ISSN 0975-4393 (Print)
2349-2988 (Online)
DOI: 10.5958/2349-2988.2017.00029.8

Vol. 09| Issue-01|
January -March 2017

Available online at
www.anvpublication.org

Research Journal of Science and Technology
Home page *www.rjstonline.com*

RESEARCH ARTICLE

Applications of Mathematics in Various Economic Fields

Minakshi
Department of Economics, Govt. College Barotiwala, Distt. Solan H.P.
*Corresponding Author E-mail:**minakshish65@gmail.com**

ABSTRACT:
This Paper describes the use of mathematics in various economic fields. Economics is incomplete without the use of mathematics. Mathematics and Economics go hand in hand. Economists use various mathematical tools for analyzing different economic theories. In research, we make use of mathematical equations to a large extent. Econometrics is an amalgamation of economic theory, mathematical economics, economic statistics, and mathematical statistics. Econometrics is mainly interested in empirical verification of economic theory. Econometrician uses the mathematical equations proposed by the mathematical economists but put these equations in such a form that they lend themselves to empirical testing. In research various mathematical tools are applied in analyzing different theories. Various Statistical tools as co-relation, average, t-test, Cai-square test and probable error and regression etc. are widely used. This paper gives an idea how mathematics is helpful in applying economics in solving various economic problems of an economy.

KEYWORD:

INTRODUCTION:

Mathematics and Economics go hand in hand. Economists use various mathematical tools for analyzing different economic theories. In research, we amalgamation of economic theory, mathematical economics, economic statistics, and mathematical statistics. Econometrics is mainly interested in empirical verification of economic theory. Econometrician uses the mathematical equations proposed by the mathematical economists but put these equations in such a form that they lend themselves to empirical testing. Broadly, Economics is divided into two major categories. Micro and Macro Economics, which was made by Ragnar Frisch. Micro Economics deals in individual behavior, while in Macro Economics economists describe all the problems of the economy as a whole. Various micro economics theories make use of mathematical equations from time to time.

APPLICATIONS IN MICROECONOMICS:

In the Demand theory ,DA= f(P_A , P_O , Y, T, E) means DA is function of P_A , P_O , Y, T and E, where DA is Demand for Commodity A. P_A is price of commodity A, P_O is price of another commodity , Y is income of consumer , T is taste of consumers and E is expectations of consumers. When we take into consideration Law of Demand we take other factors as constant factors as other things being equal. We take only two variable factors, price of A and Quantity of A. How price is going to affect demand Now let us take elasticity of demand. To measure price elasticity of demand with the help of proportionate method we use

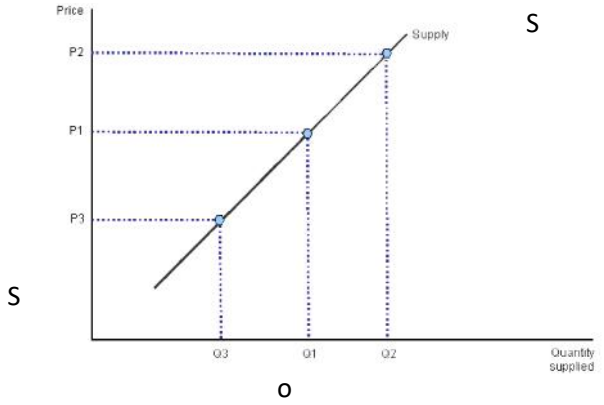
$$E_d = -\frac{Q\Delta}{P\Delta} \times \frac{P\Delta}{Q\Delta},$$

where Q is Change in Quantity demanded and P is

change in price and P and Q as original price and quantity demanded. With the help of this formula we are able to measure the percentage change in quantity demanded due to percentage change in price. Supply function shows the relationship between supply of the commodity and factors affecting supply, described as:

$S_x = f(P_x, P_R, C_P, S_t, N_P, G_P, E_P, O_P, T_P)$

Where, S_x = Supply of x, P_x is price of x, P_R is price of related goods, C_P is price of inputs, S_t is technical situation, EP is expectation of future price, Op is objectives of firm, Tp is time period, Price of commodity and quantity supplied are positively related to each other.



