Lidija Madžar[1]

ORIGINALNI NAUČNI RAD
UDK 338:517.58(497.11)
DOI: 10.56362/Rev22100007M

COBB-DOUGLAS PRODUCTION FUNCTION OF THE SERBIAN ECONOMY[2]

SUMMARY

This article is dedicated to the study of the Serbian economic production function in the period from 2010 to 2021. The constructed Cobb-Douglas production function indicated a marked labor intensity and decreasing returns to scale and inefficiency of the domestic economy. While capital showed a small, but statistically significant contribution to the output, the more abundant labor factor does not significantly affect the Gross value-added trend. Serbia should invest intensively in its human capital education and training, and advanced technologies as the fundamental prerequisite for society's development and further progress.

Keywords: Cobb-Douglas production function, Serbian economy, diminishing returns to scale, labour and capital inputs, education.

INTRODUCTION

The production function describes the relation between production inputs and the amount of output generated. The concept of the production function can be studied at the level of individually observed companies, industries, or the entire economy. This paper considers the traditional function of the Serbian economy's aggregate production. Although there are many specific mathematical forms of the production function, its neoclassical model developed by mathematicians and economists Charles W. Cobb and Paul H. Douglas in the first half of the 20th century is often applied these days (4, p. 1). These authors, while studying the logarithmic indexes of fixed capital, physical production, and the total number of employees in U.S. industry, based on data on the American economy trend in the period from 1899 to 1922, established a connection between the volume of physical production, employed labor and capital (3, pp. 139-165). Applying the Method of ordinary least squares (OLS), these authors determined that the production curve was located at approximately one-quarter of the distance between the labor and capital curves. From this also followed the conclusion that at the beginning of the 20th century, capital in American production participated with about 25% (1/4), while the labor factor had a share of about 75% (3/4) (15, pp. 1-2).

The production function is normally used to measure potential economic growth based on available production capacities, that is, on factor contribution and total factor productivity (TFC). At the same time, TFC summarizes information on achieved technological progress and allocative efficiency of inputs. By analyzing this function, it is possi-

1 Assistant Professor, Alfa BK University, Faculty of Finance, Banking and Auditing, Belgrade, e-mail: lidi.madzar@gmail.com

2 This paper is a part of the results within the research project II U-001/20, "Assessment of the impact of Covid-19 on social and economic development" of the Faculty of Finance, Banking and Auditing, Alfa BK University, Belgrade.

ble to observe changes in economic performance based on the trend of the factors' share and their overall productivity. For example, growth in capital utilization rate accompanied by growth in total factor productivity may be a good sign of specific improvements in the economy's performance, while growth in the capital share combined with stagnant total factor productivity may indicate inefficient functioning of the economy. Therefore, the production function often appears as an important instrument for analyzing and evaluating government economic policies (10, p. 465).

The neoclassical Cobb-Douglas production function was created as a result of an empirical study by the aforementioned researchers who investigated trends in the American manufacturing industry. This is a linear, first-degree homogeneous production function that observes only the influence of two factors – labor and capital on the generated output (14). The practical application of the Cobb-Douglas production function requires certain assumptions, especially about the shape of production technology, returns to scale, properties of technological progress, and the functioning of factor markets. The requirements for its application also include the assumption of positive and decreasing marginal product of labor and capital, constant returns to scale, perfect competition, and a stable technological coefficient (5, pp. 4-5).

These assumptions restrict the production elasticity concerning labor and capital factors to values between 0 and 1, so their sum should be equal to number 1. However, empirical data are not fully aligned with them, given that the shares of labor and, therefore, of capital can still change over time and differ from country to country. Moreover, for those economies that have not yet reached their stable GDP per capita and are not growing at the desired rate of technological progress, it seems that the assumption of a constant labor share is not entirely appropriate (10, p. 466). However, on the other hand, reconsidering the assumptions of the Cobb-Douglas production function would make its construction and practical implementation impossible. In its most general form, the two-factor Cobb-Douglas production function has the following form:

$$Q = AK^{\alpha} L^{\beta} \quad \text{for } \alpha > 0 \text{ and } \beta > 0 \tag{1}$$

or

$$Q = AK^{\alpha} L^{(1-\alpha)} \quad \text{for } 0 < \alpha < 1 \text{ and } \beta = 1 - \alpha \tag{2}$$

where Q represents aggregate output, K is capital input, while L is the labor factor. The constant A in this expression represents the total factor productivity, which, unlike the quantitative indicators K and L, can be interpreted as a quality factor that reflects the level of technological development of the economy and the level of achieved workforce skills and education level. In developing societies, parameter A gradually increases over time and vice versa.

