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APPLICATION OF MATHEMATICS IN ECONOMICS ANALYSIS - A STUDY

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ABSTRACT
Every academic discipline has its own standards by which it judges the merits of what researchers claim to be true. In the Physical Sciences this typically requires experimental verification. In History it requires links to the original sources. In Sociology one can often get by with anecdotal evidence that is with giving examples. In Economics there are two purposes to apply mathematics in economics, one is the mathematical tools needed to make and understand economic arguments, the second one is, though, is to teach you to speak mathematics as a second language, that is to make you comfortable talking about economics using the shorthand of mathematics. An economist of 19th century cannot even understand the economic Journals of present times. The major development of the second quarter of 20th century in the field of economics was the mathematization of economics. The application of mathematical techniques to the analysis of economic problems is a methodological possibility. During the last six decades, this methodological option has been linked to history of a significant part of economic analysis. The main objectives of the study are the use of mathematical tools in economic theory and to study the application of mathematical techniques in economic research analysis. The methodology of the study is based on secondary data. The uses of Differential calculus, Maxima and Minima etc., in economics are attempted to study in this article. The major finding of the study is mathematics played a pivotal role in economic theory and research.
Key Words: Standards, Arguments, Tools, Techniques, Methodological possibility, Research analysis

Introduction

Pure descriptive analysis was the first stage in the historical development of economic theory. However, as theories became increasingly complex, descriptive analysis became more tedious and more difficult to formulate economic theories. Particularly, the last five decades have witnessed a better understanding of economic theories. Mathematics provides the economists with a set of tools often more powerful than the descriptive analysis. Mathematics helps to translate verbal arguments into precise and concise quantitative statements or equations. It provides concrete form to economic laws and relationships and made more practical. Use of Mathematics helps in systematic understanding of the relationship and in derivation of certain results which would either be impossible through verbal argument, or would involve complex, tedious and difficult processes.

Although known from the most ancient times of human society, interdisciplinary as phenomenon has only been defined and emphasized along with its spread and rapid evolution registered during the second half of 20th century. Therefore, beside the technological development and the increase of demarcation between the economical and social areas, an increasing need for optimization appeared, with a solution in combining certain methods and techniques specific to several sciences, and applying them within their interest areas. Such phenomenon have been encountered in Economics when, in order to explain rules such as the theory of general balance or the theory of the

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marginal utility, mathematic methods based on economical thinking were used. This way it was proved that, in practice, Mathematics are not a substitute, but a complement for the economic science.

Objectives of the Study

1. To study the use of Mathematics in Economic theory concepts.
2. To observe the application of Mathematical tools in the research of economics.

Methodology

The study is based on secondary data. The author refers the research reports, articles, Books, Journals and Websites. The use of Mathematical techniques and tools in economic theoretical concepts are explained through illustrations.

Review of Literature

The link between mathematics and economics dates back to calculations of a commercial nature, which merchants had to carry out daily in ancient times. This relationship was later enriched by the financial calculations needed by users and bankers; it developed into a corpus of applications of arithmetic that is nowadays called accounting.

Adam Smith in his "An enquiry into the Nature and causes of the wealth of Nations" (1776), unanimously considered the father of economics science, does not use proportions, but rather multiplication and division-to clarify how specialization can increase a workers' productivity.

Only few years later, **Thomas Malthus** introduces arithmetic and geometric progressions in his work "An Essay on Population to explain the risk that population growth might drastically reduce the quality of life.

J.S.Mill states that the exchange rate of a currency must be such that the value of imports is equal to the value of exports. Expressed as "equation of international demand" the same proportion can be given in a mathematical form. Thus, mathematics can be used as a language to discuss economics.

One hundread years later, we find full awareness of this in an anecdotes about physicist Gibbs reported by P.A.Samuelson in a passionate defense of the importance of mathematics to economic theory. In samuelson's words "The problem of economic theory- such as the incidence of taxation, the effects of devaluation are by their nature quantitative questions"

Euler's Theorem is absolutely basic to the simplest neo-classical theory of imputation. Yet without mathematics we cannot give a rigorous proof of Euler's theorem.

