Application of Economic Functions

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THE CONTENTS

PREFACE

The twelfth consecutive International Scientific Conference "Employment, Education and Entrepreneurship" (EEE 2023), organized by the Faculty of Business Economics and Entrepreneurship, was held on October 27, 2023.

Over 130 authors and co-authors submitted 60 papers for the conference, of which 24 were from abroad. It should be noted that the works were sent by authors from Romania, North Macedonia, Croatia, Bosnia and Herzegovina, Slovenia, Hungary, Bulgaria, Italy, Philippines, Morocco, Poland, Malaysia, Great Britain, Ukraine, China, Montenegro, Turkey, Nigeria, Botswana, Sweden, Tunisia, Zimbabwe, Australia and Norway.

The main goal of the conference was to come to a conclusion about how to contribute to the increase in employment, the improvement of the quality of education and the development of entrepreneurship in Serbia and the countries of the region through the presentations of experts from theory and practice who deal with the mentioned problems.

All papers were reviewed and after certain corrections were accepted for presentation and printing in the Proceedings. The conference took place in separate units: plenary part, round table and work by sessions. The plenary part of the conference had the theme of employment, education and entrepreneurship in modern times, in which panelists made presentations related to female entrepreneurship in Africa, business project management (BPM) and the concept of 4E (Employment, Enterprise, Entrepreneurship and Employability).

Since technologies are changing at a high speed and their impact is crucial for business, education and entrepreneurship, it is necessary to adapt to these new conditions. In this sense, education is faced with new challenges that impose different behavior, adaptation, flexibility and closer cooperation with the National Employment Service. The education of personnel who are not prepared for the market is not productive, so it is necessary to change the structure of educational programs and continuously adapt teaching to the demands of the market. Special emphasis is placed on international cooperation, through which one can see one's own possibilities and work on their improvement.

The tradition of holding an international scientific conference indicates the willingness of the Faculty of Business Economics and Entrepreneurship to persevere in efforts to align its social activities with new requirements, obstacles and challenges. The continuity of holding the conference is reflected in the fact that in the twelve years of its holding, more than ten volumes of thematic collections with over 1000 published papers have been generated.

We hope that the acquired knowledge, experiences and exchange of opinions will help the participants to embark on new scientific endeavors, in research that is the basis of understanding the state and relationships in the world and around us, and that they will take the initiative to prepare new scientific papers for our next conference in 2024 . years.

In Belgrade, October 2023

Editors

APPLICATION OF ECONOMIC FUNCTIONS

Bojan Radišić[1]
Mirjana Radman-Funarić[2]
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ABSTRACT

Economic functions are the backbone of business, a crucial concept in economics. They describe the relationship between different economic variables and play a significant role in modeling real economic situations. Economic functions enable drawing conclusions about how changes in factors like prices, income, or consumer preferences will affect demand, supply, and prices. The goal in most economic situations is to achieve optimal outcomes, such as profit maximization or cost minimization. Cost functions, as one of the economic functions, allow the application of mathematical methods like differential calculus to determine the best actions or resources that will achieve economic goals. Economic functions are a tool that helps economists quantitatively analyze economic phenomena, make decisions, and shape policy. Their use contributes to a better understanding and management of the economy, aiding in the development and interpretation of economic concepts such as supply and demand. Knowledge of economic functions is crucial for understanding and improving business.

Key words: *economy, economic function, business, mathematical method*
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ECONOMIC FUNCTIONS

Mathematical functions used to describe economic phenomena are called economic functions. They form the foundation of economic theory, allowing the modeling and prediction of the behavior of economic agents, such as consumers and producers. They also analyze how changes in economic conditions reflect on the overall economy. Economic functions are instrumental in making business decisions, such as setting product prices, determining optimal levels of production and costs, and devising marketing strategies. Ultimately, economic functions enable mathematical modeling and understanding of complex economic processes, supporting informed decision-making in the field of economics.

The most commonly used economic functions include: demand function, supply function, production function, cost function, revenue function, and profit function.