This equation also tells us that the output directly depends on the consumption of inputs L and K, as well as that the part of the output that cannot be explained by these factors can be explained by the residual A, which refers to technological change. The production function constructed by Cobb and Douglas indicated a one-quarter contribution of capital and a three-quarter contribution of labor to the growth of the U.S. manufacturing industry. The coefficient of labor factor L in this function measures the percentage growth of output Q when labor factor employment increases by 1%, with other conditions remaining the same. Similarly, the capital factor coefficient K from this equation measures the percentage growth of output Q when increasing the use of capital by 1%, ceteris paribus.

MARGINAL PRODUCT OF FACTORS AND DIMINISHING RETURNS TO SCALE

An essential aspect of the production function relates to the marginal product of the employed factors. The marginal product of labor is defined as the change in production volume due to changes in the engagement of labor inputs, assuming the constancy of capital inputs and total factor productivity. This indicator is obtained as the first-order derivative of equation (1) or (2) by the variable L (4, p. 1).

$$MPL = \frac{dQ}{dL} = \frac{dAL^{\alpha}K^{1-\alpha}}{dL} = A(1-\alpha)\frac{K^{\alpha}}{L^{\alpha}} = A(1-\alpha)\left(\frac{K}{L}\right)^{\alpha} \quad (3)$$

$$MPL = (1-\alpha)\frac{Q}{L} > 0 \quad (4)$$

Given that the output Q, the labor factor L, the capital factor K, and the coefficient α must have a positive value, while the value of α is by definition less than 1, it is also observed that the marginal product of labor must be a positive number – when more labor input is consumed, the output will be higher.

On the other hand, the economic concept of diminishing returns to scale indicates that over time the marginal product of labor declines – with the increase in engagement of labor input, the constancy of capital use, and total factor productivity, output increases, but at a declining rate. In that case, the diminishing returns to scale of labor are calculated as the second-order derivative of the production function by the variable , i.e., based on the following formula:

$$\frac{dMPL}{dL} = \frac{d^2Q}{dL^2} = (-\alpha)(1-\alpha)\frac{Q}{L^2} < 0 \tag{5}$$

Since all the terms in this expression are positive with the exception of the term – α, it follows that the second-order derivative of the production function concerning the variable L is negative, indicating decreasing returns to scale of the labor factor.

Similarly, both a positive and a decreasing marginal product of capital (MPK) characterize the Cobb-Douglas production function. At the same time, the marginal product of capital MPK indicates changes in output when capital investment K increases, assuming constant labor input L and total factor productivity. By analogy to the previous Equations (3) and (4), the marginal product of capital is also positive, but it decreases over time and is obtained as the first order derivative of the production function by the capital variable K (4, p. 2).

$$MPK = \frac{dQ}{dK} = \frac{dAL^{\alpha}K^{1-\alpha}}{dK} = A(1-\alpha)\frac{L^{\alpha}}{K^{\alpha}} = A(1-\alpha)\left(\frac{L}{K}\right)^{\alpha} \tag{6}$$

$$MPK = \alpha\frac{Q}{K} > 0 \tag{7}$$

Similarly, diminishing returns to scale of capital are calculated based on the following formula:

$$\frac{dMPK}{dK} = \frac{d^2Q}{dK^2} = (\alpha-1)\alpha\frac{Q}{K^2} < 0 \tag{8}$$

Since all the terms in this expression are positive except for term *α-1*, it follows the second order derivative of the production function by variable K is negative, indicating the decreasing returns to scale of the capital factor.

FACTOR SHARE

As we have already seen, the marginal product of labor and the marginal product of capital are, in accordance with the Cobb-Douglas production function equation, obtained based on the following formulas: $MPL = (1 - \alpha)\ Q/L$ and

$MPK = \alpha\, Q/K$. These are earnings per unit of the observed factor under the assumption of perfect competition. To obtain the total factor income of both labor and capital, we need to multiply these values by the corresponding quantities of L and K inputs. In this case, we get the following system of equations (4, p. 3):