J.M.Keynes also used differential calculus and determinants in his work, 'General Theory of Employment, interest and Money'.

I Application of Mathematics in Economics Theoretical concepts:

In mathematical application of economics, assumptions and conclusions are stated in mathematical symbols and equations, whereas in literary economics, assumptions and conclusions are stated in words and sentences.

Mathematical economics refers to the applications of mathematics to the theoretical aspects of economic analysis, where Econometrics refers to the study of empirical data by statistical methods of estimation and hypothesis testing. In other words, Mathematical economics is a combination of theoretical economics and Mathematics, Whereas Econometrics is a combination of Mathematical Economics and Statistics. Mathematical Economics and Econometrics may be regarded as

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synonyms, each denoting a distinct area of application of mathematical techniques in the study of economic problems.

Some Illustrations of the Use of Mathematics in Economics:

a) **Functions**: In economics Demand is a function of price and production is a function of factors of production. Likewise, utility, cost, Revenue, profit, supply, savings etc., are the functions of some related variables. This functional relationship is a mathematical concept.

In usual language we say that demand(D) depends on the price, in mathematical terms we would say that demand is function of price while in symbolic notations we would write ; D=f(P) where 'f' stands for functional symbol. Similarly, if the utility of a commodity (U) depends on the quantity of the commodity consumed or used (q), we write;

U=f (Q) or many a times this is written as U=f(Q). In the case of production function, one variable is determine by a group of variable means one dependent variable is depends on group of independent variables. Qx=f(Px,Py,Pz,L,T,i…..n).

b) **Straight Line:** Linear function is another mathematical concept. The linear function is usually represented in a graph as a straight line. This function is also used in economic analysis, especially in demand and supply analysis. For Example: the demand curve under perfect competition is a straight line, which can be expressed as 'Linear Equation' The demand can also write as D=f(P) & D=7-p. Here 'P' is the independent variable and 'D' is dependent variable, and with a unit fall in price, demand rises by a unit.

c) **Parabola:** quadratic Function or second Degree function is yet another mathematical concept. The graph of this function is a "parabola" i.e U shaped .This technique is applied in Economics in cost "functions" since, cost curves in economics are U shaped.

d) **Differentiation:**Rate measurer: most of the economic decisions are based on mathematical concepts "Derivatives" this process is called "marginal analysis". The concept of "margin "is a basic concept in economics

For example if the total utility function U= f(Q) then the marginal utility is the first older derivative of the total utility function. i. e du/dq

Similarly all marginal concepts such as marginal productivity ,marginal revenue, marginal cost, marginal rate of substitution (MRS) ,marginal propensity to consume (MPC), marginal propensity to save (MPS) are the first older derivatives of the relevant functions .in short,differentiation is helpful to derive the marginal functions from the total functions .

e) **Slope**: Graphically the value of dy/dx is the slope or gradient of a curve. This technique is used in economics, to know the" rate of change" or the ' slope' of the curves like demand curves ,revenue curves, cost curves , indifference curves and isoquants . If the slope is negative, then the curve will be a falling curve and if the slope is positive, then the curve will be a rising one.

f) Euler's theorem or partial differentiation: If Z = f(x,y) is a homogeneous function of degree 'x' then,

x.dz/dx+y.dz/dy=xZ

Example if U =x^3+ y^3+z^3-3xyz prove that

x. du/dx+y.du/dy+z.du/dz=3u (3U….since u=x^3+y^3+z^3-3xyz)

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This is known as "Euler's Theorem on homogeneous functions. This Euler's theorem can be applied to Marginal productivity theory of Distribution in Economics.