The concept of demand indicates the quantity of a product or service consumers are willing and able to buy at various prices within a specific time frame. "The quantity demanded for products or services is the amount consumers plan to spend at a given moment and place to purchase a certain type of goods or services at different (alternative) prices." (Karić, 2006). The demand function $f(p) = a - bp$ can also be represented by a mathematical expression. The demand function expresses a linear relationship between the price 'p' and the quantity demanded 'f(p)', where 'a' and 'b' are constants determining the shape and slope of the function.

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Supply indicates the quantity of products or services that producers are willing and able to offer at different prices over a specific time period. "Supply is the readiness of producers to offer, at a certain time and place for sale, a certain quantity of a good or service at different (alternative) prices." (Karić, 2006).

When supply meets demand, the market is in equilibrium. In this state, prices stabilize, and the quantity of trade is maximized. At the equilibrium point, buyers are willing to purchase as much as sellers are ready to offer. "Thus, the free decisions of buyers and sellers are in a position to establish the equilibrium price. It cleanses the market in the sense that it does not know market surpluses that would burden producers nor market shortages that would frustrate consumers." (Ferenčak, 2003, 28).

The production function is an economic concept that describes the relationship between investment in production factors (labor, capital, raw materials) and the quantity of products or services a company can produce. The production function can be expressed in the form of an equation or a graph illustrating the quantity of products a company can produce concerning the quantity of invested production factors.

The cost function is an economic concept that describes the relationship between the quantity of production factors used in the production process and the total costs incurred by the company. The cost function is one of the key concepts in economics as it enables companies to analyze and optimize their production costs. Based on the cost function, companies can make decisions regarding the selection of optimal combinations of production factors, achieving economies of scale, determining product prices, and gaining a competitive advantage.

The revenue function is an economic concept that describes the relationship between the quantity of products or services a company sells and the total revenue the company generates from sales. The revenue function is usually depicted as linear or nonlinear, depending on the nature of the market and consumer behavior. In a linear revenue function, revenue increases proportionally with the increase in the quantity of products sold. This relationship assumes that the price of the product remains constant regardless of the quantity sold.

The profit function is an economic concept that describes the relationship between a company's revenue and costs, resulting in the total profit the company earns. The profit function can be expressed mathematically or graphically to illustrate the impact of changes in revenue and costs on the overall profit. In its simple form, the profit function can be expressed as: $Profit = Revenue - Cost$. The analysis of the profit function allows companies to identify the optimal level of production or sales strategy to achieve maximum profit.

PARTIAL DERIVATIVES IN ECONOMIC FUNCTIONS

Partial derivatives measure how the value of a function changes concerning the change in only one of the independent variables, while all other variables are considered constant. This operation is particularly crucial in multidimensional calculus and the analysis of functions with multiple variables.

It is noteworthy that the partial derivative $\partial_i f(P_0)$ is, in fact, the "ordinary" derivative at the point P_0, constrained by the function f on the direction through P_0 that is parallel to the i-th coordinate vector. (Ungar, 2005)

Partial derivatives are a fundamental tool in the analysis of functions with multiple variables and are essential for understanding changes in economics, engineering, physics, and many other scientific disciplines.

Extrema of Functions

Function $f(x,y)$ is called a function of two variables dependent on two independent variables x, y. The domain of the function $f(x,y)$ is the set of all ordered pairs (a,b) where a is from the set of values that the variable can take x, while b s from the set of values that the variable can take y: $(x,y) \to f(x,y)$. The graph of function $f(x,y)$ of two variables x and y is a set of all points that form a surface in three-dimensional space R^3 (Neralić & Šego 2009).

Definition: Function $f(a,b)$ is called a **local maximum** if there exists a circle in the domain of f with the center in (a,b) such that:

$$f(a,b) \geq f(x,y)$$

for every point (x,y) in the domain. (Barnett et al., 2006)

Definition: Function $f(a,b)$ is called a **local minimum** if there exists a circle in the domain of f with the center in (a,b) such that:

$$f(a,b) \leq f(x,y)$$

for every point (x,y) in the domain. (Barnett et al., 2006). Points of local minima and maxima are called points of **local extremes**.

