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Some Useful Applications Of Mathematics And Statistics In Economics

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ABSTRACT
The purpose of this research is to investigate how statistics and mathematics are used in economics. It will look at how these quantitative techniques are used to evaluate economic information and come to wise conclusions. The advantages and restrictions of using statistics and mathematics in economics will also be examined in this study. According to Weintraub's research, economics does not have a fixed point of reference in mathematics. He describes how the ideas of consistency and rigor in mathematics have evolved and how it has shown to be impossible to represent mathematics as a fully formed formal system. This makes it easier to recognize how applied economics, which prioritizes quantitative language, has methodological ambiguities. This paper's goal is to examine fundamental mathematical tools that are frequently employed in the study of economics, including microeconomics, macroeconomics, and econometrics. Without the application of mathematics, economic ideas are insufficient. Each topic in economics requires the application of mathematics for a correct understanding. Economic topics are made understandable by the application of mathematical tools, which might pique one's interest in the subject.

KEY WORDS:
Mathematics, Statistics, Mathematical Economics, Science Studies, Business and Commerce, Business Mathematics.
MSC: 62P20, 91B86, 91B82.

INTRODUCTION

A type of economics known as mathematical economics makes use of mathematical ideas and techniques to develop economic theories and analyze economic conundrums. Economists can do quantitative tests thanks to mathematics, and each academic discipline has its standards for evaluating the veracity of study findings. Applying mathematics to economics has two purposes: first, it provides the mathematical skills required to formulate and comprehend economic arguments; second, it helps you feel at ease while discussing economics using mathematical jargon. The application of mathematics facilitates the methodical comprehension of the relationship and the derivation of specific conclusions that would be either impossible to reach through oral argumentation or would require laborious, complicated, and challenging procedures. These days, mathematics is a crucial instrument for economic analysis. A greater grasp of various economies is provided by the application of mathematics. It is methodologically possible to use mathematical tools for the investigation of economic problems. This method is frequently referred to as mathematical economics.

The use of mathematical techniques to represent theories and examine issues in economics is known as mathematical economics. "Narrative integration of some history of mathematics with some history of economics, and thus telling a story of the development of economic analysis in the twentieth century" is the goal Weintraub sets out to accomplish in How Economics Became a Mathematical Science (2002, p.8). The narrative is organized around essay-style chapters that focus on particular events or times, such as the French growth of the Bourbaki school of mathematics and the familial background of Roy Weintraub concerning the mathematization of economics.

It is important to start by praising the volume for its fascinating and educational content. It is a vacuum in the history of economics and the forces that have shaped it that Weintraub has rightly pointed out: the history of mathematics's evolution and how it relates to economics. No matter what one's experience level in mathematics, this could be instructive. There are significant insights into mathematics as a field for individuals who discovered mathematics indirectly through economics. Math is not a homogeneous field; its nature and applications have evolved, much like economics. All the same, methodological awareness is not a regular occurrence in the teaching of mathematics or economics. Thus, individuals who come to economics via mathematics can also gain some understanding of our origins and thus better understand the connections between the various fields. Without a doubt, then, Weintraub is successful in educating his audience about mathematical economics by utilizing his in-depth understanding of the background of both fields. Thus, the main topic of discussion will be how we might apply the fresh insight he has provided us with. The first concern is one of reflexivity, which has to do with Weintraub's method of approaching his material.

One of Weintraub's most well-known methods of historiography is demonstrated in this volume. He has said before and again that he thinks several historical stories can be presented of the same times or events; there is no way to single out one as the "best" account. In a similar vein, his method of historiography (scientific studies) is just one of many.

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Furthermore, he thinks that to avoid writing history in terms of contemporary conceptions and to address contemporary challenges, these accounts are best written outside of the relevant subject. Thus, important questions are raised by Weintraub's approach to his subject and where it leads. Thus, the first focus of this work is the historiographical approach.

