

# Application of Economic Functions

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# ***THE CONTENTS***

|   |           |
|---|-----------|
| <b>PREFACE.....</b>   | <b>17</b> |
| <b>ROUNDTABLE ON GLOBAL ENTREPRENEURSHIP: AN OVERVIEW .....</b>   | <b>19</b> |
| Mirjana Radović-Marković  |           |
| <b>APPLICATION OF ECONOMIC FUNCTIONS .....</b>  | <b>23</b> |
| Bojan Radišić   |           |
| Mirjana Radman-Funarić  |           |
| Glorija Bertelović  |           |
| <b>ANALYSING online violences and their CONSEQUENSES FROM CHINESE ASPECT.....</b>   | <b>30</b> |
| Zoltán Peredy   |           |
| Wang Jiayi  |           |
| Balázs Laki   |           |
| <b>SIDE DEMAND FOR HIGHER EDUCATION: CAUSES, CONSEQUENCES AND COUNTERMEASURES.....</b>  | <b>41</b> |
| Serzhanov Vitaly  |           |
| Abramov Fedir   |           |
| Andryshyn Volodymyr   |           |
| <b>ACCOUNTING FOR SOCIAL ENTREPRENEURSHIP DEVELOPMENT AND GROWTH .....</b>  | <b>51</b> |
| Ivana Tomašević   |           |
| Sandra Djurovic   |           |
| Nikola Abramović  |           |
| <b>21<sup>ST</sup> CENTURY LEADERSHIP SKILLS AND STAFF MOTIVATION.....</b>  | <b>61</b> |
| David Edward G. Jimenez   |           |
| <b>HISTORY OF THE DEVELOPMENT OF THE AUSTRIAN SOCIAL PARTNERSHIP .....</b>  | <b>71</b> |
| Eperjesi Zoltán   |           |
| <b>CONNECTING SCIENCE ACADEMIES, EDUCATIONAL INSTITUTIONS, RESEARCH INSTITUTIONS AND COMMUNITIES FOR ECONOMIC SYNERGY AND IMPACT.....</b> | <b>83</b> |
| Dikabo Mogopodi   |           |
| Khola Mogotsi   |           |
| Onalerona Pitlagano   |           |
| <b>MASTERING TIME MANAGEMENT AT WORK .....</b>  | <b>84</b> |
| Kemal Yildirim  |           |
| Muhamad Omolaja   |           |
| Sladjana Vujičić  |           |
| <b>DEVELOPMENT OF ENTREPRENEURIAL DIGITAL COMPETENCES THROUGH EDUCATION .....</b>   | <b>89</b> |
| Mirjana Radović-Marković  |           |
| Mohsen Brahmi   |           |