Total earnings from labor input =

$$L \times (1-\alpha)\frac{Q}{L} = (1-\alpha) \times Q$$

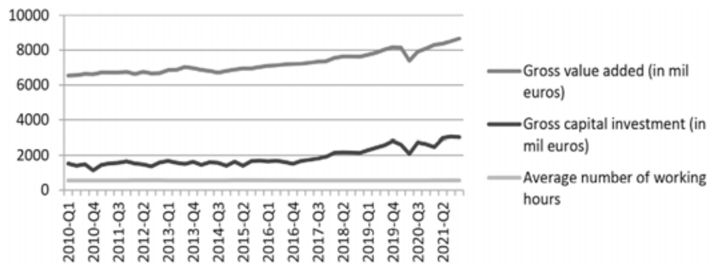
Total earnings from capital input = $K \times \alpha \frac{Q}{K} = \alpha \times Q$ (9)

The expression $1 - \alpha$ represents the share of labor in total production Q, while the parameter α represents the share of capital in the observed economy. It also follows from the above that the share of both factors amounts to 100% of production only if the sum of the exponents of the Cobb-Douglas production function is equal to the number 1.

MATERIAS, METHODOLOGY, RESULTS, AND DISCUSSION

Description of the sample

The Cobb-Douglas function of the Serbian economy was constructed on the basis of quarterly data on: a) Gross value added Q_i expressed in millions of euros and in chain indices with the base year 2010 (seasonal and calendar adjusted data), b) Gross capital investments K_i expressed in millions of euros and in chain indices with the base year 2010 (seasonal and calendar adjusted data) and c) the Average number of working hours L_i in the period from the first quarter of 2010 (2010-Q1) to the fourth quarter of 2021 (2021-Q4), which all makes 48 observations per time series observed. The analyzed data are derived from the Eurostat database. At the same time, Figure 1 shows a gradual growth trend in Gross value added and Gross capital investments in the observed period, with pronounced procyclicality of the second indicator in relation to the first. Both aggregate indicators grew gradually, with the exception of the first half of 2020, when due to the outbreak of the Covid-19 coronavirus pandemic, they experienced their sharpest decline. In contrast to these figures, one can notice that the Average number of working hours on a quarterly basis was relatively constant.



Source: Authors' calculation

Figure 1. The trend of Gross value added, Gross capital investments, and Average number of working hours in the period from the beginning of 2010 to the end of 2021

Applied methodology

As it has already been shown, the Cobb-Douglas production function can be expressed by the following equation (9, p. 25):

$$Q_i = AL_i^{\alpha} K_i^{\beta} \tag{10}$$

where Q_i is total output, L_i is labor input, K_i is capital input, while A is a constant indicating total factor productivity.

After performing logarithmization of its left and right side, and certain transformations, the Cobb-Douglas production function equation takes the following form:

$$lnQ_i = A + \alpha lnL_i + \beta lnK_i + u_i \tag{11}$$

where u_i is the random error term of the regression.

Discussion of the results and the Cobb-Douglas production function equation of the Serbian economy

In this analysis, the quarterly data on output are expressed in Gross value added in millions of euros, the quarterly data on labor input are expressed in the Average number of working hours, while the quarterly data on capital input are expressed in Gross capital investments in millions of euros. In this example, the estimation of the regression coefficients was acquired using the OLS method, while the regression analysis results are presented in Table 1.

Table 1. Results of regression analysis

Variable	Coefficient	Standard error	Value of t-statistic	Probability (Prob.)
Constant	2.6344	3.5781	0.7362	0.4654
Ln(Labour)	0.6209	0.5593	1.1102	0.2728
Ln(Capital)	0.3093*	0.0149	20.6938	0.0000
R-Squared			0.9118	
Adjusted R-Squared			0.9078	
Value of F-statistic			232.4972*	
Prob.(F-statistic)			0.0000	
Value of Durbin-Watson statistic			1.5005	

Note: * indicates statistical significance at the level of α = 0,05

Source: Author's calculation

While in this regression the input of capital was statistically significant at the significance level of *α = 0.05* (*β = 0,3093, Prob. = 0,0000 < 0,05*), the input of labor was not statistically significant because its probability was higher than the selected significance level (*α = 0,6209, Prob. = 0,2728 > 0,05*). At the same time, with an increase in the engagement of labor input by 1%, there was also an increase in output by 0.62% ceteris paribus, while with an increase in the engagement of capital input by 1%, there was only an increase in output by about 0.31% ceteris paribus. In addition, both explanatory variables showed a significant joint contribution, simultaneously describing the trend of dependent variable Gross value added, given that the value of the F-statistic was highly statistically significant (*F – statistic = 232,4972, Prob. = 0,0000 < 0,05*). Finally, the analysis showed that it was a good and valid model whose value of the adjusted coefficient of determination amounted to *Adjusted R – squared = 0,9078*, indicating that this model successfully explained about 90.78% of the variations of the dependent variable output, that is Gross value added of the Serbian economy.