LITERATURE REVIEW

Before Cournot, there were several attempts to describe economic issues using mathematical analysis. The early 1700s saw the start of these endeavors. The mercantilist, physiocrat, and classical schools do not appear to be making any significant attempts to use mathematical analysis. Although there is often a promising awareness of correlations between diverse quantities in the mercantilist literature, there is a lack of mathematical application of these relationships (Robertson, 1949, p.523). Using mathematical statistics in economics for company management studies, Hoeft R. explained in his 2013 book "Mathematical Statistics for Economics and Business. In his research work, "Economics Invents the Economy: Mathematics, Statistics, and Models in the Work of Irving Fisher and Wesley Mitchell," Daniel Breslau (2003) described. This study looks into the social origins of some of the advances in economic theory most notably statistical indicators and mechanical models that helped give rise to the economy. The complexity and heterogeneity of economic and social phenomena are reflected in the book "Mathematical Statistical Models and Quantitative Theories for Economic and Social Sciences" by S. Hoskova Mayervo et al. (2003); as a result, a wide range of issues about statistics, mathematics, education, social science, and economics have been covered in this volume. As a result, a wide range of instruments and methods that can be applied to address issues related to these subjects have been thoroughly explained. Return and cash flow predictability have been hotly contested topics in finance for many years, as noted by Ravi Bansal et al. (2007) in their study "Predictability Economics and Statistics." Dividend-price ratios are a statistically partial predictor of returns and consumption growth. The hypothesis that returns and consumption growth are somewhat predictable is supported by the long-run risks model. Threshold accepting (TA), a potent optimization heuristic from the genre of evolutionary algorithms, was described by Winker P. and Maringer D. in 2007. The problems with TA implementations are explained and illustrated with several examples from statistics, econometrics, and economics. A popular evolutionary technique in the field of control charts, the Genetic Algorithm, was found to be a promising method for solving the issues inherent in the economic and economic statistical designs of a mean value control chart in 2011 when Chih M. et al. compared the results with those from the Genetic Algorithm under the same conditions. Thomas Cleff spoke on advanced multivariate analysis, basic univariate analysis of quantitative data, scaling, and presentation in 2019. In his study, Dale J. Poirier examined the use of the terms "Bayes" and "Bayesian" in journal publications across a range of academic fields, with an emphasis on statistics and economics, since 1970.

MATHEMATICAL ECONOMICS

Mathematical economics is a branch of economics that uses mathematical methods to create economic theories and analyze economic problems. Mathematics helps economists to conduct quantifiable experiments and develop models for predicting future economic growth. Advances in computing power, big-data techniques, and other advanced mathematical technologies have played a vital role in making quantitative methods a fundamental aspect of economics. All of these elements are supported by scientific methods that advance the study of economics. The combination of statistical methods, mathematics, and economic principles has created a whole new branch of econometrics called mathematical economics. To prove, disprove, or forecast economic behavior, mathematical economics relies on statistical observations. Although the researcher's bias heavily influences the discipline of economics, mathematics enables economists to describe an observable phenomenon and offers the backbone for theoretical interpretation. In the past, economics relied heavily on anecdotal evidence or situational theories to make economic phenomena significant. However, mathematical economics introduced formulae for quantifying economic changes, which has led to most economic theories now containing some kind of statistical evidence. Mathematical economics has paved the way for genuine economic modeling, making theoretical economic models useful instruments for day-to-day economic policymaking. Econometrics as a whole aims to translate qualitative statements into quantitative statements. Mathematical economics is especially useful in solving optimization problems. For example, a policymaker may look for the best change out of a variety of changes to affect a particular outcome.

UNDERSTANDING THE ROLE OF MATHEMATICS IN ECONOMICS

Understanding the core components that make up an industry can help you make a more informed decision about whether to pursue a potential career. When considering a career as an economist, it can be beneficial to examine the elements of the field, such as the role of mathematics in economics. Strong mathematical skills can be beneficial to an aspiring economist, as there are segments of the industry devoted to using math to improve performance. In this article, we discuss the role of mathematics in economics, show why math is important for economics, list the types of math economists use, and explain the uses of math in economics. Economists can conduct quantitative experiments and develop models for forecasting future economic growth with the use of mathematics. Large-data approaches, computational capacity and other cutting-edge mathematical technology have all contributed significantly to the acceptance of quantitative methods as a core component of economics.