Theorem 1 (Necessary condition for extremes) Let $T = f(a,b)$ be a point of local extremum of the function $f(x,y)$ then all first partial derivatives are equal to 0:

$$\frac{\partial f(a,b)}{\partial x} = 0 \quad (1)$$

$$\frac{\partial f(a,b)}{\partial y} = 0 \quad (2).$$

A point where all first partial derivatives are equal to zero is called a **stationary point**.

Theorem 2 (Sufficient condition for extremes) Let $T = f(a,b)$ be a stationary point of the function $f(x,y)$ and let H determinant be defined as:

$$H = \begin{vmatrix} \dfrac{\partial^2 f(a,b)}{\partial x^2} & \dfrac{\partial^2 f(a,b)}{\partial x \partial y} \\ \dfrac{\partial^2 f(a,b)}{\partial x \partial y} & \dfrac{\partial^2 f(a,b)}{\partial y^2} \end{vmatrix}$$

1. If $H > 0$ tada funkcija ima ekstrem u $f(a,b)$:
   a. For $\frac{\partial^2 f(a,b)}{\partial x^2} > 0$ then the function has a local minimum at T,
   b. For $\frac{\partial^2 f(a,b)}{\partial x^2} < 0$ then the function has a local maximum at T.
2. If $H > 0$ the function does not have an extremum at point T.
3. If $H = 0$ further examination is required to determine if there is an extremum at point T.

Function Elasticity

In accordance with the definition of demand, a reduction in the price of a product stimulates the demand for it, just as a higher price reduces demand. Elasticity of the function is a concept that measures the relationship between the change in one variable (most commonly price) and the change in another variable (most commonly quantity demanded or supplied). The elasticity of the function enables the analysis of the market's reaction to changes in prices, income, costs, or other factors.

The coefficient of partial elasticity of two variables $f(x, y)$ with respect to the variable x is defined as follows:

$$E_{f,x} = \frac{x}{f(x,y)} \frac{\partial f(x,y)}{\partial x} \tag{3}$$

The coefficient of partial elasticity $E_{f,x}$ na razini $(x, y) = (x_0, y_0)$ approximately explains the percentage increase in function value f, if variable x from the level x_0 increases by 1%, and variable y remains unchaged.

The coefficient of partial elasticity of two variables $f(x, y)$ with respect to the variable y is defined as follows:

$$E_{f,x} = \frac{y}{f(x,y)} \frac{\partial f(x,y)}{\partial y} \tag{4}$$

The coefficient of partial elasticity $E_{f,x}$ on level $(x, y) = (x_0, y_0)$ approximately explains the percentage increase in function value f, if variable x from the level y_0 increases by 1%, and variable x remains unchanged.

If the coefficient of partial elasticity is greater than 1 (in absolute value), it indicates elastic demand, meaning that a change in price has a relatively large impact on the change in demand. If the price elasticity is less than 1, it indicates inelastic demand, meaning that a change in price has a relatively small effect on the change in demand. If the coefficient of partial elasticity is equal to 1, it is unitary elasticity, where price and demand change equally. (Chiang, A.C., 1994).

Cross-elasticity coefficients are a special case of partial elasticity coefficients and describe the behavior of the demand function for one product when the price of another product changes:

- The product is a normal good if an increase in the price of that product (good) causes a decrease in the demand for that good.
- The cross-elasticity coefficient is positive; the products are substitutes – if an increase in the price of one leads to an increase in the demand for the other (e.g., coffee and tea).
- The cross-elasticity coefficient is negative; the products are complements – if an increase in the price of one leads to a decrease in the demand for the other (e.g., coffee and sugar).