In this Curve SS is supply curve which is positively related to price when price is OP_1 then Quantity supplied is OQ_1. When price increases to P_2 then Quantity increases to Q_2 and vice versa.

Now let us take up production function, $P_x = f$ (B, L, K ,E) where ,P_x is Production of X , B= Land, L= Labour, K= capital, E = Entrepreneur . Production of X is the function of Land, Labour, Capital and Entrepreneur. Condition for producers equilibrium is given as below:

$$W/R=MPL/MPC = MRTS_{LC}$$

Where, W= price of capital , R is price of Labour, MPL = Marginal productivity of Labour and MPC = marginal Productivity of capital. $MRTS_{L\,C}$ is Marginal Rate of technical substitution of Labour and Capital.

Now let us take up Cost Function,
Long Run Cost Function: C =f (Q, T, Pf)
Short Run Cost Function: C =f (Q, T, Pf, K)
Where C = Total cost, Q= Output, T= Technology, Pf = Price of factors, & K = Fixed factors.

It means Long run, short run costs of production are function of so many factors discussed above. Thus in micro economics, various micro economic theories are explained with the help of mathematical equations.

APPLICATIONS IN MACRO ECONOMICS:

Now we take up some macro economic theories based on mathematical equations.In classical theory of employment, level of employment is determined by level of production and demand for labour and supply of labour .

$$P = f (N, K, L, T)$$

In the short run (K) capital, (L) land, (T) Technique are held constant, hence level of production depends upon level of N.

$$P = f (N)$$

$$ND= f (W/P)$$

Demand for labour is function of W/P Real Wages.

$$NS = f (W/P)$$

Supply of labour is function of W/P real wages. P is price level, W is money wages

$$ND=NS$$

Demand for Labour = Supply of Labour

Level of N is determined where demand for labour is equal to supply of labour.
In quantity theory of money, PT= MV+M'V'
Demand for money = Supply of money.
M=Quantity of money in the economy, V= Velocity of circulation of money
M' = Quantity of credit money, V' = Velocity of circulation of credit money.

In Keynesian theory of effective demand the level of employment is determined at the point where aggregate demand is equal to aggregate supply. In Keynesian theory, demand is more effective factor than supply. He concludes that if we want to remove depression from the economy we have to increase demand not supply. The equilibrium may be at less than full-N, where AD=AS. In equilibrium, in four sector model;

$$I+ G+ M = S+ T+ X,$$

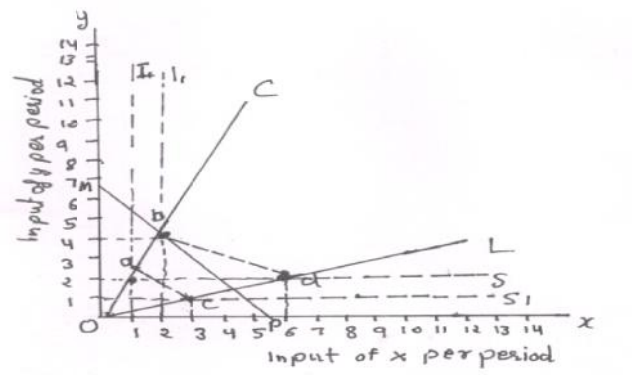
Aggregate Demand= Aggregate Supply

Where I is Investment, G is Government Expenditure, X is exports expenditure on exports and S is savings, T is Tax, and M is Imports.

In describing various problems of economy, Macro Economic theories are very helpful. For eg. If economy is facing problem of depression , trade cycles, low growth rate, inflation, international liquidity, devaluation of currency, unemployment, under-employment and adverse balance of payment. Macro economic theories which are analyzed by making use of mathematical equations give solution to these basic problems of world economies. These important macro economic theories as consumption function, Theory of effective demand, different growth models, trade cycle theories which help solving all the problems of economy. To stabilize our economy by smooth functioning of all the sectors we need efficient use of fiscal and monetary policies. These theories help us to solve all the economic problems which are necessary for steady state growth.