a) The role of mathematics in economics

Although mathematics has a role in all types of economics, it's most common in mathematical economics, where it's a core component. In mathematical economics, economists apply mathematical principles to economic theory. An economist may use mathematics alongside other methods tools and techniques, such as data harvesting and computer algorithms.

b) Importance of mathematics in economics

Mathematics in economics allows an economist to offer more precision with their projections and analysis. This may allow them to extract increased guidance from the results of their analysis. Using hard data and mathematical calculations can also reduce the potential for bias and economic projections. The importance of mathematics in economics has increased with the growing presence of computing in the field. Computer technology allows economists to process large amounts of data or more complex mathematical equations more easily. This expands the capability of mathematics in economics and may make it a more appealing field to pursue when working as an economist, as computers can make complex calculations easier to complete.

1. Types of math in economics

When applying mathematics as an economist, you may make use of many types of mathematics. The most common forms of mathematics in economics are:

Algebra

Algebra is a basic math field, and it serves as a foundation for many other forms of mathematical calculation. Algebra allows an individual to solve equations with one or more variables, finding the result for a variable under defined conditions. For an economist, algebra is a useful mathematical skill for calculation and projection. Working with variables allows an economist to perform a task such as setting a target growth rate and solving for the required related variables to reach that rate using an established equation.
Related: Algebraic Mathematical Equations: Definitions, Types and Examples

Calculus

Calculus is a mathematical field dealing with rate-of-change calculations. Basic calculus courses are a common component in many high school curricula. Students may also pursue advanced study during their undergraduate education when interested in working in a mathematical field. Calculus can be a powerful tool for an economist when assessing economic performance and making projections. Using calculus to generate curves based on economic information allows you to identify trends and make more informed decisions. As an economist, you may apply this to projects such as market assessment, supply and demand analysis, and economic forecasting.

Probability

The mathematical field of probability measures the likelihood of a specific occurrence or outcome. Probabilistic assessment allows a mathematician to identify whether a potential outcome is likely to occur and to compare the relative likelihood of two or more potential outcomes. As an economist, understanding probability can be useful when making estimations of likely outcomes to economic decisions. By combining the probability of different potential outcomes multiplied by the estimated cost or benefit of each outcome, you can assess the expected cost or benefit of an economic plan.

Statistics

Statistics is a mathematical study that focuses on the collection, sorting, and analysis of sets of data. It allows a mathematician to assess a population represented within the data. That is a critical skill for tasks such as modeling and projecting behaviors or responses within a community. Statistics is a valuable mathematical skill for an economist because it allows you to work with large amounts of data. Applying statistical calculations to datasets may allow you to identify key trends or information on grouping within a community. You may then use this information to guide yourself or others in decision-making positions when making suggestions for plans or policies.

a. Functions

A mathematical function explains how two or more variables relate to one another. In other words, a function expresses how one variable depends on one or more other variables. Hence, we can express a variable's value as $y = f(x)$ in mathematics if it depends on another variable, x. The statement suggests that each value of the variable y is based on a distinct value of the variable x. The dependent variable in the function $y = f(x)$ is y, and the independent variable is x. In economics, production is determined by the factors of production, while demand is determined by price. In layman's terms, we state that price determines demand (D).

b. Differentiation

Rate measurer: The majority of economic choices are predicated on mathematical ideas "Synonyms" We refer to this procedure as "marginal analysis." The notion of "margin" is fundamental to economics. The marginal utility is the first-order derivative of the total utility function, for instance, if $U= f(Q)$ is the total utility function. i. e. du/dq In a similar vein, the first-order derivatives of the pertinent functions determine all marginal notions, including marginal productivity, marginal income, marginal cost, marginal propensity to save (MPS), and marginal rate of substitution (MRS). The marginal functions can be extracted from the total functions with the aid of differentiation, in short.

c. Slope

In graph form, a curve's gradient or slope is represented by the value of dy/dx. In economics, this method is used to determine the "rate of change" or "slope" of curves such as those representing demand, revenue, cost, and indifference.

d. **Parabola**

Another idea in mathematics is the quadratic function, sometimes known as the second-degree function. This function's graph is formed like a "parabola," or U. Since cost curves in economics are U-shaped, this technique is used in cost "functions" in the field of economics.