If z=f (L.K) is linearly homogeneous function, z=L.dz/dl+ k. dz/dk

g) Maxima: In economics, we are interested in analyzing the consumer equilibrium and Firm's equilibrium. The optimization in Calculus is helpful in the study of Consumer's equilibrium and Equilibrium of the Firm. Consumer is in equilibrium only when his utility is maximum. Hence, with the help of optimization technique, we can calculate the maximum utility of the consumer and in turn the consumer's equilibrium.

Likewise, firm is in equilibrium only when its profit is maximum. Through differentiation, we can determine the maximum profit of the firm, and in turn, Equilibrium of the Firm. Symbolically, we Can represent this as π= R-C. Where, π= profit, R=Revenue, C-Cost. For maximum profit əπ/əq=0 and $ə^2$ $^{\pi}/əq^2$< 0. Where q= the level of output.

h) Minima: Sometimes, the firm's objective may be to maximize the cost for a given level of output. Minimization in Mathematics is useful to calculate the minimum average cost and minimum marginal cost a given level of output.

For a maximum, First derivative=0, second derivative <0,

For minimization, First derivative =0, second derivative >0

I) Difference and Differential Equations: Difference and Differential equations are very helpful to study the "Macro Economic Theories" and the 'Theories of Economic Growth."

Application of "Difference Equations' to economic theories are abundant. A few of them are Multiplier and Accelerator Interaction and Cob-web Model. Likewise, the application of differential equations to economic analysis is also much. For instance ,in the national income analysis and Domar economic growth model ,the differential equations are applied.

J) Elasticity: Demand is a decreasing function of price and the "Elasticity of demand" is defined as the ratio of proportionate change in demand to proportionate change in price.In fact ,elasticity is a mathematiclal concept .symbolically we can represent the elasticity of demand as

x or ed= dq/dp .P/Q

Where P price and Q is quantity demanded of a commodity.

K) Simultaneous Equations: The equilibrium price is that price at which the quantity demanded equals the quantity supplied. This analysis is carried out through the solution of a system of two

Simultaneous Equations with two unknowns: namely price and quantity.

Example: Demand function =9P+20

Supply function = 11P+ 14

9P-11p = 14-20

-2P = -6

P= 6/2 =3

L) Economic models : prof. P.C Mahalanob is, famous mathematician and economist has given a good model to economy in the second five year plan .In planning models, sect oral targets are fixed only with the help of mathematical models like input –output model and linear programming .Determinants and matrix Algebra of Mathematics are of immense use in such techniques.

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Mathematics is indispensable to calculate "capital formation" and interest rates .thus, in all most all fields of economics, mathematics is useful.

M) Input-Output analysis; Input-output analysis is a mathematical technique for studying the production structure of an economy on the assumption of mutual interdependence of the various sectors of the economy. The primary purpose of the input-output analysis is to calculate the out-put levels in various industries that would be required by particular levels of demand for final goods.

II) Application of Mathematical tools and techniques in Economic Research:

The most successful applications of mathematics to economic research have extolled its role as a knowledge tool. The application of Mathematics in economic analysis and research increased.

Economics relies heavily on mathematics and statistics which play a prominent role in the research culture of the discipline. Within under graduate curriculum in Economics, attention has been paid both to the development of standalone modules and to integrating quantitative skills into other core modules throughout the degree program.

A number of economies departments have implemented different strategies to (extra support, streaming, bridging modules) address the challenges presented by the varied mathematical and statistical backgrounds of their students.

Mathematics and statistics are an integral part of economics discipline in higher education. The mathematisation of economic theory is well established, has a long history (Weintrallb, 2002) and was seen by many leading scholars as a way of legitimizing the discipline and making it more scientific in its approach. This dependence of economics on mathematics is most readily indentified in the academic literature.

The importance of quantitative skills in economics is recognized and in higher education attention have been both to the development of standalone modules and to integrating quantitative skills into other theoretical areas of economics.

Conclusion

The versatility of the roles that mathematics carries out in economics- such as technique, analysis and rhetorical tool- implies that it is to be considered by all means a professional requisite indispensable to the modern economist. Here is P.A. Samuelson's advice to a youth with modest mathematical background who wishes to study economic analysis in depth.