The built Cobb-Douglas production function also indicated that the sum of the partial elasticity coefficients of labor and capital input was 0,9302 (*$\alpha + \beta$ = 0, 6209 + 0,3093 = 0,9302*), further suggesting that the Serbian economy has diminishing returns to scale, that is, it is not efficient. From the conducted regression analysis, the Cobb-Douglas production function of the Serbian economy took the following form:

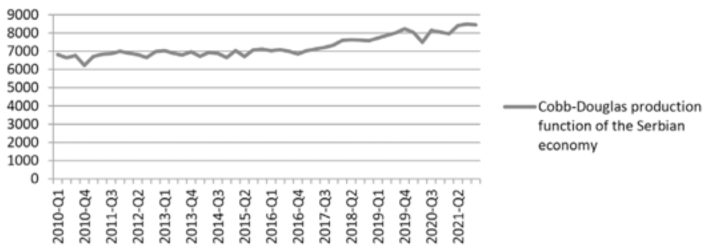
$$lnQ_i = 2{,}6344 + 0{,}6209 \ln L_i + 0{,}3093 \ln K_i + u_i \qquad (12)$$

The constructed production function also indicates the labor intensity of the Serbian economy because for the production of the same output level, it is necessary to engage proportionately more labor than capital. In other words, the production function in Serbia is labor-intensive because the labor factor L_i participates almost twice as much in the formation of aggregate output (α = 0,62) than the capital factor *Ki* (β = 0,31). At the same time, we can notice the tendency of decreasing returns to scale of the Serbian economy, given that the sum of the regression coefficients α and β from equation (11), i.e., the sum of exponents from equation (10) was less than 1 ($\alpha + \beta = 0{,}6209 + 0{,}3093 = 0{,}9302 < 1$).

Finally, by taking antilogarithm on both sides of the equation (12), the Cobb-Douglas production function of the Serbian economy was obtained in its following original form:

$$Q_i = 13{,}935 L_i^{\,0{,}6209} K_i^{\,0{,}3093} \tag{13}$$

The ultimate form of the Cobb-Douglas production function of the domestic economy is derived from the above, which is presented in the following Figure 2.



Source: Authors' calculation

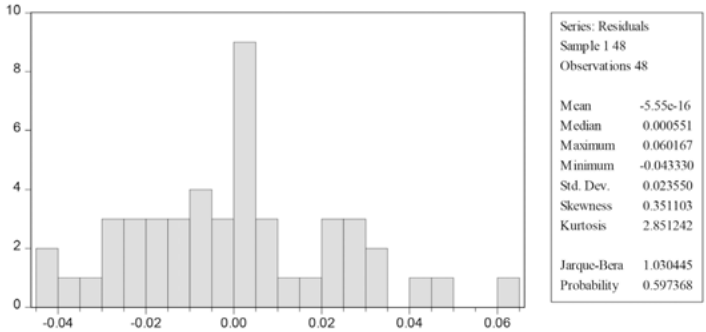
Figure 2. Cobb-Douglas production function of the Serbian economy in the observed period

POST HOC TESTS

Testing the normality of the distribution of residuals

In testing the normality of the residuals` distribution, one starts from the null hypothesis that the random error of this linear regression model has a normal distribution.

The obtained value of the Jarque-Bera test in the amount of 1.0304 and its associated statistically non-significant probability in the value of *Prob.* = 0,5974 > 0,05 indicated that we could not reject the null hypothesis H_0 about the normality of the random error term distribution, which satisfied the first of three conditions for the validity of this model. In other words, this result further meant that from the aspect of normality of random error distribution, it was a good fitted and acceptable model.



Source: Authors' calculation

Figure 3. Results of descriptive statistics of the proposed model

Testing the heteroskedasticity of residuals

When testing the heteroskedasticity of the obtained model residuals, the null hypothesis generally presumes that there is no heteroskedasticity in the residuals of the model, that is, that the variance of the random error is constant and homoscedastic. To test the heteroskedasticity of the residuals, the Breusch-Pagan-Godfrey test was first applied, the results of which are shown in Table 2.