APPLICATION OF ECONOMIC FUNCTIONS IN TRADE

With the aim of achieving and maximizing profit, specific business segments in the company have been analyzed to provide insights into functions crucial for managing operations and making strategic decisions. It is essential to determine the dependencies of the demand functions for product A and product B.

The store offers two types of products: product A and product B. When acquiring tools, each unit of product A is purchased at a price of 2 euros, and each unit of product B at 3 euros. The company has assessed the equations of daily demand for these two products:

$x(p_1, p_2) = 75 - 40p_1 + 25p_2$ (demand for product A)

$y(p_1, p_2) = 80 + 20p_1 - 30p_2$ (demand for product B)

where p_1 is the selling price of a product A and p_2 the selling price of product B.

The daily cost function is known:

$$T(p_1, p_2) = 2x + 3y.$$

Firstly, to determine the dependencies of the demand functions for product A and product B, the calculation of partial and cross-elasticities was performed at the price levels $p_1 = 2$ euros and $p_2 = 3$ euros. According to formulas (3) and (4), it follows:

$$Ex_1(p_1, p_2) = \frac{-40p_1}{75 - 40p_1 + 25p_2}$$
$$Ex_1(2{,}3) = -1{,}1429$$

$$Ey_1(p_1, p_2) = \frac{20p_1}{80 + 20p_1 - 30p_2}$$
$$Ey_1(2{,}3) = 1{,}3333$$

$$Ex_2(p_1, p_2) = \frac{25p_2}{75 - 40p_1 + 25p_2}$$
$$Ex_2(2{,}3) = 1{,}0714$$
$$Ey_2(p_1, p_2) = \frac{-30p_2}{80 + 20p_1 - 30p_2}$$
$$Ey_2(2{,}3) = -3$$

If the price p_1 increases by 1%, while p_2 remains the same with prices $p_1 = 2$ and $p_2 = 3$ euros, the value of the demand function for product A will decrease by 1.14%. In the case where the price of p_1 remains the same, and p_2 increases by 1% at the same prices, the demand for the specified product will increase by 1.07%. The products are substitutes.

Similarly, the value of the demand function for product B will increase by 1.33% if the price of p_1 increases by 1%, and p_2 remains the same with prices $p_1 = 2$ € and $p_2 = 3$ €. In the case where the price of p_1 remains the same, and p_2 increases by 1% at the same prices, the demand for the specified product will decrease by 3%. The products are substitutes.

Therefore, from the solutions, it can be concluded that product A and product B are substitutes. This result is logical since they are related products sold by the same trading company. An increase in the price of one product from this company leads to an increase in the demand for the other product.

Furthermore, the daily costs of the trade are given by the formula:

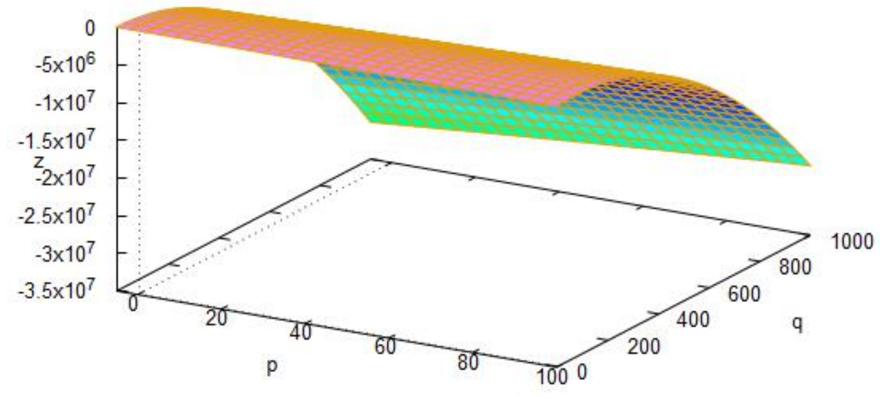
$$T(p_1, p_2) = 2x + 3y.$$

The revenue function is determined by multiplying the demand function by the product price. Thus, the demand function for product A is multiplied by the selling price of product A, and the demand function for product B is multiplied by the selling price of product B. To obtain the total revenue, these two functions are summed up:

$$R(p_1, p_2) = p_1 \cdot x(p_1, p_2) + p_2 \cdot y(p_1, p_2)$$
$$R(p_1, p_2) = 75p_1 + 80p_2 + 45p_1p_2 - 40{p_1}^2 - 30{p_2}^2$$

