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The effect of infrastructure and human resources on the higher education services output

E R Wulan*, A Muhyiddin, H Ainissyifa and M A Ramdhani

UIN Sunan Gunung Djati Bandung, Jalan A. H. Nasution No 105 Bandung, Indonesia

*elis_ratna_wulan@uinsgd.ac.id

Abstract. The performance of the supply side of the economy of the higher education services is often identified with the growth rate of potential output. Potential output was approached by using the exponential function such as the Cobb-Douglas production function that used to measure the growth of potential output, namely the contribution of labor, capital and total factor productivity. Consumer education services demand fluctuated, encourage the higher education to be able to determine precisely the quantity of academician in achieving optimal production according to market demand. It aims to create efficient use of academician as an effort in facing a competitive global market competition, namely the ASEAN Economic Community. Through the exponential function such as the Cobb-Douglas production function was analyzed whether the addition or subtraction of labor education impact on higher education labor productivity, as well as the order of priority can be determined in accordance with the conditions of output scale.

1. Introduction

The consumer demand fluctuated education services, encourage universities to be able to determine precisely the quantity of labor education in achieving optimal production according to market demand [1]. It aims to create efficient use of labor education as an effort facing a competitive global market competition, namely the ASEAN Economic Community. Using the Cobb-Douglas production function will be analyzed whether the amendment to the addition or subtraction of labor education impact on labor productivity in education, as well as the production function of each product can also note the order of priority of its production in accordance with the conditions of output scale product itself [2].

The production function is the physical relationship between inputs of production and production (output). Analysis of the production function often performed by researchers. There are several models of production functions such as simple linear production functions, quadratic production function, polynomial square root production function, and the Cobb-Douglas production function [3]. One of the functions of production is most often used in solving problems in the field of economy is a model of the Cobb-Douglas production function. On the model of the Cobb-Douglas production function, the parameter value estimators also shows the amount of elasticity of each factor input to output [4]. Overall the amount of elasticity shown, demonstrating the level of magnitude of returns to scale [5].

Based on the above background, the existing problems can be formulated as follows: What is the returns to scale condition of higher education services when analyzed using analysis of Cobb Douglas production function? By knowing the elasticity and return to scale, then a college can plan the use of input variables to produce the output variable specific, and can evaluate production systems that exist

within the college [2]. The aim of this study is to analyze the factors of production in the field of higher education services.

2. Background theory

2.1. Exponential function

The exponential function is a function of a constant rank of independent variables. The simplest form of the exponential function is [6]

$$y = n^x, where\ n > 0 \tag{1}$$

The general form of the exponential function is:

$$y = n^{kx} + c, where\ n \neq 0, k\ and\ c = constants \tag{2}$$

2.2. Cobb-douglas production function

The specific form of the production function is

$$y = ax^b \tag{3}$$

The Cobb-Douglas production function advantage is the rank of the independent variable coefficient indicates the level of elasticity. The disadvantage is the data needs to be linearized with the logarithmic($log\ y = log\ a + b\ log\ x$) before processed using multiple regression analysis. Cobb-Douglas production function is a function or equation involving the dependent variable and two or more independent variables [5]. General form of the Cobb-Douglas function is as follows:

$$y = a\ x_1^b\ x_2^c\ x_3^d \tag{4}$$

The data obtained were analyzed using the Cobb-Douglas function, then the data must be transformed first into a linear form by using the natural logarithm which can then be processed further using multiple linear regression analysis. The equation becomes [7]:

$$ln\ y = ln\ a + b\ ln\ x_1 + c\ ln\ x_2 + d\ ln\ x_3 \tag{5}$$

By changing the equation into the natural logarithm then easily be obtained parameters of efficiency and elasticity input.

2.3. Production elasticity

Production elasticity is the percentage change in the production of a good by a firm, divided the percentage change in an input used for the production of that good, for example, labor or capital. Production elasticity shows the responsiveness to the output when. There is a change in one input [8].

2.4. Return to scale

The production function illustrates the real and measurable productive process. In the production function we want to know how much output is produced if the number of inputs added with the same proportion, it is apparent from the return to scale generated. Return to scale is a change in the proportion of the total input to total output [9].

