**Mathematical Economics**

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# Abstract

Taking under consideration the growing importance of mathematics in the field of economics; it is analyzed that mathematics permits the economists to create models and conduct quantifiable to test the future economic activity. In economics, the types of mathematics in economics include: statistics, calculus and algebra. The significant advancements in the big data techniques, computing power and other advanced mathematics applications have played significant roles in making quantifiable methods a standard economics element.

The differential calculus is based on some fundamental concepts of the real numbers; limits, functions and continuity, which are highly significant concepts of mathematics, which have been formulated and had their modern content assigned during mathematical analysis development and during the studies of its foundation. The linear model is the form of the mathematical models, which helps in understanding as well as exploring the meaning of the functional relationships and equations.

In addition, the mathematical optimization tends to provide the self-constrained introduction to as well as the control techniques and survey of mathematical programing and their application to dynamic and static problems in economics. The wider application of the theory of game in economics ranges from analysis of economic competition to the economic phenomenon, such as: voting theory, bargaining mechanism design, political economy, behavioral economics and experimental economics. The econometrics modeling could drive the business ahead, helping in optimization of cost, better or smarter decision making and better understanding of the customer demand in the market. The matrix algebra involves various problems that tend to demonstrate the foundation expressions of matrix algebra as well as the illustration of using algebra for a number of economic problems and issues.

# Introduction

Economics is the social science that does not only explain what goes on in economy of cone country but also describes how the economy operates and makes predictions related to what might happen to the specific variables of economy if certain changes take place. Thus, the use and application of mathematics are fundamental to any serious application of economies. The economics file is riddled with mathematics applications and equations to a greater extent. In economics, the types of mathematics include: statistics, calculus and algebra.

Algebra is widely used as a mean of making computations, such as: the total revenue and total cost; whereas, the calculus is used in order to find the growth models, profit maximization curves as well as utility curves. The Mathematical economics is the economics model that utilizes the principles and methods of Math, to create economic theories as well as investigates the economic quandaries. It is pertinent to note that the mathematics permits the economists to create model and conduct quantifiable test in order to predict the economic activity in near future. Following are some mathematical representation of the economic problems:

# Differential calculus

In mathematics, differential calculus is used to find the rate of change of quantity with respect to other. The differential calculus makes it possible to easily compute the function’s limit in many cases. Differentiation is one of the methods that is critically used to find the slope of the function at any point. The basis differentiation techniques are easy to apply, and are quite straightforward. In order to drive the expression for slope of y=6x^2 function for any value of x the basis differentiation rules require you to:

* Multiply the whole term by the value of x power, and
* Subtract 1 from the x power.

With the use of the aforementioned rule, the slope of the function becomes;

2 \* 6x2-1 = 12x

This is called y derivative with respect to x and is written dy/dx.

y = 6x2

216

54

24

6

0 1 2 3 4 5 6 x

The graph of the y=6x^2 function shows that any term in x2 would be increasing at an ever increasing rate as x is increased. In other words, the slope of the function must rise as x increases. The actual value of the slope could be estimated for any given value of x by entering the given value of x into the formula of Slope = 12x.

Consequently, the differential calculus is based on some fundamental concepts of the real numbers; limits, functions and continuity, which are highly significant concepts of mathematics that have been formulated and assigned with their modern content during the mathematical analysis development as well as during the studies of its foundation. (Rosser, 2018).

# Linear models

The linear equations are of paramount importance in the file of mathematics because they could be easily used to model any real world phenomenon, involving variable. The linear model is one form of the mathematical models that helps in understanding as well as exploring the meaning of the functional relationships and equations. The form of the linear function is as follows:

**y = f(x) = a + bx**

The graph shows negative, positive and zero relationship between dependent and independent variables, which are illustrated below:

Negative Zero Positive

The equation of the straight also referred to mathematical model of deterministic nature. In other words, the linear regression analysis is considered as the predictive tool for modeling the relationship between the variable with the set of the independent variable. The applications of the linear mathematical models are as follows:

* To model the casual relationship between parameters; the least square regression is used.
* The linear regression is used in customer survey results analysis and market research studies. (Chakure, 2019).

Thus, the application of the linear mathematical models in many areas, helps in understanding & predicting the behavior of complicated and complex systems or analyzing the financial, experimental and biological data. (Krukrubo, 2019). Additionally, the linear algebra is the mathematics of modern technological world of complicated multivariable systems. The linear transformation and the vector spaces are central themes of much of mathematics. (Tucker, 1993).

# Mathematical optimization

In economics, the mathematical optimization tends to provide the self-constrained introduction and it controls the techniques and surveys of mathematical programing and their application to dynamic and static problems in economics. (Intriligator, 2002 ). In addition to this, the mathematical optimization provides statistical foundation of an efficient usage as well as the utilization of the resources, and the applicability of the optimization theory to economics stems from its effectiveness in solving the problems of economic allocations. Not only this, it also helps in solving calculus optimization problems, which include: optimizing to both reduce the cost and maximize the revenue or to maximize the profit returns.