Conference Proceedings

|  |            |
|--|------------|
| <b>PROBLEMATIZATION AS A WAY OF CREATION INTERESTING KNOWLEDGE IN ENTREPRENEURSHIP ....</b>  | <b>90</b>  |
| Salah Koubaa<br>Mateusz Tomanek<br>Zakia Benhida   |            |
| <b>CRM IN HIGH EDUCATION.....</b>  | <b>96</b>  |
| Carmine D'Arconte<br>Zorana Nikitovic  |            |
| <b>A CYBERSECURITY MODEL WITH AI/MACHINE LEARNING AND METAVERSE–BASED BIG DATA<br/>ANALYTICS ARCHITECTURE FOR SDG IMPLEMENTATION AND EEE IN AFRICA .....</b> | <b>107</b> |
| Gabriel Kabanda  |            |
| <b>THE NEED FOR EDUCATION FOR INTERFAITH DIALOGUE AS A CONDITION FOR STABILITY AND<br/>ECONOMIC DEVELOPMENT OF THE REPUBLIC OF NORTH MACEDONIA .....</b>     | <b>108</b> |
| Nikola Gjorshoski  |            |
| <b>INCREASE OF FISCAL BURDEN IN ROMANIA IN 2023 – IMPACT ON THE ECONOMY .....</b>  | <b>118</b> |
| Emanuel George Mesteru<br>Nikola Radić   |            |
| <b>DETERMINANTS OF YOUNG PEOPLE IN AGRICULTURE - THE EXPERIENCE OF THE EU AND SERBIA ...</b>   | <b>127</b> |
| Aleksandra Tošović-Stevanović  |            |
| <b>PERFORMANCE TRADE OF THE EUROPEAN UNION AND SERBIA –<br/>METHODOLOGICAL AND EMPIRICAL ANALYSIS .....</b>  | <b>134</b> |
| Dragana Vojteški Kljenak<br>Radojko Lukić  |            |
| <b>MACROECONOMIC FACTORS AS DETERMINANTS OF THE BELGRADE STOCK EXCHANGE:<br/>EVIDENCE FROM THE ORDINARY LEAST SQUARES METHOD.....</b>                        | <b>147</b> |
| Sunčica Stanković<br>Dragan Cvetković<br>Miljana Barjaktarović   |            |
| <b>GREEN MARKETING – A CONCEPT PREFERRED BY THE MODERN CONSUMER .....</b>  | <b>155</b> |
| Ljiljana Dimitrijević<br>Maja Cogoljević<br>Vladan Cogoljević  |            |
| <b>TESTING PSYHOMETRIC PROPERTIES OF SEHC SCALE IN SERBIAN CONTEXT .....</b>   | <b>164</b> |
| Vesna Jovanović<br>Katarina Njegić<br>Vesna Milanović  |            |



Conference Proceedings

|  |            |
|--|------------|
| <b>RESEARCH ON THE SALES IMPACT OF MODERN COMMUNICATION TECHNOLOGIES<br/>IN THE REPUBLIC OF SERBIA.....</b>  | <b>174</b> |
| Maja Cogoljević<br>Ljiljana Dimitrijević<br>Vladan Cogoljević  |            |
| <b>TRADE BARRIERS BETWEEN CHINA AND THE UNITED STATES OF AMERICA DURING<br/>THE PERIOD OF 2017 – 2020. ....</b>                                    | <b>184</b> |
| Davor Bešić<br>Nikola Radić<br>Vlado Radić   |            |
| <b>IMPACT OF THE WAR IN UKRAINE ON INFLATION IN THE EUROPEAN UNION .....</b>   | <b>195</b> |
| Dragan Momirović<br>Raica Milićević<br>Ninoslav Erić   |            |
| <b>IMPACT OF TARGET INFLATION RATE ON FINANCIAL STABILITY OF<br/>REPUBLIC OF SERBIA ECONOMY .....</b>  | <b>204</b> |
| Miloš Roganović<br>Đorđe Vidicki   |            |
| <b>THE ASSESSMENT REVISION OF THE MECHANISMS EFFICIENCY IN RISK MANAGEMENT IN THE<br/>SERBIAN BANKING SECTOR – FOCUSING ON EXTERNAL FRAUD.....</b> | <b>214</b> |
| Tamara Vesić<br>Milan Gavrilović<br>Jovana Vesić   |            |
| <b>FAMILY BUSINESS DEVELOPMENT IN SERBIA FROM THE ASPECT OF RURAL TOURISM POTENTIAL... ..</b>  | <b>224</b> |
| Edita Kastratović<br>Milan Dragić  |            |
| <b>THE SUCCESS OF INVESTING IN SERBIAN INVESTMENT FUNDS .....</b>  | <b>234</b> |
| Milan Gavrilović<br>Jovan Petronijević<br>Cvetko Lazović   |            |
| <b>CONTEMPORARY CONTROVERSES ABOUT THE RELATIONSHIP BETWEEN INFLATION AND<br/>UNEMPLOYMENT – A COMPARATIVE ANALYSIS .....</b>                      | <b>241</b> |
| Milan Radičević  |            |
| <b>RESEARCH ON THE INNOVATIVE CAPACITY OF SMEs IN SERBIA, CONCERNING THE<br/>PROTECTION OF INTELLECTUAL PROPERTY .....</b>                         | <b>250</b> |
| Nenad Ravić<br>Djordje Spasojević<br>Tamara Vesić  |            |



