ATLANTIS PRESS

Advances in Social Science, Education and Humanities Research, volume 543

Proceedings of the 2021 6th International Conference on Social Sciences and Economic Development (ICSSED 2021)

Research on Relationship Between Local Government Expenditure and Total Output in China

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ABSTRACT
Since the impact of the international financial crisis in 2008, countries have expanded their expenditure levels to varying degrees in order to promote economic development and recovery. The paper first establishes a theoretical model of the relationship between government expenditure and the contribution rate of total output growth, and then analyzes their relationship based on China's local fiscal data (665 in total) from 2013 to 2018. The theoretical model shows that government expenditure not only directly promotes output growth, but also indirectly promotes output growth through the promotion of consumption and investment. At the same time, it also estimates the contribution rate of government expenditure to output growth. In addition, the linear regression results show that government expenditure has a positive correlation with total output. Finally, data visualization analysis is carried out for each prefecture-level city in Zhejiang Province, and it is further concluded that government expenditure has a positive effect on the economy.

Keywords: *government expenditure, total output, theoretical model, linear regression, data visualization*

1. INTRODUCTION

Due to the impact of the international financial crisis, all countries have begun to implement proactive fiscal policies and expand government expenditures to achieve macroeconomic regulation and control of economic operations. According to Keynesian theory, the government expands the scale of expenditure during economic depression, and reduces the scale of expenditure during economic prosperity to adjust economic operation in the short term from a demand perspective. But from the perspective of economic growth, government spending can also affect output growth by affecting total supply.

Since the 1980s, a large number of studies on government expenditure and output growth have appeared abroad. Ram (1986) [1] used the parallel data of 115 countries to make a relevant econometric analysis on the relationship between government consumption and output growth, and found that under the condition that government expenditure accounts for a certain proportion of GDP, increasing government expenditure growth rate has a positive effect on output growth. But the increase in government spending exceeding this ratio will have a negative impact on economic growth. Barro (1990) [2] conducted research from the perspectives of government productive expenditure and consumer expenditure under the framework of endogenous output growth theory. The results show that capital has increasing returns to scale when government expenditures remain unchanged, but government The return to scale brought by both expenditure and private investment research is constant, and this proves the idea that government expenditure may have a positive impact on output growth.

It can be seen that although many scholars have analyzed and studied the relationship between government expenditure and total output growth, these studies only verify the correlation between government expenditure and total output growth from an empirical perspective [3]. However, it has not measured the contribution rate of government expenditure to the growth of total output. This article attempts to construct a theoretical model to measure the contribution rate of government expenditure to the growth of total output. The structure of the paper is as follows: The second part is the filtered variables and data sets. The third part will provide linear regression analysis to assess the relationship between variables. This section also shows the python code used for the analysis, as well as the output and results. The fourth part discusses the hypothesis of each model and the test results of validity.

In the fifth part, a data visualization analysis was carried out for each prefecture-level city in Zhejiang Province. Finally, draw the conclusion of the correspondence between government expenditure and total output.

2. METHODS AND MATERIALS

This article assumes a closed economy. Its components include: representative families with unlimited life spans, homogeneous and fully competitive enterprises, and government departments. Households obtain utility from consumption; enterprises employ labor and leased capital for output in accordance with conditions of perfect competition, and maximize profits; the government implements a one-time proportional total tax burden and provides public goods for enterprises [4].

2.1. Family Department

Assuming that there are a large number of identical economic agents with infinite lives in society, their preferences can be expressed by the following time-divisible utility function:

$$U(C,G_1) = \int_0^{\infty} \frac{1}{\gamma}(CG_1^{\eta})^{\gamma} e^{-\rho t} dt \quad (1)$$

Among them, η measures the impact of government consumption expenditure on individual utility (or private welfare). At the same time, we also assume that both private consumption and government expenditure G_1 obtain positive marginal utility, making 0< η . $-\infty < \gamma < 1, \gamma\eta < 1, \gamma(\eta+1) < 1$. C_t is household consumption expenditure, and G_1 is government consumption expenditure. ρ is the time preference parameter. The larger the value, the more consumers prefer the current consumption and recent consumption. Here we assume that the initial population is 1, and η is the population growth rate. In equilibrium, the labor market is cleared, the family obtains the desired number of jobs, the average wage income is equal to w_t, and the family rents out capital to obtain interest income r_t.Therefore, for consumption, the budget constraints are:

$$K = rK_t + w_t L_t - C_t - nK_t \quad (2)$$

2.2. Corporate Sector

This paper draws on Barro (1990) method of including government expenditure in the production function in his economic growth model, and divides the total government expenditure into two parts, namely, government consumption expenditure and government investment expenditure. If there is technological progress, and the production function form still adopts the Cobb-Doglass production function form:

$$Y = F(G_2, K, L) = Ae^{rt} G^{\alpha(1-\beta)} K^{\beta} L^{1-\beta} \quad (3)$$

