Pinky Rani
Assistant Professor (Guest Faculty)
Department of Economics
Maharaja College
Veer Kunwar Singh University, Ara
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INTRODUCTION

In Economics, the concept of derivative plays a very important role in decision making. The marginal functions used in economics that is defined as the change of one variable with respect to another variable uses the concept of derivative. Many economic models are constructed in continuous time and use the time derivative. For example, the economic cycle or business cycle or trade cycle represents a wave of the Gross Domestic Product(GDP). The fluctuations mean a change, and the rate of change is measured using the concept of derivative.

20.10 Application of Differentiation in Economic Theories

Differentiation is extensively used in economic research to study functional relationships between economic variables. Below are few examples:

1. **Microeconomic Theories** such as the Demand Theory uses derivative to measure the price elasticity of demand, income elasticity of demand and cross elasticity of demand.

$$e_p = \frac{dQ}{dP} \times \frac{P}{Q}$$

Here,

e_p is the price elasticity of demand

P is the price

Q is the quantity demanded

$\frac{dQ}{dP}$ is the change in quantity demanded with respect to change in price

2. **Macroeconomic Theories** such as the Theory of Consumption uses derivative to study the marginal propensity to consume and the marginal propensity to save. Marginal Propensity to Consume (MPC) is defined as the change in consumption when income changes and Marginal Propensity to Save is the change in Savings when income changes.

Therefore, in the consumption function,

$$C = a + m\,(Y - T)$$

C is induced consumption, Y is income, T is tax, m is the MPC defined as $\frac{dC}{dY}$ and 'a' is autonomous consumption.

3. **Theories of Growth** such as the Harrod Domar Growth Model use the dot notation of derivative. According to this model, the output growth rate is equal to the savings rate times the marginal product of capital minus the depreciation rate. Dot notation ($\dot{Y}$) is used for the derivative of a variable with respect to time.

Mathematically,

$$\frac{\dot{Y}}{Y} = sc - \delta$$

Here,

$\frac{\dot{Y}}{Y}$ is the output growth rate; s is savings rate, c is marginal product of capital and δ is the depreciation rate.

4. **Theory of Distribution** uses the Euler's Theorem. If the total output (Q) is a function of two inputs, Labour (L) and Capital (K), then the production function may be represented as $Q = f(L, K)$. If $Q = f(L, K)$ is linearly homogenous, then

$$K\frac{\partial Q}{\partial K} + L\frac{\partial Q}{\partial L} \equiv Q$$

The economic interpretation of this theorem is that, under constant returns to scale, if each input is paid an amount equal to its marginal product, $\frac{\partial Q}{\partial K}$, the marginal product of capital and $\frac{\partial Q}{\partial L}$, the marginal product of labour, the total product (Q) will be exactly exhausted.