Conference Proceedings

|  |            |
|--|------------|
| <b>ENTREPRENEURSHIP IS THE BACKBONE OF THE ECONOMIC GROWTH OF THE NATIONAL ECONOMY .....</b>               | <b>258</b> |
| Milica Cvetković<br>Vladimir Đorđević<br>Aleksandar Momčilović   |            |
| <b>CODEPENDENCE OF THE DEVELOPMENT OF SELECTIVE TOURISM, ORGANIC PRODUCTION, AND THEIR FINANCING .....</b> | <b>265</b> |
| Milan Beslač<br>Vladan Cogoljević<br>Slavoljub Vujović   |            |
| <b>FUNCTIONALITY OF KNOWLEDGE ACQUIRED DURING FORMAL EDUCATION .....</b>                                   | <b>275</b> |
| Gordana Gavrić<br>Marija Čukanovic Karavidić<br>Fadil Mušinović  |            |
| <b>DIGITALIZATION AND ECONOMIC GROWTH OF SMALL COUNTRIES IN THE AGE OF GLOBALIZATION .....</b>             | <b>282</b> |
| Mirjana Radović-Marković<br>Dušan Marković<br>Vera Karadjova   |            |
| <b>CONTRIBUTION OF INDUSTRY 5.0 IN PROMOTING SUSTAINABLE DEVELOPMENT .....</b>                             | <b>289</b> |
| Vlado Radić  |            |
| <b>FACTORING FROM THE ASPECT OF NATIONAL AND INTERNATIONAL LAW .....</b>                                   | <b>300</b> |
| Milica Miloradović<br>Nevenka Vojvodić Miljković   |            |
| <b>TRADITIONAL SOCIO-CULTURAL OBSTACLES TO THE DEVELOPMENT OF ENTREPRENEURSHIP IN SERBIA.....</b>          | <b>307</b> |
| Pešić Jenačković Dragana<br>Simić Žikica   |            |
| <b>THE ROLE OF ARTIFICIAL INTELLIGENCE IN INVESTMENT FUNDS MANAGEMENT .....</b>                            | <b>316</b> |
| Jovan Petronijević<br>Tamara Vesić<br>Alen Popović   |            |
| <b>RISKS OF USING ARTIFICIAL INTELLIGENCE IN INVESTMENT FUNDS MANAGEMENT.....</b>                          | <b>323</b> |
| Jovan Petronijević<br>Milan Gavrilović<br>Nikola Radić   |            |