Among them, G_2 is government investment expenditure. Suppose the total government expenditure is G, and $G_j = k_j G$ (k_j is the proportion of various expenditures in expenditure G , and $k_j \in (0,1)$). α represents the degree of crowding of public goods, and its value range is $0 \le \alpha \le 1$. Under the given price conditions, the enterprise produces according to the above formula (3), and its goal is to maximize its after-tax profit, which is expressed by the formula:

$$\max\ [(1-\tau)Ae^{rt} G_2^{1-\beta} K^{\beta} L^{1-\beta} + \theta G_2 - w_t L_t - (r+\delta)K_t] \quad (4)$$

2.3. Government Department

Government departments collect taxes from enterprises according to a certain proportion, and at the same time provide certain public goods for enterprises [3]. Assuming that the government implements a balanced budget policy, that is: $G = \tau Y$. Therefore, the following formula holds:

$$G = \tau_1 Y + \tau_2 Y \quad (5)$$

2.4. Economic General Equilibrium

In the macro economy as a whole, assuming that both enterprises and households are price receivers of market commodities, then enterprises and households face the same interest rate and wage rate, and the commodity market and labor market achieve a balance between supply and demand. The macroeconomic equilibrium solution in this case is the solution of the following maximization problem:

$$maxU\ (C,G_1) = \int_0^{\infty} \frac{1}{\gamma}(CG_1^{\eta})^{\gamma} e^{-\rho t} dt \quad (6)$$

$$\dot{K} = (1-\tau)Ae^{rt} G_2^{1-\beta} K^{\beta} L^{1-\beta} + \theta G_2 - C_1 - (n+\delta)K$$

In order to solve the output growth rate of the above maximization problem, construct a Hamilton function:

$$\tilde{H} = \frac{(CG_1^{\eta})^{\gamma}}{\gamma} + \lambda[(1-\tau)Ae^{rt} G_2^{1-\beta} K^{\beta} L^{1-\beta} + \theta G_2 - C_1 - (n+\delta)K] \quad (7)$$

Where λ is the Hamilton multiplier, we get:

$$\frac{\partial \tilde{H}}{\partial c} = C^{r-1} G_1^{r\eta} - \lambda = 0 \quad (8)$$

$$\dot{\lambda} = \rho\lambda - \lambda[(1-\tau_1-\tau_2+\theta\lambda_2)A\beta e^{rt} G_2^{1-\beta} K^{\beta} L^{1-\beta} - (n+\delta)] \quad (9)$$

The transversal conditions are:

$$\lim_{t\to\infty} K_t\, \lambda e^{-\rho t} = 0 \quad (10)$$

From equation (8), we can get:

$$(\gamma - 1)\frac{\dot{c}}{c} + \gamma\eta\frac{\dot{G_1}}{G_1} = \frac{\dot{\lambda}}{\lambda} \tag{11}$$

From equation (9), we can get:

$$\frac{\dot{\lambda}}{\lambda} = \rho - (1 - \tau_1 - \tau_2 + \theta\lambda_2)A\beta e^{rt}G_2^{1-\beta}K^{\beta}L^{1-\beta} - (n + \delta) \tag{12}$$

From the above formula (10) and formula (11), we can get:

$$(\gamma - 1)\frac{\dot{c}}{c} + \gamma\eta\frac{\dot{G_1}}{G_1} = \rho - (1 - \tau_1 - \tau_2 + \theta\lambda_2)A\beta e^{rt}G_2^{1-\beta}K^{\beta}L^{1-\beta} - (n + \delta) \tag{13}$$

In order to further solve the problem, we will make further assumptions that collective rationality and individual rationality are unified, that is, there is no information asymmetry between the individual and the government, and a good communication, decision-making and execution can be established between the government and the individual. According to the utility function, the marginal utility of individual consumption and collective consumption are equal on the optimal consumption path, so that:

$$\frac{\partial U}{\partial C} = \frac{\partial U}{\partial G_1}$$

that is:

$$\frac{dC}{c} = \eta\frac{dG_1}{G_1} = \phi = \frac{\dot{c}}{c} = \eta\frac{\dot{G_1}}{G_1} \tag{14}$$