Table 2. Breusch-Pagan-Godfrey test results

Observed statistic	Value of statistic	Probability (Prob.)
F-statistic	3,8111*	0,0296
Obs*R-squared	6,9527*	0,0309
Scaled explained SS	5,6563	0,0591

Note: * indicates statistical significance at the level of $\alpha = 0{,}05$

Source: Author's calculation

As already mentioned, this test starts from the null hypothesis H_0 that there is no heteroskedasticity in the model. However, the analysis results indicated that the F-statistic value of 3.81 was statistically significant ($Prob.F(2{,}45) = 0{,}0296 < 0{,}05$), implying the conclusion that this model was burdened by probable heteroscedasticity of residuals.

However, the applied Harvey method (11, pp. 461-465) for testing multiplicative heteroskedasticity in the linear regression model, under the null hypothesis H_0 about the presence of homoscedasticity, indicated the opposite findings, i.e., the absence of residual heteroscedasticity, with the obtained value of F-statistics of around 1.85 and its real probability of $Prob.F(2,45) = 0{,}1686 > 0{,}05$ (Table 3). In addition, the results also indicated that the value of the Observed R-squared was $Obs{*}R - sqared = 3{,}6514$, with its accompanying probability of $Prob.Chi - Square(2) = 0{,}1611 > 0{,}05$. These findings further suggested that we should not reject the null hypothesis H_0 about the homoscedasticity of the residuals' variance, with the conclusion that there was probably no heteroskedasticity of the residuals in this model.

Table 3. Results of the applied Harvey test

Observed statistic	Value of statistic	Probability (Prob.)
F-statistic	1,8525	0.1686
Obs*R-squared	3,6514	0.1611
Scaled explained SS	4,6078	0.0999

Source: Author's calculation

Testing for autocorrelation of residuals

For the residuals of the linear regression model to be free from autocorrelation, the value of the Durbin-Watson test statistic should range from 1.5 to 2.5 (9, pp. 101-102). Even a first look taken at the results of the regression model of the estimated Cobb-Douglas production function indicated a possible absence of autocorrelation, with a Durbin-Watson test statistic value of around 1.5 (Table 1). In addition, the shape of the analyzed autocorrelation function, i.e. autocorrelogram in a graphical sense did not show a recognizable decreasing form. At the same time, the obtained values of autocorrelation coefficients were statistically insignificant, supporting the conclusion about the absence of serial correlation. Namely, all the obtained probability values of the Q-statistic of autocorrelation coefficients were greater than 0.05 (Table 4).

Bearing in mind that in the analysis, all three conditions of the model validity were satisfied, it can be concluded that the constructed Cobb-Douglas function was well fitted, as well as that it was a good and acceptable model.

Table 4. Correlogram results

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*. |	. |*. |	1	0.204	0.204	2.1276	0.145
. |*. |	. | . |	2	0.096	0.057	2.6089	0.271
. | . |	. | . |	3	0.000	-0.031	2.6089	0.456
. | . |	. | . |	4	-0.016	-0.017	2.6237	0.623
. |*. |	. |*. |	5	0.080	0.094	2.9825	0.703
. |*. |	. |*. |	6	0.104	0.078	3.6000	0.731
. |*. |	. | . |	7	0.108	0.063	4.2876	0.746
.*| . |	.*| . |	8	-0.118	-0.173	5.1225	0.744
. | . |	. | . |	9	-0.050	-0.003	5.2740	0.810
. | . |	. |*. |	10	0.030	0.074	5.3294	0.868
. |** |	. |** |	11	0.220	0.218	8.4705	0.671
. | . |	.*| . |	12	0.052	-0.080	8.6483	0.733
. | . |	. | . |	13	0.047	0.008	8.8005	0.788
.*| . |	.*| . |	14	-0.115	-0.119	9.7275	0.782
.*| . |	. | . |	15	-0.133	-0.046	11.005	0.752
. | . |	. | . |	16	-0.023	-0.016	11.046	0.807
. | . |	. | . |	17	0.000	-0.022	11.046	0.854
. | . |	. | . |	18	0.027	-0.017	11.104	0.890
.*| . |	.*| . |	19	-0.166	-0.116	13.376	0.819
.*| . |	. | . |	20	-0.087	-0.004	14.024	0.829