Conference Proceedings

|  |            |
|--|------------|
| <b>COMPETITIVE STRATEGY AND SUPPLY CHAIN, AND CORPORATE GOVERNANCE –<br/>THE FRUSTRATION OF THE MANAGEMENT FUNCTIONS – PART I .....</b>  | <b>329</b> |
| Miodrag Cvetković  |            |
| <b>COMPETITIVE STRATEGY AND SUPPLY CHAIN, AND CORPORATE GOVERNANCE –<br/>THE FRUSTRATION OF THE MANAGEMENT FUNCTIONS – PART II .....</b> | <b>338</b> |
| Miodrag Cvetković  |            |
| <b>THE APPLICATION OF BLOCKCHAIN TECHNOLOGY IN EDUCATION .....</b>   | <b>347</b> |
| Jelena Bačević<br>Vladan Pantović<br>Vojkan Vasković   |            |
| <b>ADVANCED INTERNET TECHNOLOGIES FOR ECONOMISTS, LAWYERS AND MANAGERS<br/>New core curriculum development .....</b>                     | <b>356</b> |
| Dragorad Milovanović<br>Vladan Pantović<br>Slađana Vujičić   |            |
| <b>LEGAL FORMS OF BUSINESS ASSOCIATIONS AND COMPANIES IN THE<br/>SERBIAN COMMERCIAL CODE OF 1860 .....</b>                               | <b>365</b> |
| Slobodan Jovanović   |            |
| <b>IS THE ROMAN SOCIETAS (CONTRACT OF PARTNERSHIP) STILL ALIVE TODAY?.....</b>   | <b>372</b> |
| Aleksandra Jovanovic<br>Aneta Atanasovska Cvetkovic  |            |
| <b>DETERMINING THE APPLICABLE LAW FOR CROSS-BORDER INFRINGEMENT OF<br/>PERSONALITY RIGHTS IN THE MEDIA.....</b>                          | <b>381</b> |
| Jelena Vlajnić<br>Živorad Rašević<br>Snežana Plavšić Prelević  |            |
| <b>THE INTERPRETATION OF LAWS AND LEGAL GAPS .....</b>   | <b>389</b> |
| Sandra Pajić Šavija  |            |
| <b>WOMEN AND THE ACQUISITION OF THE RIGHT TO INDEPENDENTLY UNDERTAKE LEGAL<br/>TRANSACTIONS .....</b>                                    | <b>398</b> |
| Snežana Prelević Plavšić<br>Živorad Rašević<br>Danijela Despotović   |            |



**Conference Proceedings**

|  |            |
|--|------------|
| <b>INFLUENCE OF POLITICAL RISK AND COUNTRY RISK ON THE CAPITAL ALLOCATION OF INSURANCE COMPANIES .....</b>   | <b>409</b> |
| Marija Lukić<br>Tatjana Piljan   |            |
| <b>MANAGEMENT OF COMPETENCIES AND SKILLS IN THE PROJECT TEAM .....</b>   | <b>418</b> |
| Goran Lapčević<br>Milan Krstić<br>Eugen Popescu  |            |
| <b>ADVANCEMENTS IN HEALTHCARE AND HUMAN RESOURCE MANAGEMENT: CHALLENGES AND OPPORTUNITIES IN THE AGE OF TECHNOLOGY .....</b>   | <b>427</b> |
| Usman Iqbal<br>Suleman Atique<br>Mihajlo Rabrenović  |            |
| <b>ANALYSIS OF CHANGING TRENDS IN PUBLIC RELATIONS INDUSTRY – PUBLIC RELATION AGENCIES AS LEADERS OF THE FEMALE DOMINANCE IN MANAGEMENT POSITIONS IN CROATIA .....</b> | <b>432</b> |
| Marina Đukić<br>Tatjana Ileš<br>Mirela Belaj   |            |
| <b>THE IMPACT OF INNOVATIVE VIDEO GAME TECHNOLOGY ON THE BUSINESS CLIMATE ON THE CITY OF NOVSKA .....</b>  | <b>443</b> |
| Marijana Mitrović  |            |
| <b>LOBBYING'S EFFECTS ON ORGANIZATIONAL TRANSFORMATION .....</b>   | <b>452</b> |
| Renata Čupić   |            |
| <b>DIGITALIZATION AND ITS IMPACT ON THE DEVELOPMENT OF MICRO AND SMALL ENTERPRISES IN THE REPUBLIC OF CROATIA .....</b>  | <b>462</b> |
| Josipa Pleša   |            |
| <b>COMMUNICATION CHANGES AND CHALLENGES BEFORE, DURING, AND AFTER THE PANDEMIC IN BUSINESS .....</b>   | <b>470</b> |
| Ivana Brkljača   |            |
| <b>THE INFLUENCE OF STRATEGIC COMMUNICATION ON TRUST BETWEEN THE PATIENT AND DENTIST – FOCUS GROUP WITH ITALIAN PATIENTS .....</b>                                     | <b>480</b> |
| Etienne Šajn   |            |