Returns to scale is used to see how the output reacts to the addition of all inputs simultaneously [10]. A production function denotes constant returns to scale, if multiplication all input produces exactly the same output multiplication as a percentage. If multiplication all input produces a smaller output multiplication, then the production function denotes decreasing return to scale. Otherwise, if the multiplication of all inputs produces a greater output multiplication, then the production function denotes increasing returns to scale [11].

3. Methodology

The method used in this research is quantitative method by analyze the relationship between human resources and infrastructure to the competitive advantages of Islamic higher education. The statistical test used is Multiple Regression Analysis.

Multiple Linear Regression analysis was used to measure the effect of more than one predictor variable (independent variable) on the dependent variable. Multiple linear regression model as follows [12]:

$$Y = a + b_1 x_1 + b_2 x_2 + \cdots + b_n x_n \quad (6)$$

Normal equation for the regression coefficients can be given by the following equation:

$$\sum Y = a\,n + b_1 \sum x_1 + b_2 \sum x_2 \quad (7)$$

$$\sum x_1\, Y = a \sum x_1 + b_1 \sum x_1^2 + b_2 \sum x_1\, x_2 \quad (8)$$

$$\sum x_2\, Y = a \sum x_2 + b_1 \sum x_1\, x_2 + b_2 \sum x_2^2 \quad (9)$$

After knowing all the variables in a multiple linear regression model and then determine the correlation between the variables using a statistical test (F Test).

4. Results and discussion

Cobb-Douglas production function used in this research is [8]:

$$Y = a\, {x_1}^{\alpha}\, {x_2}^{\beta} \quad (10)$$

Then formed their natural logarithms equation, in order to obtain:

$$Ln\, Y = Ln\, a + \alpha\, Ln\, x_1 + \beta\, Ln\, x_2 \quad (11)$$

Analysis of the exponential function with Cobb-Douglas method applied in the simulatiom data at State Islamic University Syarif Hidayatullah Jakarta, State Islamic University Maulana Malik Ibrahim Malang, and State Islamic University Sunan Kalijaga Yogyakarta. Simulation data are presented in table 1.

Table 1. Simulation data of research funding, number of human resources and output of higher education services in State Islamic University Syarif Hidayatullah [13].

Year	Research Funding (Million Rupiahs) (x_1)	Number of Human Resources (person) (x_2)	Output of Higher Education Services (person) (Y)
2012	4000	1420	18125
2013	4400	1434	19938
2014	4840	1448	21932
2015	5324	1462	24125

Analysis result using Cobb Douglas production function as follows:

$$Y = 35{,}17345082 - 0{,}825184611\, X_1 + 1{,}83552408\, X_2 \quad (12)$$

Because $F_{calculation} \leq F_{Table}$ is $0.013222302 \leq 199$ then H_0 is accepted, so it can be concluded that the input (infrastructure and human resources) has no effect on the output of higher education services. From the analysis conducted inputs (infrastructure and human resources) are not significantly influential

on the output of higher education services. Then return to scale the results can be seen from the $\alpha + \beta$ = -0.825184611 + 1.83552408 = 1.010339469, it can seen that $\alpha + \beta > 1$ so State Islamic University Syarif Hidayatullah Jakarta are in conditions of increasing returns to scale. This means that the proportion of additional factors of production higher education services will generate additional production of higher education services that a larger proportion.

Data simulation at State Islamic University Maulana Malik Ibrahim Malang are presented in table 2.

Table 2. Simulation data of funding, number of human resources and output of higher education services in State Islamic University Maulana Malik Ibrahim Malang [14].

Year	Funding (Ten of million Rupiahs) (x_1)	Number of Human Resources (person) (x_2)	Output of Higher Education Services (person) (Y)
2011	13353,0190046	602	8555
2012	18075,8635729	608	9506
2013	21954,3997014	614	10562
2014	24149,83967	620	11682
2015	26564,82364	626	12850

Analysis result using Cobb Douglas production function as follows:

$$\beta = 10{,}47617091 \tag{13}$$

Parameter β is used to measure the percentage increase in output higher education services due to the increase of one percent of the fund reception input while the number of human resources is kept constant. Analysis Cobb Douglas production process cannot continue because the value of $\beta > 1$ and too large that 10.47617091. It is not eligible for return to scale so that conditions cannot be obtained a description of the production process [12].