APPLICATIONS IN PLANNING:

Linear programming technique has turned out to be a highly useful tool for analysis in development planning. In linear programming definite objective is set to maximize income and minimize cost. Input-Output analysis, which is based on matrix method is used to describe inter-relationships between various sectors and the structural relationships between each sector. On the other hand demand, Supply, Production function are used in describing various micro economic theories. Linear Programming is a mathematical device developed by mathematician George Dantzig in 1947 for planning. It applies to those problems which require the solution for maximization or minimization. Problems subject to system of linear inequalities and stated in terms of certain variables. It is defined as a method to decide optimum combination of factors to produce a given output. In plan formulation the planners have to decide whether to use labour intensive or capital intensive technique of production, depending on its outlay. Let us suppose that it is planned to produce a commodity Z, using X & Y inputs, its objective is to maximize output. It has two alternative production processes (Capital intensive) and (Labour Intensive).The constant is the given cost outlay as shown in the figure.



Units of Y (input) per period are measured along the vertical axis and units of X (input) per period are shown on horizontal axis. If process C requires two units of Y to every unit of input X, it will produce 50 units of commodity Z. if the inputs of X and Y are doubled to four units of Y and two units of X ,output is also doubled to 100 units of Z. These combinations of X & Y are represented by a & b, establish the output scale along the capital intensive process ray OC. On the other hand same units 50 of good Z can be produced by process L by combining three units of X with one unit of Y. 100 units of Z can be produced by doubling the inputs X & Y to 6 units of X and 2 units of Y. These outputs scales are established along the labour intensive process ray OL, as represented by input combinations c & d. If points a & c at 50 units output level on the linear ray OC & OL are joined, they form an isoquant (shown dotted) $Iacs_1$. At the 100 units output level the corresponding isoquant is I_1bds. The cost restraint is represented by iso cost curve mp and it places a limit on the production capacity of the project. The project can be produced with either of the two available techniques C and L with in the area represented by the triangle Obd. In the same way Input – Output technique is used in planning. It tells us that there are industrial inter relationships and inter dependencies in the economic system as a whole. The inputs of one industry are the outputs of another industry and vice versa. The input output table relates to the economy as a whole in a particular year. It shows the values of the flows of goods and services between different productive sectors especially inter industrial flows. A three sector economy is taken in which there are two inter industry sectors, agriculture industry and one final demand sector. An economy behaves and assumes a certain pattern of flow of resources in two ways. They are (a) the internal consistency or balance of each sector of the economy. (b) the external stability of each sector or inter-sectoral relationships. Leontief calls them the fundamental relationship of balance and structure, when expressed mathematically they are known as “balance equations” and the structural equations. If the total output of X_i of the i^{th} industry be divided into various number of industries 1, 2, 3, n, then we have the balance equation,

$$X_i=X_{i1}+X_{i2}+X_{i3}+\_\_\_\_\_+X_{in}+ D_i \text{ ----------(1)}$$

If the amount say Y_i absorbed by the outside sector is also taken into consideration , then the balance equation of the i^{th} industry becomes,

$$X_i=X_{i1}+X_{i2}+X_{i3}+\_\_\_\_\_+X_{in}+D_i+Y_i$$

$$\text{Or} \quad \sum_{j=1}^{n} Xij + Yi = Xi\text{----------(2)}$$

Y_i stands for the sum of flows of the product of the i^{th} industry , to consumption, investment and exports , net of imports etc. It is also called “Final bill of goods” which it is the function of the output to fill. The balance equation shows the conditions of

equilibrium between demand and supply. It shows the flows of output and inputs to and from one industry to other industries and vice versa.