e. Economics is a Social Science

It describes more than just the state of the economy. It makes predictions about what might happen to specific economic variables if certain changes occur, such as what impact a crop failure will have on crop prices, what impact an increase in sales tax will have on the price of finished goods, and what would happen to unemployment if government spending is increased. It aims to explain how the economy functions. It also makes some recommendations for rules that businesses, governments, or other economic actors could adhere to to distribute resources effectively. Any meaningful application of economics to these fields requires a solid understanding of mathematics. An overview of the (qualitative and graphical) approaches and viewpoints of economists is provided in Applications of Mathematics in Economics. It makes economic laws and relationships more tangible and more applicable.

2. Uses for mathematics in economics

If you're working in economics, you may use math for a variety of professional purposes. Some of the most common uses for mathematics in economics include:

a) Analysis

Analysis is a key responsibility of an economics professional. Economic work often includes assessing information about economic performance, markets, and other key economic data and extrapolating relevant information from the data. This allows individuals making economic decisions to do so while using information from various sources. Math plays a large part in many forms of data analysis. This can include both the simple mathematics to perform tasks such as finding averages to advanced mathematics in the form of differential equations. Strong math skills in a diverse range of math capabilities can help an economist complete their analytical work more effectively.

Related: Understanding Economics: Indicators, Types, and Why Economists Are Important

b) Modeling

An economic model provides a visualization of key economic data. Using a model can make it easier for individuals to conceptualize or understand the state of an economic market. A model may also provide a new form for data that offers insights that the raw dataset does not. As an economist, you are likely to use your math skills throughout the process of creating an economic model. Accurate math provides reliable data you can use in constructing a model, which can increase the value of the model provided upon completion.

c) Projection

Economic projections provide predictions of future economic behavior and patterns. Accurate projections are a valuable tool for economists, as it allows them to make decisions for future planning based on the state and behavior of the market in the future. Math is an integral part of creating economic projections. It allows an economist to perform calculations on economic data, often using the principles of calculus to assess potential changes in the data over time. Developing your mathematical skills as an economist can help improve the accuracy of your calculations both by ensuring you complete them correctly and expanding the number of calculations and math principles you understand and may apply to your work.

ROLE OF STATISTICS IN ECONOMICS

Data collection, organization, analysis, interpretation, and presentation are all included within the topic of statistics. Understanding economic data, such as the relationships between quantity and price, supply and demand, economic production, GDP, national per capita income, etc., depends heavily on statistics.

a) Measures of Central Tendency [9, 10, 11]

A segment of the central tendency is a solitary worth that endeavors to portray an assortment of data by distinguishing what is going on inside that assortment of data. Thus, they are frequently known as estimations of focal arrangement. They are additionally considered to outline insights. The normal, usually known as the mean, is maybe the focal propensity metric with which you are generally mindful, yet there are likewise the middle and the mode. Albeit the mean, middle, and mode are dependable marks of focal inclination, certain circumstances make a portion of these pointers more significant than others. We will look at the mean, mode, and middle in the accompanying segments, as well as figure out how to compute them and when they are generally helpful.

i.Mean

The mean, usually alluded to as the normal, is the most famous and notable focal propensity estimation. Although it may be applied to both discrete and continuous data, its most frequent application is to continuous data (for more information on data types, see our tutorial on the Different Types of Variables). The mean is equivalent to the complete number of values in the informational collection partitioned by the absolute number of values in the informational collection. Formula: $\mathbf{A.M} = \frac{\sum \mathbf{fx}}{\mathbf{N}}$

ii.Mode

In measurements, the worth that shows up most often in a specific set is alluded to as the mode. A worth or number in an information assortment that shows up as often as possible or with a high recurrence is known as a mode or modular worth. It is one of the three proportions of focal propensity along with mean and middle. For example, the method of sets 3, 7, 8, 8, and 9 is 8. Subsequently, finding the mode for a little arrangement of information is direct. A worth set might contain one mode, a few modes, or no modes by any means. Formula: $\mathbf{M_o = l + \frac{f - f_{-1}}{2f - f_{-1} - f_1} \times i}$