From the production equation (3) and equation (5), the following relationship can be obtained:

$$G_2 = (A\tau_2 e^{rt}K^{\beta}L^{1-\beta})^{\frac{1}{1-\alpha(1-\beta)}} \tag{15}$$

Incorporating equations (13) and (14) into equation (12), the individual consumption path equation of the optimal consumption growth path is obtained:

$$g_c = \frac{\dot{c}}{c} = [\rho - (1 - \tau_1 - \tau_2 + \theta\lambda_2)A\beta(A\tau_2 e^{rt})^{\frac{\alpha(1-\beta)}{1-\alpha(1-\beta)}}K^{\frac{(\phi-1)(1-\alpha)}{1-\alpha(1-\beta)}}L^{\frac{1-\beta}{1-\alpha(1-\beta)}} + (n + \delta)]/2\gamma - 1 \tag{16}$$

It can be seen that under optimal equilibrium conditions, $g_c = g_Y$, and the growth rate of per capita consumption will produce different growth effects depending on the value range of β. In order to obtain the relationship between government consumption expenditure and investment expenditure on the optimal growth path, by taking a partial derivative of one of the variables ($\frac{\partial g_c}{\partial \tau_2}$), the optimal government consumption expenditure can be obtained and the ratio of productive expenditure. Therefore, we can get the following conclusions:

Conclusion 1: When $\alpha = 1$, it means that the government provides pure public goods for the production of enterprises, and there is no overcrowding. From equation (15), it can be seen that the per capita consumption growth rate at this time is:

$$g_c = \frac{\dot{c}}{c} = [\rho - (1 - \tau_1 - \tau_2 + \theta\lambda_2)A\beta(A\tau_2 e^{rt})^{\frac{1-\beta}{\beta}}L^{\frac{1-\beta}{\beta}} + (n + \delta)]/2\gamma - 1 \tag{17}$$

When $\frac{\partial g_c}{\partial \tau_2} = 0$, we can get that the optimal allocation ratio between government consumption expenditure and investment expenditure is $\tau_1 = 1 - \frac{1-\theta}{1-\beta}\tau_2$. Therefore, we can get government consumption The contribution rate of expenditure to output growth is:

$$\frac{G_t}{Y_t} = (1 - \frac{1-\theta}{1-\beta}\tau_2)g_Y \tag{18}$$

Conclusion 2: When $0 < \alpha < 1$, the public goods provided by the government for the production of enterprises are crowded and partially competitive. At this time $\beta - 1 < \frac{(\beta-1)(1-\alpha)}{1-\alpha(1-\beta)} < 0$. When the consumption growth rate at this time is obtained partial derivative, the optimal allocation ratio relationship between government consumption expenditure and investment expenditure is obtained as $\tau_1 = 1 - \frac{1-\theta}{1-\alpha(1-\beta)}$, and the corresponding government's contribution rate to output growth is:

$$\frac{G_t}{Y_t} = (1 + \frac{\theta-\alpha(1-\beta)}{1-\alpha(1-\beta)}\tau_2)g_Y \tag{19}$$

Conclusion 3: When $\alpha = 0$, the public goods provided by government departments to enterprises are completely competitive, which is no different from private goods, which is equivalent to the government not providing public goods for enterprises. At this time $\frac{(\beta-1)(1-\alpha)}{1-\alpha(1-\beta)} = \beta - 1 < 0$, the consumption growth rate is the same as the Ramsey model [5].

3. DATA ANALYSIS OF CHINA LOCAL FINANCE

3.1. Data Sorting and Choose

First, import data through python and obtain summary information about the data. After obtaining the summary information, it is found that there are 12 columns and 665 rows in this type of data. Among the 12 columns of data, fiscal expend, total import and total output are all very important information, which can be further studied in the future.

3.2. Linear Regression

Many data sets contain multiple quantitative variables, and the purpose of analysis is usually to correlate these variables with each other. Therefore, it is easiest to find the relationship between government expenditure and total production by using linear regression. Seaborn's regression graph is mainly to add a visual guide to help emphasize the patterns in the data set during exploratory data analysis. By comparing government expenditures, exports and imports, we can determine the relationship between government expenditures and total production, which can be clearly shown in Figure 1.