During the analysis of business components, the profit function is calculated by subtracting expenses from revenue.

$$P(p_1, p_2) = R(p_1, p_2) - T(p_1, p_2)$$
$$P(p_1, p_2) = 95p_1 + 120p_2 + 45p_1p_2 - 40{p_1}^2 - 30{p_2}^2 - 390$$



Graph 1: Trade revenue function

Source: authors

When determining the maximum revenue, we employ the method of critical points in the theorems of necessary and sufficient conditions for extrema.

$$H = \begin{pmatrix} \frac{\partial^2 P}{\partial {p_1}^2} & \frac{\partial^2 P}{\partial p_1 \partial p_2} \\ \frac{\partial^2 P}{\partial p_2 \partial p_1} & \frac{\partial^2 P}{\partial {p_2}^2} \end{pmatrix}$$

$$\frac{\partial^2 P}{\partial {p_1}^2} = -80$$

$$\frac{\partial^2 P}{\partial p_1 \partial p_2} = 45$$

$$\frac{\partial^2 P}{\partial {p_2}^2} = -60$$

$$\frac{\partial^2 P}{\partial p_2 \partial p_1} = 45$$

$$detH = \begin{vmatrix} -80 & 45 \\ 45 & -60 \end{vmatrix}$$

$$detH = -80 \cdot (-60) - 45 \cdot 45$$

$$detH = 2775$$

Given that the second derivative of the profit function with respect to p_1 at the stationary point is less than zero, and the determinant of the Hessian matrix is greater than zero, the maximum of the function can be calculated using formulas (1) and (2):

$$80p_1 - 45p_2 = 95 / \cdot 9$$

$$45p_1 - 60p_2 = -120 / \cdot (-16)$$

$$720p_1 - 405p_2 = 855$$

$$-720p_1 + 960p_2 = 1920$$

$$555p_2 = 2775 / : 555$$

$$p_2 = 5$$

$$80p_1 = 95 + 45 \cdot 5$$
$$80p_1 = 320 /: 80$$
$$p_1 = 4$$

The profit function attains a local maximum at a point M(4,5).

$$P(p_1, p_2) = 95p_1 + 120p_2 + 45p_1p_2 - 40p^2 - 30{p_2}^2 - 390$$
$$P(4,5) = 100$$
$$x(p_1, p_2) = 75 - 40p_1 + 25p_2$$
$$x(4,5) = 40$$
$$y(p_1, p_2) = 80 + 20p_1 - 30p_2$$
$$y(4,5) = 10$$

The business will achieve a maximum profit of €100 when it sells 40 units of product A at a price of €4 each and 10 units of product B at a price of €5 each.

CONCLUSION

Analysing economic functions empowers economists to predict market behavior. Based on these functions, conclusions can be drawn about how changes in factors like price, income, or consumer preferences will impact demand, supply, and prices. In most economic situations, the goal is to achieve optimal results, such as profit maximization or cost minimization. Economic functions, like cost functions, enable economists to use mathematical methods, such as differential calculus, to determine the best actions or resources that will achieve these goals.

Essentially, economic functions are tools that allow economists to quantitatively analyze economic phenomena, make decisions, and shape policy, contributing to a better understanding and management of the economy. The use of functions in economics is crucial as it contributes to the development, interpretation, and understanding of economic concepts such as supply and demand, as well as other economic phenomena. Understanding functions, their properties, and applications can greatly contribute to the development and improvement of businesses. The application of knowledge about functions leads to progress in both fundamental and advanced aspects of business, enabling predictions regarding the quantity of production needed to meet the market demand, as well as determining the price at which these products will be sold.

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