iii.Median

The middle is the centre number in an arranged, climbing, or plummeting rundown of numbers and can be a more spellbinding of that informational collection than the normal. The point above and below which half (or 50%) of the observed data falls is known as the midway of the data. Formula : $\mathbf{M_d = l + \frac{\frac{1}{2}N - F}{f} \times i}$

b) Measures of Dispersion

Two data sets may be completely different even though they have the same mean. Thus, one must be aware of the degree of variability to describe data. The dispersion measures provide this information. The three most widely used metrics of dispersion are range, interquartile range, and standard deviation.

i. Range

In statistics, the range is the difference between the highest and lowest values in a data set. For instance, the range will be 10 minus 2 equal to 8 if the given data set is 2, 5, 8, 10, 3. Formula: $\mathbf{R = R_g - R_l}$

ii. Quartile Deviation

Half the difference between the upper and lower quartiles is the quartile deviation's mathematical definition. The term "quartile deviation" can be used here; The upper quartile is denoted by Q3, while the lower quartile is denoted by Q1. The Semi-Interquartile range is another name for the quartile deviation. Formula : $\mathbf{Q.D = \frac{1}{2}(Q_3 - Q_1)}$

iii. Average Deviation

Analysts utilize the typical deviation, one of the numerous changeability records used to depict the spread of estimations inside a populace. Tracking down the mean and afterward, the particular distance between each score and that mean, whether or not the score is above or beneath the mean, yields the typical deviation of a gathering of scores. It is additionally called a normal outright deviation. The formula for determining the average deviation can be found below. Formula : $\boldsymbol{\delta_A} = \frac{\sum \mathbf{f(x - A)}}{\mathbf{N}}$

iv. Standard Deviation

The measurement of standard deviation demonstrates the degree of variation (such as spread, scattering, and spread) from the mean. The standard deviation displays the "typical" variation from the mean. It is a well-liked variable since it restores the original units of measurement from the data collection. Similar to the variance, when the data points are close to the mean, there is a minor variation, and when the data points are far from the mean, there is a huge variation. The standard deviation determines how far the values deviate from the mean. All values are used to calculate Standard Deviation, the most common measure of dispersion. Therefore, the standard deviation's value is affected by even a single value change. It is free of beginning yet not of scale. It can also be used to solve some complex statistical problems. Formula: $\boldsymbol{\sigma} = +\sqrt{\frac{\sum \mathbf{f(x - M)}^2}{\mathbf{N}}}$

v. Variance

Variance is a measurement of how evenly dispersed a set of data is. If every value in the data is the same, there is no variance. Positive variances are any that are greater than zero. In contrast to a high variance, which suggests that the data points are widely scattered from both the mean and one another, a low variance shows that the data points are close to the mean and one another. The total of the squared distances between each point and the mean can be thought of as the variance. is the ratio of how noticeably a variety of information is dispersed. If every value in the data is the same, there is no variance. Positive variances are any that are greater than zero. While assuming the information focuses are disproportionately spread away from the mean and from one another shows a large fluctuation, a little shift indicates that the information focuses are close to the mean and one another. As a result, the difference is defined as the squared deviation from each highlighted mean. **Variance Formulae:**

The population variance formula is given by: $\sigma^2 = \frac{1}{N}\sum_{i=1}^{n}\left(X_i - \mu\right)^2$, The sample variance formula is given by: $s^2 = \frac{1}{n-1}\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2$

vi. Correlation

Correlation is a technique for determining connections between two variables. You used a "dissipate plot" to analyze the relationship between two variables to determine if they are related. There are many proportions of association for factors that are estimated at the ordinal or more elevated level of estimation, however, the connection is the strategy that is most often utilized. Demonstrating that there is practically no connection between the two factors is a relationship coefficient that is either certain or negative and exceptionally close to nothing. Assuming that the connection coefficient is close to one, it implies that the two factors have a positive affiliation and that adjustments of one variable are related to changes in the other. A relationship coefficient that is near - 1 signifies a negative relationship between two factors when there is an expansion in one and a decrease in the other. Albeit a relationship coefficient can be accommodated parts that are assessed on a scale like evident, ordinal, range, or extent level, its importance is humble. For ordinal scales, the relationship coefficient can be determined utilizing Spearman's rho. The correlation coefficient, often known as Pearson's r, is the one that is most frequently used for interval or ratio level scales.

