The Application of Douglas Production Function in Urban Local Economic Growth Management Under Computer Big Data

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Abstract. Cobb Douglas production function also has unique advantages in quantitative analysis of the factors that influence urban economic growth, as well as the short-term and long-term effects and adjustments of various resource inputs on urban economy. Cobb Douglas production function combined with computer technology, the data analysis is more targeted. Therefore, it has been more and more widely used in the study of urban local economic growth management. This paper first analyzes the cobb-douglas production function theory, and then studies the practical application of the cobb-douglas production function model in urban local economic growth. Finally, through the estimation and adjustment of the Cobb Douglas production function model with computer technology, the influence and effect of different variables on the local economic growth of the city were analyzed.

Keywords: Douglas Production Function, Urban Local Economic Growth Management, Computer Big Data

1. Introduction
With the continuous improvement of China's urbanization construction level, the urban local economy has also achieved rapid growth [1]. Urban economic growth is closely related to factor input and its equilibrium relationship - that is, in the case of factor scarcity and cannot be completely replaced, economic growth is restricted by the amount of factor input and its equilibrium relationship, so it can be said that there is a direct impact relationship between the two [2]. Cobb Douglas production function plays an important role in analyzing and studying the contribution of human capital to urban economic development, the relationship between urban economic growth and input factors, and the influence of labour, technology and capital on urban economic growth. In addition, Cobb Douglas production function also has unique advantages in quantitative analysis of the influencing factors of urban economic growth, as well as the short-term, long-term impact and adjustment of various resource inputs on urban economy. Therefore, it is of great practical significance to study the application of Cobb production function in urban local economic growth management.

2. Cobb Douglas production function theory
Cobb Douglas production function can comprehensively analyze the factors of urban local economic
growth, and the required data is easy to obtain. The calculation process of Cobb Douglas production function is simple, and its calculation formula is as follows:

\[ Q = AK^\alpha L^\beta \] (1)

In which, \( \alpha \) and \( \beta \) are unknown elements in the formula 1, in order to calculate \( \alpha \) and \( \beta \), the natural logarithm of the two sides of the formula is first obtained, then it has:

\[ \ln Q = \ln A + \alpha \ln K + \beta \ln L \] (2)

Let \( \alpha + \beta = 1 \), then there is:

\[ \ln Q / L = \ln A + \beta \ln K / L \] (3)

The linear regression method \( \alpha \) and \( \beta \) can be obtained by calculating the linearized formula. According to the following formulas (4), (5), (6) and (7), the output change rate, technical coefficient change rate, capital change rate and labour force change rate of urban areas in the current year can be calculated respectively.

\[ \Delta Q = \log(Q_n / Q_{n-1}) \] (4)

\[ \Delta A = \log(A_n / A_{n-1}) \] (5)

\[ \Delta K = \log(K_n / K_{n-1}) \] (6)

\[ \Delta L = \log(L_n / L_{n-1}) \] (7)

Among them, \( \alpha \) is the elasticity of output to labour input, which indicates the percentage change of output when labour input changes while capital input remains unchanged[3-4]. Similarly, \( \beta \) is the elasticity of output to capital input while labour input remains unchanged. The sum of \( \alpha + \beta = 1 \) gives the information of scale reward, which is the response of output to the proportion of input[5-6]. Parameter \( A \) can be regarded as an efficiency parameter, because the size of a directly affects the output when it is fixed with \( K \). The meaning of the value of \( \alpha + \beta \) is shown in Table 1.

**Table 1.** The meaning of the value \( \alpha + \beta \)

| Value  | Meaning of the value                                           |
|--------|---------------------------------------------------------------|
| \( \alpha + \beta < 1 \) | Diminishing returns on scale, i.e. one time of input will bring less than one time of output. |
| \( \alpha + \beta = 1 \) | The return on scale remains the same, i.e. one time of input will lead to one time of output. |
| \( \alpha + \beta > 1 \) | Increasing returns on scale, that is, one time of input will bring more than one time of output. |

It can be seen from table 1 and the above formula Cobb Douglas production function theory that Cobb Douglas production function can analyze and study the impact of fixed capital investment and labour input on urban local economic growth and urban local economic development.