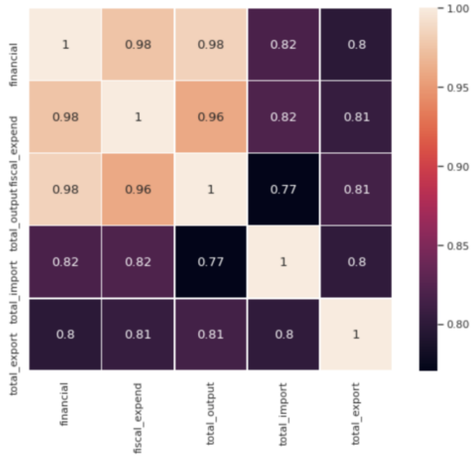

FIG.1 The relationship between government spending, total imports and exports, and total output

Then, in Figure 2, call the regplot and implot function in python to draw a scatter plot of the two variables of government expenditure x and total production y. Finally, the regression model y~x is fitted and the regression line and the 95% confidence interval of the regression are drawn and find the optimal regression line.

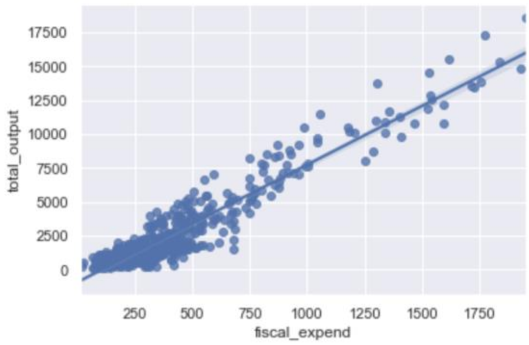

FIG.2 The regression model

In Figure 2 and Figure 3, by combining Seaborn's jointplot function for data visualization, the linear relationship between government expenditure and total production can be obtained, as well as the trend of change between the two. They can be clearly seen that government expenditure and total production have a positive linear relationship. Figure 4 is a 3D attempt to return.

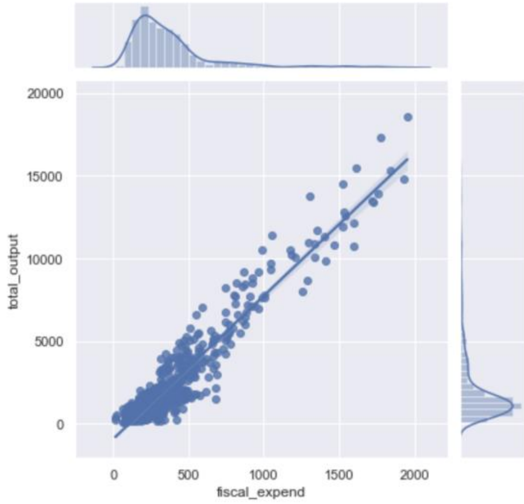

FIG.3 The linear relationship between government expenditure and total production

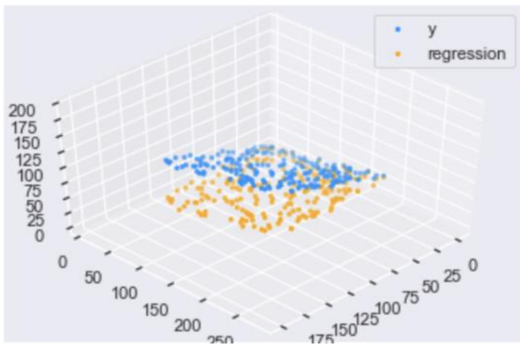

FIG.4 3D attempt to return

4. ANALYZE EACH PREFECTURE-LEVEL CITY IN ZHEJIANG

After analyzing all the cities in the China, then began to choose a representative coastal province, which is Zhejiang. It is the most economically developed place in China. Next, perform data visualization and analysis on its 7 prefecture-level cities. Figure 5 is obtained using R's barplot function. The advantage of the barplot is that it can show data clearly and comparability. This picture clearly shows that Hangzhou, Ningbo and Wenzhou are the top three cities in Zhejiang's financial situation during this period.

