific. Some of the concepts and theories like input-output analysis, linear programming, theory of games and economic behaviour, economic problems of optimum allocation of resources, organizing and planning of production, hyper formalistic methods now the application of computer simulation, normative economics ideas into positive economics for testing its validity given the normative assumptions, and failure of some mathematical models. This paper discusses about the evolution of mathematical economics critically.*

Keywords: Mathematical economics, input-output analysis, linear programming, rigorous science.

## Introduction

Mathematics is an accommodative science which fit in to any branch of other subjects. It makes that subject more quantitative from qualitative perspectives. Economics as a rigorous science and also the major user of mathematical tools. This makes economics concepts with mathematical conjectures, allegories and experimental refutations. Mathematical Economics and econometrics are the vibrant branch of study in economics. These have turned the subject towards more scientific and used for economics model building which are academically debatable issues for its high order dependency and its originality issues. With these an attempt is made in this article to study the use of mathematics in economic analysis critically.

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**Evolution of mathematics in economics**

The mathematical economics, formalism as well as axiomatization is embedded with mathematical usage. Giovanni Ceva wrote about money and used mathematics in his economics analysis, while describing monetary materials he articulated that "every kind of money can be separated as its intrinsic value and external value. Then postulating that, ceteris paribus, the external value of a currency is inversely related to its quantity and external value of money is directly proportional to the population of a country. He proved his first theorem that the external values of two currencies are in compound proportion, made up of the direct proportion of their respective popu1ations and inverse proportion of their quantities" (his essay's title is "De re numaria, quoad fieri potuit geometrice tractata, ad illustrissimos te excellentissimos dominos praesidem quaestoresque huius arciducalis Caesarie magistratus Mantuae". as quoted in R.D. Theocharis,1983).

Adam Smith, David Ricardo, J.S. Mill and other distinguished classical economists have not used mathematics for their popular theories contributed to economics. However, Agustin Cournot, Stanley Jevons, Leon Walras, Neumann and Morgenstern, Debreu and many more economists have used mathematics in their imperative contribution to economics. Cournot (1838) in his book on Mathematical Principles of the Theory of Wealth-ll criticized authors who had written on political economy and stated that "They imagined that the use of symbols and formulas could only lead to numerical calculations, and as it was clearly perceived that the subject was not suited to such a numerical determination of values by means of theory alone, the conclusion was drawn that the mathematical apparatus, if not liable to lead to erroneous results, was at least idle and pedantic. But, those skilled in mathematical analysis know that its object is not simply to calculate numbers, but that is also employed to find the relations between magnitudes which cannot be expressed in numbers and between functions whose law is not capable of algebraic expression".

Schumpeter (1826) opined for origin for mathematical economics, dating from the early 19th Century, Johann Heinrich von Thünen's "Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie". He gives credit to von Thünen, explaining that spatial economic theory remained a German tradition and completely slipped out from the predominantly Anglo-Saxon main stream economics around 1960. Contrary to this Joseph Bertrand attacked for too much mathematics applications in economic theory. Frances Edgeworth in his "Mathematical Psychics" of 1881, William Stanley Jevons and "The Theory of Political Economy" 1871, Wilfredo Pareto and "Manuel d'économie politique pure" 1874, and Wilhelm Launhardt, with "Mathemaische Begründung der Volkswirtschaftslehre" 1885 have used mathematics in their propositions. Leontief (1942) in his input-output analysis and Danzig (1949) linear programming are famous for mathematical treatment of economics. von Neumann and Morgenstern (1944) have applied matrix algebra and game theory.