**Conference Proceedings**

|   |            |
|---|------------|
| <b>THE CODE OF ETICS APPLICATION IN THE CREATION OF HEADLINES ON PORTALS<br/>REGARDING THE CASE OF MASS MURDER IN ELEMENTARX SCHOOL VLADISLAV RIBNIKAR.....</b> | <b>489</b> |
| Marija Gojković<br>Rade Babović   |            |
| <b>WHAT IS A STARTUP .....</b>  | <b>498</b> |
| Siniša Pekevski   |            |
| <b>ECOTOURISM AS AN OPPORTUNITY FOR THE DEVELOPMENT OF<br/>HEALTHY SUSTAINABLE TOURISM IN THE REPUBLIC OF SERBIA .....</b>                                      | <b>505</b> |
| Ana Milojevic Jelisijević<br>Shaik Azahar Shaik Hussain   |            |
| <b>UNDERSTANDING CONSUMER WORD PREFERENCES USING<br/>THE MAXFIDD METHOD – CASE STUDY.....</b>   | <b>512</b> |
| Lea Cok<br>Jani Toroš   |            |





## ***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*





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***APPLICATION OF ECONOMIC FUNCTIONS***

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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*

***JEL Classification:*** *M21, C02,*

***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.



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### *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  $b$  is from the set of values that the variable can take  $y$ :  $(x, y) \rightarrow f(x, y)$ . 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:

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

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*



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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:

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

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 unchanged.

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

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

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  $x_0$  increases by 1%, and variable  $y$  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:

$$x(p_1, p_2) = 75 - 40p_1 + 25p_2 \quad (\text{demand for product A})$$

$$y(p_1, p_2) = 80 + 20p_1 - 30p_2 \quad (\text{demand for product B})$$

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



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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:

$$R(p_1, p_2) = p_1 \cdot x(p_1, p_2) + p_2 \cdot y(p_1, p_2)$$

$$R(p_1, p_2) = 75p_1 + 80p_2 + 45p_1p_2 - 40p_1^2 - 30p_2^2$$

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

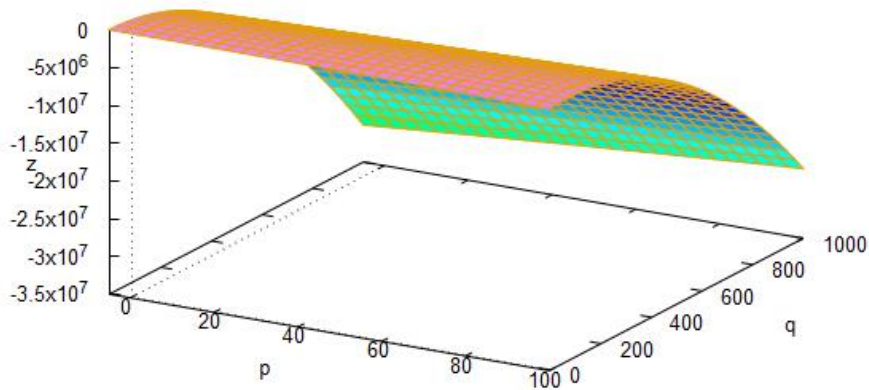
$$P(p_1, p_2) = R(p_1, p_2) - T(p_1, p_2)$$

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





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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.

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

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

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

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

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

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

$$\det H = -80 \cdot (-60) - 45 \cdot 45$$

$$\det H = 2775$$

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):

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

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

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$$720p_1 - 405p_2 = 855$$

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

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$$555p_2 = 2775/ : 555$$

$$p_2 = 5$$



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$$80p_1 = 95 + 45 \cdot 5$$

$$80p_1 = 320 / : 80$$

$$p_1 = 4$$

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

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

$$P(4,5) = 100$$

$$x(p_1, p_2) = 75 - 40p_1 + 25p_2$$

$$x(4,5) = 40$$

$$y(p_1, p_2) = 80 + 20p_1 - 30p_2$$

$$y(4,5) = 10$$

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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