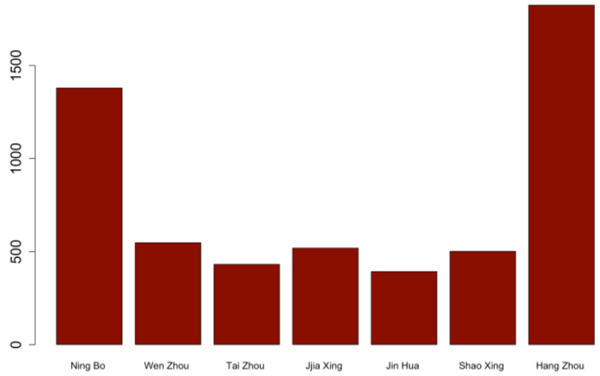

FIG.5 The financial situation of various cities in Zhejiang

Then, extract the data of various prefecture-level cities in Zhejiang from the entire database. These data include financial, fiscal_expend, total_import, total_export, total_output, per_output, total_employ and year, a total of eight columns of data. Then we use the parisplot function to analyze three variables and get Figure 6.

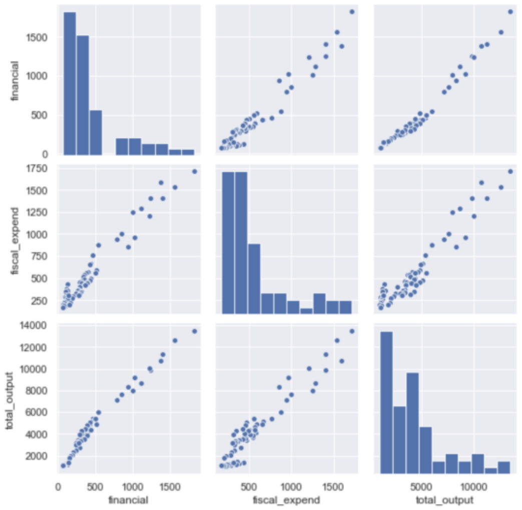

FIG.6 The relationship between the three variables

The pair plot is built on two basic graphics, histogram and scatter plot. The histogram on the diagonal can see the distribution of a single variable, while the scatter plot on the upper and lower triangles shows the relationship between the two variables. For example, the chart in the fifth column of the second row shows a scatter plot of total_output and fiscal expenditure. The default scatter plot matrix chart can often provide valuable insights. From the figure, it can be observed that total output and fiscal expenditure are positively correlated, which indicates that the total output and economic situation of prefecture-level cities with high fiscal expenditure are also higher. Then use Seaborn's pairplot equation to generate a graph of the relationship between fiscal expenditure and total output of each city in Zhejiang from 2013 to 2018 (Figure 7).

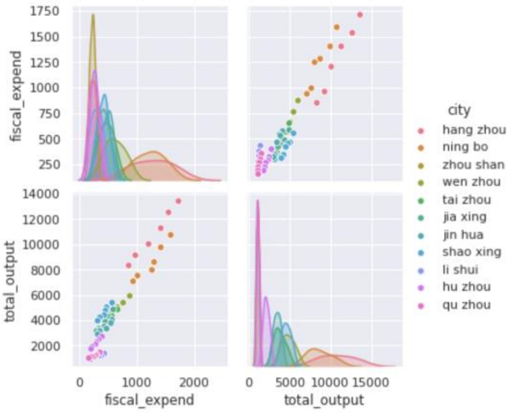

FIG.7 The relationship between fiscal expenditure and total output in 11 cities

Combining Figure 6 and Figure 7, we can know that fiscal expenditure and total output have a positive relationship, and total output and financial are also positive. Therefore, it can be concluded that fiscal expenditure and financial are also positive. Therefore, the greater the fiscal expenditure of a prefecture-level city, the more it can stimulate local economic development.

5. CONCLUSION

This paper firstly constructs a theoretical model of the contribution rate of government expenditure to production growth, and then uses python to perform linear regression based on fiscal expend and total output of relevant local fiscal data in China. The research results show that there is a certain correlation between government expenditure and production growth. Regression model and theoretical model show that government spending has a certain contribution to production growth. The main reason is that a certain scale of government expenditure can realize the optimal allocation of total social resources, the rapid growth of economic scale, and the continuous optimization of economic structure [6]. Therefore, the government must adopt an effective fiscal expenditure policy to increase investment in human capital, infrastructure, research and development, etc., so that government expenditure can provide a strong guarantee for economic and production growth, and its contribution rate will increase.

ACKNOWLEDGMENT

The second author has the same contribution as the first author. The authors would like to thank the anonymous reviewers and editors for their valuable comments and suggestions to improve the quality of this paper.

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