**3. Practical application of Cobb Douglas production function model in urban local economic growth**

**3.1. The selection of Cobb Douglas production function model**

Cobb Douglas production function is applied to analyze the contribution rate of various factors in economic growth, and to analyze the analytical framework of endogenous economic growth theory in urban areas. First of all, energy resources are internalized as factors affecting economic growth, excluding capital stock, labour force, technological progress and other aspects. Secondly, taking
energy resources as an endogenous variable of production function to make an empirical analysis on the factors influence the urban local economic growth, Cobb Douglas production function is set as a model containing several aspects as shown in Figure 1 below.

![Cobb Douglas production function model](image)

**Figure 1.** Cobb Douglas production function model

\[ Y = AK\alpha L\beta Eu \]  

(8)

In formula (8), \( Y \) represents GDP, \( a \) represents technological progress, \( K \) represents capital stock, \( L \) represents labour force, and \( E \) represents energy consumption. In addition, \( \alpha, \beta \) and \( u \) represent the input-output elasticity coefficient of each factor and the contribution rate of each factor to the GDP. According to the economic significance of the data, take logarithm on both sides of the model, and get the linear model shown in formula (9):

\[ \ln Y = \ln A + \alpha \ln K + \beta \ln L + u \ln E + e \]  

(9)

### 3.2. Data source and variable description

Firstly, select the economic data of local cities in the past ten years, and set the capital stock. Use the perpetual inventory method as shown in formula (10) below to calculate the capital stock \( K \).

\[ K_n = K_{n-1}(1-D_n)+L_n \]  

(10)

In which, \( K_n \) represents the capital stock in the \( n \)th year of urban areas, \( K_{n-1} \) represents the capital stock in the \( n_{th} \) year of urban areas, in represents the investment in the \( n_{th} \) year of urban areas, and \( D_n \) represents the depreciation rate of fixed assets in the \( n_{th} \) year of urban areas. Since the depreciation rate of fixed assets in urban areas is not collected in the data collection, 6% depreciation rate is used as the depreciation rate of fixed assets in urban areas. The fixed asset investment in urban areas is determined by data investigation, and the ratio of fixed asset investment to fixed asset depreciation rate is taken as the basic capital stock.

Secondly, the labour input \( L \) adopts the number of employees at the end of each year in urban areas, while the energy consumption \( E \) is obtained based on the total energy consumption in the statistical yearbook of urban areas, so as to ensure that the contribution of energy consumption to the economic growth of urban areas can be comprehensively reflected.

### 4. Estimation and adjustment of Cobb Douglas production function model

In order to determine the linear relationship between variables \( LNY, LNK, LNL \) and \( LNE \), this paper uses econometric analysis software to estimate the OLS of urban local economic sample data, and obtains the gravel map as shown in Figure 2. From the results shown in Figure 2, it can be seen that these variables are indeed linear relationships, so the Cobb Douglas production function model can use linear models.
The correlation coefficient matrix of each variable is used to judge the correlation degree of each explanatory variable. By calculating the coefficient matrix of each variable, the correlation coefficient matrix is obtained as shown in Figure 3 below:

**Figure 2.** Linear relationship between variables

The correlation coefficient matrix of each variable is used to judge the correlation degree of each explanatory variable. By calculating the coefficient matrix of each variable, the correlation coefficient matrix is obtained as shown in Figure 3 below:

|       | LNE | LNK | LNL |
|-------|-----|-----|-----|
| LNE   | 1.000000 | 0.993759 | 0.924739 |
| LNK   | 0.993759 | 1.000000 | 0.915347 |
| LNL   | 0.924739 | 0.915347 | 1.000000 |

**Figure 3.** The variable correlation coefficient matrix

From the coefficient matrix of the variables, we can see that the correlation coefficient among the explanatory variables is high, which shows that there is a high multi-collinearity among the three variables of capital stock, labour input and energy consumption in the urban local economy. In addition, capital and labour force have a significant role in promoting the economic growth of urban areas. Moreover, there is increasing returns to scale in urban local economic growth, and the input of production factors in the same proportion will bring greater output. Scale expansion will produce economies of scale and agglomeration effects.

### 5. Conclusions

Cobb Douglas production function plays an important role in the analysis and research of the contribution of human capital to the development of urban local economy, the relationship between urban economic growth and input factors, and the influence of labour, technology and capital on urban economic growth. Based on the study of the practical application of Cobb Douglas production function model in urban local economic growth, and the estimation and adjustment of Cobb Douglas production function model, this paper verifies the influence and function of labour, technology and capital on urban local economic growth, and that the growth of urban local economy requires technological innovation and the overall utilization of factors Rate. In addition, urban areas should also actively introduce resources to achieve the balance between the accumulation of production factors and economic efficiency growth.

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