Data simulation in State Islamic University Sunan Kalijaga Yogyakarta is presented in table 3.

Table 3. Simulation data of fund, number of human resources and output of higher education services in State Islamic University UIN Sunan Kalijaga Yogyakarta [15].

Year	Funding (Hundreds Million Rupiahs) (x_1)	Number of Human Resources (person) (x_2)	Output of Higher Education Services (person) (Y)
2010	2395,955	1009	9977
2011	4827,306	1019	11085
2012	8749,667	1029	12317
2013	9624,6337	1039	13685
2014	10587,09707	1050	15206
2015	11915,80678	1061	16895

Analysis result using Cobb Douglas production function as follows:

$$\beta = 1531{,}051884 \tag{14}$$

Parameter β is used to measure the percentage increase in output higher education services due to the increase of one per cent of the fund reception input while the number of human resources is kept constant. Analysis Cobb Douglas production process cannot continue because the value of $\beta > 1$ and the

value is very large 1531.051884. It is not eligible for return to scale so that conditions cannot be obtained a description of the production process [12].

Based on in-depth analysis of the three cases above, then obtained the following results:

- The advantages of the Cobb-Douglas production function are (1) Form of Cobb-Douglas production function is simple and easy application; (2) Cobb-Douglas production function is able to describe the state of returns to scale, whether it is increasing, stable or decreasing; (3) Coefficients of Cobb-Douglas production function directly describe the elasticity of each input that is used, in this case the infrastructure and human resources, and is considered to be studied in the Cobb-Douglas production function; and (4) The coefficient intercept of Cobb-Douglas production function is an index of production efficiency that directly describe the efficiency of using inputs in order to produce outputs of the production system services at the college [16].
- Shortage of Cobb-Douglas production function are (1) This variable measurement error lies in the validity of the data, whether the data used is correct, too extreme upward or vice versa. This measurement error will cause the amount of elasticity to be too high or too low, and (2) In practice, the management factor is a factor that is also important to increase production, but the variable is sometimes too difficult to measure and is used in the independent variable in the estimation of Cobb-Douglas production function [2].

5. Conclusion

Exponential function using the Cobb-Douglas can be used to analyze the factors of production in the field of higher education services. The results of this study are in line with previous studies on productivity analysis using Cobb Douglas Production function [7], [8], [12], [16], [2]. The results obtained in the first case study that the effect of input (infrastructure and human resources) to the output of higher education services can be seen from $F_{calculation} \leq F_{tabel}$ that is $0.013222302 \leq 199$ so that it can concluded that input (infrastructure and human resources) are not significantly influential on the output of higher education services, which means that any changes in the input (infrastructure and human resources) did not affect the change in output higher education services. It needs to be further explored on other factors such as significantly affecting management by performing a sensitivity analysis on the input and output variable modifications Cobb-Douglas function performed in the service sector with all the characteristics that are different from manufacturing.

In the second and third case study analysis Cobb Douglas production process cannot continue because the value of β are very large that 10.47617091 and 1531.051884. It is not eligible for return to scale so that conditions cannot be obtained a description of the production process. The nature of the production elasticity of higher education services in the first case is elastic which can be seen from the magnitude of $\alpha + \beta = -0.825184611 + 1.83552408 = 1.010339469$, it can be concluded that any change of input (infrastructure and human resources) then changes in higher education services output would certainly exceed the percentage change in the input (infrastructure and human resources).

In this research only examines the exponential function with Cobb-Douglas method in which to assess the effect of input (infrastructure and human resources) against production output of higher education services. For further research can assess the exponential function with a modified method of Cobb-Douglas production function for field services. Multi-year research is needed to get accurate results in terms of specifications services variable and services Exponential function using the Cobb-Douglas can be used to analyze the factors of production in the field of higher education services. The results obtained in the first case study that the effect of input (infrastructure and human resources) to the output of higher education services can be seen from $F_{calculation} \leq F_{tabel}$ that is $0.013222302 \leq 199$ so that it can concluded that input (infrastructure and human resources) are not significantly influential on the output of higher education services, which means that any changes in the input (infrastructure and human resources) did not affect the change in output higher education services. It needs to be further explored on other factors such as significantly affecting management by performing a sensitivity analysis on the

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