The system of balance equation in the analysis presents the conditions of internal consistency of the plan. Since X_{i2} stands for the amount absorbed by the industry 2 i^{th} industry it follows that X_{ij} stands for the amount absorbed by the j_{th} industry of ith industry. The input co-efficient of ith industry is denoted by,

$$a_{ij} = X_{ij} / X_j - \quad (3)$$

Where X_{ij} is the flow from industry i to j, X_j is the total amount of industry j a_{ij} is constant called technical co-efficient in the i^{th} industry. The technical co-efficient shows the no. of units of one industry's output that are required to produce one unit of another industry's output. Equation 3 is called structured equation . It shows that the output of one industry is absorbed by all industries so that flow structure of entire economy is revealed. The number of structural equations give a summary description of the economy's existing technological conditions. The matrix of technical co-efficient of production for any input-output table with n sectors would consist of n×n elements. There being two sectors for example :, 2×2 technical co-efficients of matrix would be arranged as follows.

	Technology Matrix A	
	Agriculture	Industry
Agriculture	a_{11}	a_{12}
Industry	a_{21}	a_{22}

The matrix shown above describes how output of one sector is used as input in other sector as a_{11}. Agriculture output is used in agriculture sector as input as a_{12} shows how agricultural output becomes input in Industry and so on.

APPLICATIONS IN OTHER FIELDS OF ECONOMICS:

We use quadratic equations for the solution of various economic problems as demand is equal to supply gives equilibrium price. We can find out equilibrium price by applying quadratic equations. In the same way different differential equations are used in economics in the determination of elasticity of demand, concepts of costs, Revenue, Marginal revenue product, Marginal physical product, and Marginal product etc. Maxima and minima are used to find out maximum output and minimum cost. The two major objectives in production are maximization of output and minimization of cost. Application of partial derivatives in Euler's Theorem is based on homogeneous production. A function V = f (x y) is homogeneous of degree h if, $f(t_x, t_y) = t^h f(x,y)$, where h is a constant and t is any positive real number. A standard mathematical result of Euler's theorem is that if a production function involves constant returns to scale then sum of marginal products will actually add upto the total product. Thus if a linear homogeneous production function be

$$P = f(L, C) \text{ , the Enler's theorem}$$
$$P = L \quad \partial f / \partial L + C \ \partial f / \partial C$$

Since $\partial f / \partial L$ is the marginal product of labour and Jf/JC is the marginal product of capital , the equation states that the marginal product of labour multiplied by number of laborers (each of whom is paid this amount) plus the corresponding total payment to capital equals the total product P. On the other hand partial derivatives are also used in describing discriminating monopoly and production function and elasticity of substitution which is explained with the help of Cobb-Douglas production function. Now let us econometrics which is concerned with the empirical determination of economic laws. Econometrics provide such numerical estimates which tells us how much is the change in demand due to change in price. But laws of economics as law of demand is unable to describe how much is decrease in demand due to increase in price. Thus econometrics make it possible to apply mathematical statistics to economic data with empirical support to models constructed by mathematical economics and to obtain numerical results. Various micro and macro economic theories are practically implemented in equational forms with the help of econometric forecasting, research in various fields is made possible with the use of econometrics. Statistical tools are used in research as average is helpful in comparison if we have to compare per capita income of two countries. It is possible with the help of average Parametric and non- parametric test as T-test, F test and cai-square test, sign test, median test are used to find accuracy in research. In the same way other methods as regression, correlation method, least squares and sampling methods are used in research which is helpful in solving various economic problems.

REFERENCES:

1. Keynes, Post Keynesian Economics; R.D Gupta; Kalyani Publications, New Delhi-Ludhiana, Revised Edition (1983).
2. Lectures on Elementary mathematics; Ramesh Chander; New Academic Publishing Co. Jalandhar, 5th edition (1996).
3. Basic Statistics for Economists; T. R. Jain, Dr. S.C. Aggarwal, Dr. R.K Rana; VK (India) Enterprises New Delhi-2, Latest Edition (2007).
4. Basic Econometrics; D. N. Gujarati; McGraw-Hill Inc. New Delhi, International Edition (1995).
5. Economics of development and Planning; M. L. Jhingan; Vrinda Publications New Delhi, 36th revised Edition (2003).
6. Advanced Economic Theory; H. L. Ahuja; S. Chand Publications New Delhi (2007).

Received on 15.11.2016 Modified on 30.11.2016
Accepted on 06.12.2016

Research J. Science and Tech. 2017; 9(1):175-178.