Marshall was a mathematician and emphasised non-mathematical analysis of economics used mathematical presentations. Evans (1930) in his Mathematical Introduction to Economics applied calculus of variations to economic analysis. Wicksell (1934) was professor of mathematics with doctorate in mathematics has no significant impact in economic analysis. Frank Ramsey (1927) mathematician applied calculus of variations to study the saving behavior and economic optimization. John Maynard Keynes (1972) stated that Ramsey's "I think, one of the most remarkable contributions to mathematical economics ever made ...". Koopmans (1965) poited that Ramsey's contribution was almost totally ignored by economists until 1960's. Edgeworth (1881), Hotelling (1925), Evans (1925) and Roos (1928) are known to be good examples of the efforts made in this direction. Debreu (1986), made a beginning of modern mathematical economics and sets a new level of logical rigor for economic reasoning" by presenting for the first time a new mathematical method for economic analysis. Alchian (1951), Friedman (1953), Hayek (1945), and Georgescu-Roegen (1971) have also approached economics in a different way.

In 1944, John von Neumann and the economist Oskar Morgenstern published their work on The Theory of Games and Economic Behavior which is a landmark contribution in the field. Irving Fisher, Arthur Bowley, and Alfred Cowles of the Cowles Commission for Research in Economics have said in Section I of the Constitution as “the Econometric Society is an international society for the advancement of economic theory in its relation to statistics and mathematics”. Keynesian revolutions gave foundation to modern economics and used differential and integral calculus to explain economic occurrences, consequences, and activities elaborately.

Ragnar Frisch in his first editorial to Econometrica (1932) wrote that “Econometrics is by no means the same as economic statistics. Nor it is identical to what we call general economic theory, although a considerable portion of this theory has a definitely quantitative character. Nor should econometrics be taken as synonymous with the application of mathematics to economics. Experience has shown that each of these three viewpoints, that of statistics, economic theory and mathematics, is a necessary, but not by itself a sufficient condition for a real understanding of the quantitative relations in modern economic life. It is the unification of all three that is powerful. And it is this unification that constitutes econometrics”.

The first Sveriges Riksbank Prize in Economics was awarded to Ragnar Frisch and Jan Tinbergen in 1969 for “having developed and applied dynamic models for the analysis of economic processes.” Leonid Kantorovich, a Russian mathematician, was awarded the Nobel Prize in Economics in 1975 for developing the mathematical theory of linear programming and applying it to economic problems of optimum allocation of resources. Gerard Debreu, a French mathematician, is another example who won the Nobel Prize in Economics in 1983 for his contributions to the general equilibrium analysis. Leonid Kantorovich (1939) on organizing and planning of production and Wassily Leontief (1941) on input-output analysis were so significant that were awarded the Nobel prizes in 1975 and 1973, respectively.

In development economics, apart from the use of hyperformalistic methods now the application of computer simulation, inductive methods etc., are omnipresent. With regard to the analysis of economic issues, positive economics and normative economics play a vital role. Positive economics has testable compositions. We can rephrase normative economics ideas into positive economics for testing its validity given the normative assumptions. In the process, the quantification takes place to make these ideas with more scientific approach. For example, in the circular flow of income, let us assume that the distribution of income is given, here for instance the positive economics analysis states that even when the absolute income increases the income of the rich and the poor remain relatively the same. With regard to normative assumptions for example when we analyse about in one market and its alteration in another market can be ignored. Similarly, share market volatility, foreign exchange oscillations, food security studies, impact evaluation studies etc., positive and normative economics interpretation and rephrasing takes place. In all these paradigms, the use of mathematics is enormous and also make the hypotheses easy and understandable to anyone even to the critics of mathematics.

## Conclusion

Mathematical models used in economics uses empirical data with rules. The mathematics of economics is learning and the development of fractional calculus applications in economics is a new direction which causes revolution in economic theory. Mathematics is helpful in building economic models, but using sophisticated mathematical models is questionable under pretext of the failure of some of the mathematical models in the economic development of countries worldwide. However, the use of mathematics makes the subject more scientific and very easy to understand the rigorous economic theories. The evolution of mathematical economics is spread over more than 300 years experiencing appreciation and criticisms and occupied an important place in the field of science. It has grown like any other imperative disciplines to receive Nobel Prize for many years.

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