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ANALYSIS OF DEMAND, SUPPLY, AND REVENUE FUNCTIONS USING DERIVATIVES

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Abstract: This article examines the use of mathematics in economics with a focus on marginal analysis and production optimization, the application of the hosilae to economics, and in the context of elastic demand and supply analysis. The article reveals the importance of mathematical methods and concepts in economics, their use in analyzing problems and finding optimal solutions, as well as their role in understanding market processes and making economic decisions.

Key words: marginal analysis, hosilae, microeconomics, optimization, maximization, minimization, elasticity, market equilibrium.

Modern mathematics is distinguished by its intensive integration into other sciences. Mathematics has become a precise research method for many fields of knowledge and a means of formulating concepts and problems with great accuracy. Without modern mathematics, which possesses a developed logical and computational apparatus, progress in various areas of human activity would not have been possible.

One of the main applications of derivatives in economics is the study of marginal analysis. Marginal analysis involves examining incremental changes in economic variables such as production, consumption, or cost, and their impact on the overall system. The use of derivatives allows economists to determine the marginal effects of these changes by calculating the derivatives of relevant functions. For example, the derivative of a production function can provide insight into the marginal product of labor or capital, which is essential for determining optimal input levels and making production decisions.

Marginal analysis is particularly important in microeconomics, where it is used to analyze firms' production decisions, consumer behavior, and market equilibrium. Economists can determine the marginal utility of a good by taking the derivative of the utility function with respect to consumption, thereby understanding how an individual's consumption choices change with variations in income or prices. Similarly, in the case of firms, derivatives enable economists to analyze how changes in input prices or technology affect a firm's production decisions and output levels.

Another important application of derivatives in economics is in the field of **optimization**. Economists often aim to optimize economic variables such as utility or cost by finding the maximum or minimum points of the corresponding functions. By taking the derivative of the objective function and setting it equal to zero, economists can identify **critical points** that represent potential optima. These points help determine the optimal level of production, pricing strategies, resource allocation, and other key economic decisions.

Below, we will consider problems related to **cost minimization** and **profit maximization**.

Suppose a firm's **demand function** is ($P(Q)$) and its **cost function** is ($TC(Q)$). It is required to determine the level of output that maximizes the firm's revenue or minimizes its costs.

First, let's examine the method for determining the level of production that maximizes the firm's revenue. For this purpose, we write the firm's **total revenue function** as:

TR = P

where (TR) is the firm's total revenue, (P) is the product price, and (Q) is the quantity produced.

Using the given demand and cost functions, we express total revenue as a function of (Q), i.e., (TR(Q)), and then find its **critical points**. To do this, we take the **first derivative** of (TR(Q)) and set it equal to zero:

TR'(Q) = 0

The solution to this equation, (Q = Q_1), gives the output level that provides an **extreme value** of the revenue function.

To determine the **nature of the extremum**, we take the **second derivative** of the revenue function and check its sign. If

TR''(Q_1) < 0

then the function (TR(Q)) reaches its **maximum** value at (Q = Q_1).

Thus, if the firm produces (Q = Q_1) units of output, its revenue will be maximized.

Optimization is applied in various economic contexts. For example, in **production theory**, economists aim to minimize costs while maximizing production. By taking derivatives of the **production function** and the **cost function**, they can determine the **optimal combination of inputs** that minimizes costs for a given level of output.

Similarly, in **consumer theory**, economists use derivatives to analyze problems of **utility maximization**, where individuals seek to maximize their satisfaction (utility) subject to **budget constraints** and given prices.

Derivatives are also used in **the analysis of elasticity** in economics. Elasticity measures how responsive one economic variable is to changes in another. For example, **the price elasticity of demand** measures the percentage change in the quantity demanded resulting from a 1% change in price. By taking the derivative of the demand or supply function with respect to the relevant variable, economists can calculate **elasticity coefficients**. The values of elasticity are crucial for understanding market dynamics, determining prices, and conducting policy analysis.

The **price elasticity of demand** measures the percentage change in the quantity demanded as a result of a 1% change in price. This helps economists understand how sensitive the demand for a product is to changes in its price.

Every change in the price of a product affects its demand and supply. The indicator that shows the effect of a price change on demand is called **demand elasticity**. This indicator is expressed as the ratio of the relative change in demand to the relative change in price.

Demand elasticity is denoted as EQD(P)E_{Q_D}(P)EQD (P) and is determined by the following formula:

$$E_{QD}(P)=\frac{\frac{\Delta Q_D}{Q_D}}{\frac{\Delta P}{P}}$$

here:

Q_D- the quantity of output produced to satisfy demand (D).

$\frac{\Delta Q_D}{Q_D}$ – relative change in demand.

$\frac{\Delta P}{P}$ – relative price change.

In macroeconomics, derivatives are used to analyze economic growth rates and fluctuations. The concept of a derivative is applied to variables such as gross domestic product (GDP) to calculate growth rates and identify turning points in the business cycle. By studying the rate of change of these variables, economists gain insight into the health of the economy, the effectiveness of policy measures, and the potential impact of economic shocks. Derivatives are used to calculate the growth rates of macroeconomic variables such as gross domestic product (GDP), investment, consumption, and employment. The growth rate represents the percentage change in a variable over a given period of time. By taking the derivative of a variable with respect to time, economists can determine the rate of change in the variable. This provides insight into the rate of economic growth or contraction. For example, to calculate the annual growth rate of gross domestic product, economists take the derivative of GDP with respect to time (usually measured in years) and express it as a percentage. A positive growth rate indicates that the economy is expanding, while a negative growth rate indicates that it is contracting. By studying the pattern of growth rates over multiple periods, economists can identify trends, cycles, and potential reversals in economic performance.

Summary:

Based on the above information, it can be concluded that the use of derivatives in economics is diverse and covers various sub-sectors. It allows economists to analyze marginal effects, optimize variables, determine elasticity, evaluate financial instruments, and study macroeconomic trends. Derivatives provide important tools for understanding economic relationships, making informed decisions, and formulating economic policies.

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