Source: Author's calculation

Limitations of the proposed model

The limitations of this analysis stem from the definition and initial assumptions of the constructed Cobb-Douglas production function of the Serbian economy. The resulting Cobb-Douglas production function of the domestic economy considers only two production inputs (labor and capital), which it does not do with the other factors commonly used in the production process. In addition, this research considered only the volume of capital available for investment in production and not the total available capital that can only be engaged during periods of full employment. Finally, the obtained Cobb-Douglas production function is based on the assumption of perfect substitutability of production factors, stable technological progress, and perfect competition in the production factors' market. Despite this, based on the calculated coefficients of partial elasticity of labor and capital factors α and β, this model could represent a good instrument for monitoring the relative factor shares in total production, determining the nature of returns to scale, and various cross-sectoral comparisons.

Finally, bearing in mind that the constructed model of the Cobb-Douglas production function of the Serbian economy had no serial correlation, that it had a normal distribution of residuals, and that some of the applied tests indicated the absence of heteroscedasticity of the residuals, it is concluded that the proposed model is statistically valid and of high quality. The author of this article believes that in these circumstances, the model can be accepted as valid and applicable when modeling the trend of the dependent variable because it meets at least two of the three required criteria of statistical quality.

CONCLUDING REMARKS

This paper is dedicated to the analysis of the production function of the Serbian economy for the period from the beginning of 2010 to the end of 2021. The constructed Cobb-Douglas production function indicated the labor intensity and the inefficiency of the Serbian economy embodied in its declining returns to scale. While capital had a statistically significant influence, the input of labor did not contribute statistically significantly to the trend of the dependent variable expressed in Gross value added. Labor-intensive and resource-intensive products dominate the structure of domestic production, indicating its extremely low level of specialization. These findings imply the need for improvements in the real economic sphere by increasing productivity, competitiveness, and product quality, using more advanced production technologies and modern management methods, introducing more efficient production processes, differentiating the structure of the production of domestic goods and services, improved certification of articles, adapting products and services to the latest international standards, more intensive crediting of production and sales, etc. In these efforts, a special place belongs to the promotion of non-price competitiveness factors of domestic products and services, such as quality, shape, ease of use, design, packaging, product life, safety and reliability, speed of delivery, provided after-sales services, compliance with warranty periods, servicing and timely procurement of spare parts, etc. All these efforts require a well-trained and qualified workforce and strong technological equipment of the economy.

The central place of all activities aimed at strengthening the efficiency and competitiveness of the domestic economy should also belong to technological progress that would lead to an increase in the optimal utilization rate of production capacities, an increased volume of trained and competent workforce and management, better organization of production processes, and thus to the more efficient disposition of resources, raw materials, and energy sources (13, pp. 3-30). We should also insist on the intensive application of advanced technologies that add value to products and services. We should also improve technological knowledge, especially in process and corporate management. In addition, the domestic economy is burdened by the insufficient volume and mobility of a qualified labor force, implying the need for additional investments in its education and training. Here comes to the fore the role of the state, which appears in the role of regulator, but also as a provider of education services, which is why it plays a crucial role in expanding its availability and improving its quality. Available and quality education is a prerequisite for the growth of the human capital volume, which further determines productivity and the ability to create and adopt innovations. In addition to this role, the state also plays a key role in financing fundamental scientific research. At the same time, its expenditure policy directly affects the fundamental determinants of economic growth, i.e., the amount and character of employed work, physical capital, and technological progress (1, p. 21). These findings are also supported by the theory of investment in human capital, which insists on intensive financing of the education of society as a critical prerequisite for prosperity and economic growth in the modern era of industrialization (17, p. 38). To all this, the still unfavorable aspects of the domestic business environment should be added, which also constrain the competitiveness of domestic small and medium-sized enterprises. Finally, effort should also be put into improving companies' access to capital so that they could take advantage of the economies of scale, and thus more easily penetrate foreign markets (16, p. 3), thus raising the level of competitiveness, productivity and technological intensity of the domestic economy.