vii. Coefficient of Correlation

In statistics, a relationship between two variables is typically determined using a coefficient of correlation. There is an assortment of connection coefficients, each meaning a specific incentive for the strength of the direct connection between the factors X and Y, or X and Y. Nonetheless, Pearson's connection, normally known as Pearson's R, is the connection coefficient that is oftentimes utilized in direct relapse. The accompanying equation can be utilized to portray the example connection coefficient: $r = \frac{\sum\left[\left(x_i - \bar{x}\right)*\left(y_i - \bar{y}\right)\right]}{\sqrt{\sum\left(x_i - \bar{x}\right)^2 * \left(y_i - \bar{y}\right)^2}}$

viii. Pearson's Coefficient Correlation

The degree of connection between two parameters that are directly related is determined using Karl Pearson's coefficient of connection, a complex numerical technique. The correlation coefficient is represented by the letter "r". Karl Pearson's Coefficient of Relationship, otherwise called Karl Pearson's Coefficient of Association, is a proportion of an immediate affiliation that reaches from - 1 to +1 in esteem. A huge negative relationship is shown by a worth of - 1, while an enormous positive connection is demonstrated by a worth of +1. Formula : $\mathbf{r} = \frac{\sum \mathbf{xy}}{\sqrt{\sum(\mathbf{x})^2\sum(\mathbf{y})^2}}$

ix. Spearman's Rank Correlation Coefficient

Spearman's position relationship coefficient, indicated by r, is a mathematical worth with the end goal that $-1 \le r \le 1$. It gives a proportion of the probability of one variable expanding as different builds (an immediate affiliation) or of one variable diminishing as different expands (a backward affiliation). Positive values indicate direct associations, while negative values indicate inverse associations. A value of 0 does not indicate any association. r is closer to 1 or 1, the stronger the association, and the weaker the association, the closer it is to 0. Rank connection coefficient upsides of 1 or −1 imply that either the positions concur (r = 1) or they are immediate alternate extremes (r = −1). Formula : $\mathbf{r = 1 - \frac{6\sum d^2}{n\left(n^2 - 1\right)}}$

OBJECTIVES OF THE STUDY

1. To research how mathematical principles are applied in economic theory.
2. To observe the many uses of mathematical instruments in economics study.

METHODOLOGY

The articles, books, journals, and websites are all cited by the author. Illustrations are used to demonstrate how mathematical tools and techniques are used in economic theoretical concepts.

CONCLUSION

The world over, mathematics is used. Economics and business both heavily rely on mathematics. One feels powerless in all facets of economic relations without mathematics. Calculus is therefore essential for calculating taxes, profit, and revenue all of which are critical for any kind of business. Applying mathematics to economics has two purposes: first, it provides the mathematical skills required to formulate and comprehend economic arguments; second, it helps you feel at ease while discussing economics using mathematical jargon. It is methodologically possible to use mathematical tools for the investigation of economic problems. This method is frequently referred to as mathematical economics. The use of mathematical techniques to represent theories and examine issues in economics is known as mathematical economics. Economists can formulate meaningful, testable hypotheses about a wide range of intricate topics that are more difficult to discuss informally thanks to mathematics. Distinguishing Rate measurer: "Derivatives," a branch of mathematics, provide the basis of most economic choices. Slope: A curve's gradient, or slope, is represented graphically by the value of dy/dx. Quadratic parabola Another concept in mathematics is function, sometimes known as second-degree function. This function's graph is a "parabola." Functions: The relationship between two or more variables is described by a mathematical function. This paper's goal is to examine fundamental mathematical tools that are frequently employed in the study of economics, including microeconomics, macroeconomics, and econometrics. Without the application of mathematics, economic ideas are insufficient. Each topic in economics requires the application of mathematics for a correct understanding. Economic topics are made understandable by the application of mathematical tools, which might pique one's interest in the subject.

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