In the similar manner, the constraint optimization, which is also called mathematical programing model, is widely used in economic analysis for providing a valuable information and deeper insights into the behavior of the economic agents and for preparing of decision support system for playmakers and businessmen. The mathematical optimization is used as an instrument for the qualitative analysis and also for a wider range of applications in economies, which are as follows:

* Efficiency analysis.
* Industrial economics.
* International economics.
* Input-output economics.
* Quantitative economics.
* Environmental economics. (Pardalos, 2019).

In addition to this, one of the mathematical optimizations is the linear optimization, which is used to achieve the best outcome, such as: lowest cost or maximum profit in the mathematical model, the requirements of which are represented by the linear relationship. There are various elements of the model, which include: the constraints, decision variables and the objective function. Thus, the linear programing helps the economists in making processes that are both cost effective and efficient. On the other hand, the non-linear programming optimization is another method of the mathematical optimization model in which some of the objective functions or constraints are non-linear. Hence, the mathematical optimization using both linear programing and non-linear programing, provide valuable insights and information base for the optimum allocation of the scarce resources and it also helps in analyzing and evaluating the profit and cost of various alternatives.

# Game theory

The theory of game is one of the branches of the applied mathematics, which is widely used in economics. With the use of the theory of game; the real-world scenarios for various situations, such as: product releases as well as pricing competition, could be laid out and the outcomes could be estimated. The economist often use the theory of game in order to understand the behavior of oligopoly firm, and it also help to easily predict the likely outcomes and results when the firm tends to engage in certain behaviors, such as: collusion and price-fixing.

In addition to this, the wider application of the theory of game in economics ranges from the analysis of economic competition to the economic phenomenon, such as: voting theory, bargaining mechanism design, political economy, behavioral economics and experimental economics.

# Econometrics

The econometrics is the application of the methods of statistics to economic data for the purpose of giving an empirical content to the economic relationship. Econometrics is the use of the statistical methods and techniques to understand the test theories as well as economic issues. Modeling choices and preferences of customers with the use of the econometrics approach could improve the strategy of the firm, decision making and hence saves resources and costs as well. Additionally, it helps in decision making in areas where the risk factor is high, thus the econometric modeling could help in reducing the risk exposure as well as in predicting the outcomes with some probability to make the process of decision making considerably easier.

Moreover, the prediction of the demand from the customers could help to appropriately allocate the staff resources, thus the efficient staff allocation facilitates in meeting the needs of customers with less delay and without resources wastage. Hence, the econometrics modeling could drive the business ahead, helping in optimization of cost, better or smarter decision making and better understanding of the customer demand in the market. (Sarkar, 2020).

One of the methods of econometrics is the least square estimations, which is statistical procedures to find the best fit for the set of points of data by minimizing the sum of the residuals of point from the plotted curve. Another widely used method of the econometrics is the maximum likelihood estimation, which is used to estimate the parameters of the probability distribution by maximizing the function of likelihood. The reason of using the maximum likelihood estimate model is to get the robust parameter estimates.

# Matrix algebra

Matrix algebra is used in statistics for the purpose of expressing the collection of data and it is the art of manipulating matrix in a way that is similar to manipulating the ordinary numbers in ordinary algebra. The matrix is the set of the elements that is organized in the columns and rows.

a b

c d

Whereas a and b are the diagonal elements and c and d are the off-diagonal elements.

One important application of the algebra matrix in economics is that it helps in handling the large system of equations, and it also helps in testing for the existence of a solution to the system of equations before attempting to solve them. The matrix algebra involves various problems that tends to demonstrate the foundation expressions of matrix algebra as well as the illustration of using algebra for a number of economic problems and issues. (Shayle R. Searle, 2001).

# Minimization and maximization

The cornerstone of the economic thinking is that the people are supposed to be rational, and the rational behavior of the people means minimizing the cost and maximizing the profits, thus the rational households tend to maximize utility and the rational firms maximize the profits. Both utility maximizers as well as the profit maximizers need to minimize the costs. It is pertinent to note that the profit maximization objective could be achieved when the marginal revenue is equal to the marginal cost.

**Profit maximization marginal revenue (MR) = marginal cost (MC)**

Whereas, the rule of minimizing the cost of operations is that all the levels of the labor and capital, such as: marginal product of labor divided by wage is equal to the marginal product of capital divided by the capital rental price.

**MPL / w > MPK / r**

**MPL / w and MPK / r**

Whereas the profit function is as follows;

**Technical factors**

The use of fixed factors

Production function

**Cost function**

**C = Cc(q)**

**Profit function**

(q) = R(q) – Cc(q)

**Economic factors**

The price of the inputs

**Revenue function**

**R = R(q)**

**Market factors**

The type of competition

The market demand

In economics, the maximization of the profit is the short run and the long run process by which the out, input and price levels are determined by the organization, which lead the organization towards the highest profit returns. An assumption to the classical economics is that the organizations seek to minimize the cost of business operations and maximize the profit returns in order to lead the market. (Sampson, 2015).

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