Apparently, therefore, there is more mathematics in economics then in any of the other social sciences and even than in more traditional scientific disciplines.

The need for mathematics in economics is more that obvious. I consider that in fact, Mathematics and economics have formed a symbiosis, each one acting as "Alma mater" for the other, offering new sources for theories postulates, axioms, theorizations and explanations.

References

Websites

- www.google.com
- www.wicipedia.com

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BOOKS

a) Dr.Balwant Kandoi, "Mathematics for Business and Economics with Applications", vol-II, Himalaya Publishing House
b) PULAK CHAKRAVARTY, "Quantitative Methods For Management and Economics, Himalaya Publishing House.
c) Bose " An Introduction to Mathematical Economics" Himalaya Publishing House,2007
d) Mehta, B.C and Madanani, G.M.K. "Elementary Mathematics in Economics" Lakshmi Narayana Agarwal Educational Publications, Agra, 2009

Articles

1) Augsburg T. (2006) Becoming Interdisciplinary. An introduction to Interdisciplinary studies. 2nd edition New York. Kendal/Hunt publishing.
2) Jula A. Interdisciplinaritatea Transdisciplinaritatea, Factori de Crestere a Calitatii Invatamantului Universitar.
3) Schumpeter J. (1994) History of economic analysis. Oxford university press.
4) Georgescu- Roegen N. Legea entropiei si procesul economic, editura Expert, Bucuresti, 1996.
5) Schultz H. (1938) The theory and measurement of demand. Chicago
6) Pareto V. (1909) Manuel d'economie politique, Paris.
7) Elgar, ISBN 1843763354.s
8) Weinstein M. Paul A (2009) Samuelson Economist, Dies at 94 New York Times.
9) Ewald C (2007) Mathematical Finance Introduction to continuous Time Financial Market Models. University of Sydney. School of Mathematics and statistics.
10) Weintraub ER (2002) How Economics became a Mathematical Science. Durham. NC, Duke University Press.2
11) Richards J, (1988) Mathematical visions the Pursuit of Geometry in Victorian England. San Diego Academic Press.
12) Cournot A (1897) Researches into the mathematical principles of the theory of wealth. New York.
13) Edgeworth F. (1881) Mathematical Psychiscs. An Essay on the Application of Mathematics to the Moral Sciences. Lodon.
14) Leontief W (1954) Mathematics in Economics. Bulletin of the American Mathematical Society.
15) Samuelson P (1947) Foundation of Economic Analysis. Cambridge.
16) Walas L, Elements of pure economics. 1974/1900.
17) Keynes J M (1936) The General Theory of Employment, Interest and Money. Macmillan, London.
18) Zakha W J (1992) The Nobel Prize Economics lectures. A Cross-Section of Current Thinking. Avebury, Aldershot.
19) Ingrao B, Israel G (1987) La Mano Invisible: L' equilibrio Economico nella Storia della Scienza, Laterza Bari English edition. B, Israel G (1009) The invisible hand: Economic Equilibrium in the History of Scidnce. The MIT Press, Cambridge (Mass).
20) Mirowski P (1991) The when, the how and the why of Mathematical Expression in the History of Economic Analysis, Journal of Economic Perspectives 5: 145-157

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21) Samuelson P A. (1952) Economic Theory and Mathematics- An appraisal, American Economic Review, Papers and Proceedings 42: 55-66.
22) Various Authors (1981-1991) Handbook of Mathematical Economics, 4 vol, North Holland, Amsterdam.
23) Von Neumann J (1947) The Mathematician, in: The works of the mind. R.B. Heywood (Ed), University of Chicago Press, Chicago. Pp 180-196.
24) Stigler G J, Stigler S M Fried land C (1995) the Journals of Economics, Journal of Political Economy 103-331-359.
25) Morgan T (1989) Theory versus Empiricism in Academic Economics: Update and comparisons, Journal of Economic Perspectives. 2: 159-164.