LITERATURE

1. Arsić, M., Fiskalna politika i održivi ekonomski rast u zemljama Zapadnog Balkana, *International Scientific Conference Jahorina Business Forum 2022*, Ekonomski fakultet Pale, Istočno Sarajevo, 2022, pp. 15-26.
2. Breusch, T. S., Pagan, A. R., A simple test for heteroscedasticity and random coefficient variation, *Econometrica*, 47(5), 1979, pp. 1287-1294. Available at: https://doi.org/10.2307/1911963. Accessed on: 10/29/2022
3. Cobb, C. W., Douglas, P. H., A theory of production, *American Economic Review*, 18, 1928, pp. 139-165.
4. Cottrell, A., The Cobb–Douglas Production Function, *Economics 207*, 2019. Available at: http://users.wfu.edu/cottrell/ecn207/cobb-douglas.pdf. Accessed on: 11/01/2022
5. Dybczak, K., Flek, V., Hájková, D., Hurnik, J., Supply Side Performance and Structure in the Czech Republic (1995-2005), *CNB Working Paper Series*, No. 4/2006, Czech National Bank, Prag, 2006.
6. Eurostat, Average number of usual weekly hours of work in main job, by sex, age, professional status, full-time/part-time and occupation, 2022. Available at: https://ec.europa.eu/eurostat/databrowser/view/LFSA_EWHUIS__custom_3719948/default/table?lang=en. Accessed on: 10/31/2022
7. Eurostat, Gross Capital Formation, 2022. Available at: https://ec.europa.eu/eurostat/databrowser/view/NAMQ_10_GDP__custom_3719917/default/table?lang=en. Accessed on: 10/31/2022
8. Eurostat, Gross Value Added, 2022. Available at: https://ec.europa.eu/eurostat/databrowser/view/NAMQ_10_GDP__custom_3719914/default/table?lang=en. Accessed on: 10/31/2022
9. Gujarati, D., Econometrics by Example, Palgrave Macmillan, New York, 2012.
10. Hájková, D., Hurnik, J., Cobb-Douglas Production Function: The Case of a Converging Economy, *Czech Journal of Economics and Finance*, 57(9), 2007, pp. 465-476.
11. Harvey A. C., Estimating Regression Models with Multiplicative Heteroscedasticity, *Econometrica*, 44(3), 1976, pp. 461–465. https://doi.org/10.2307/1913974
12. Jarque, C. M., Bera, A. K., Efficient tests for normality, homoscedasticity and serial independence of regression residuals: Monte Carlo evidence, *Economics Letters*, 7 (4), 1981, pp. 313–318. doi:10.1016/0165-1765(81)90035-5
13. Jefferson Institute, Konkurentnost privrede Srbije, Jefferson Institute, Narodna banka Srbije i EastWest Institute, Beograd, 2003.
14. Kwatiah, N., Production Function, Economicsdiscussion.net, 2022. Available at: https://www.economicsdiscussion.net/production-function/the-cobb-douglas-production-function/18519 Accessed on: 11/01/2022
15. Smirnov, R. G., Wang, K., The Cobb-Douglas Production Function Revisited, *Recent Developments in Mathematical, Statistical and Computational Sciences*, Springer Proceedings in Mathematics & Statistics, Springer, Berlin, 2021.
16. Udovički, K., Džagić, V., Analiza performansi i lanaca vrednosti odabranih sektora, CEVES i Privredna komora Srbije, Beograd, 2017.
17. Wulan, E. R., The Utilization of the Cobb-Douglas Production Function for Analyzing Indonesia's and Malaysia's Economic Growth, *International Journal of Nusantara Islam*, 2013, pp. 38-44. Available at: http://digilib.uinsgd.ac.id/4078/1/24-46-1-PB.pdf. Accessed on: 11/03/2022

Rad primljen: 15.10.2022 • Prihvaćen: 29.11.2022.

COBB-DOUGLASOVA PROIZVODNA FUNKCIJA PRIVREDE SRBIJE

REZIME

Ovaj članak je posvećen izučavanju proizvodne funkcije privrede Srbije za period od početka 2010. do kraja 2021. godine. Konstruisana Cobb-Douglasova proizvodna funkcija je ukazala na izrazitu radnu intenzivnost, kao i na opadajuće prinose i neefikasnost domaće privrede. Dok je kapital pokazao mali, ali i statistički značajan doprinos outputu Srbije, obilniji faktor rada ne utiče na trend Bruto dodate vrednosti na statistički značajan način. Srbija treba intenzivno da ulaže u obrazovanje i obuku ljudskog kapitala, kao i u napredne tehnologije koje dodaju vrednost, jer je to osnovni preduslov razvoja i napretka društva.

Ključne reči: Cobb-Douglasova proizvodna funkcija, privreda Srbije, opadajući prinosi, inputi rada i kapitala, obrazovanje.