An Empirical Analysis of the Relationship between Shanghai’s Economic Growth and Fiscal Expenditure

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Keywords: Fiscal Expenditure, Economic Growth, VAR Model, Unit Root Test, Granger Causality Test.

Abstract. There are three viewpoints towards the relationship between fiscal expenditure and economic growth. The first type is that fiscal expenditure improves the economic growth, the second is that fiscal expenditure holds up the economic growth. While the last type of viewpoint is that fiscal expenditure makes no difference on the economic growth. The paper will do the empirical study on the relationship between fiscal expenditure and economic growth of Shanghai by VAR model. The result shows that fiscal expenditure is not the Granger Cause of economic growth. While under the 1% significance level, the economic growth is regarded to be the Granger Cause of fiscal expenditure. It means that the increase of Shanghai fiscal expenditure decreases consumer expenditure and investment, which makes fiscal expenditure have no effect on the output. To avoid the crowding-out effect, the government needs to get the optimum fiscal expenditure and consider to limit the financing activity of private departments so that private investment will not be crowded out.

Introduction

The classical economic theory says that the best government is the government who intervenes least on the economy.[1] However, as the development of economy and society, this view has been gradually negated. The government plays a more important role in the development of economic society. The effective public finance system is the precondition of economic growth.

Since the reform and opening-up, the economy of Shanghai has developed rapidly. The GDP rose from 30 billion to 2746.615 billion between 1978 and 2016, which increased by more than 90 times. Besides, the fiscal expenditure of Shanghai increased from 2.601 billion to 691.894 billion between 1978 and 2016, which grew by more than 266 times. Is there a statistical correlation between Shanghai’s fiscal expenditure and economic growth? Are their changes synchronous? The paper is going to do empirical study on the relationship between fiscal expenditure and economic growth by VAR model.

The Theoretical Model [2,3,4,5]

IS-LM Model. According to macroeconomics, under the expenditure approach, the domestic income is $Y = C + I + G + NX$. In the equation, $Y$ is domestic output, and $C$ is Consumption, and $I$ stands for Investment, and $G$ is Government Purchase, $NX$ stands for Net Export. When the other elements are unchanged, $Y$ will increase due to the increase of $G$, but the government expenditure will not rise ultimately because it is limited by the government income. As it shows in Fig.1, when government expenditure increases and the other elements remain stable, IS curve will move from IS$_1$ to IS$_2$, which causes the domestic output move from $Y_1$ to $Y_2$. 
Endogenous Growth Model. Endogenous Growth Model brings government expenditure to the production function of domestic output, which is \( Y = F(K, N, G) \). While \( K, N \) and \( G \) stand for capital, labor and government expenditure respectively. As for the derivatives regard to time \( t \),

\[
\frac{dY}{dt} = \frac{\partial F}{\partial K} \cdot \frac{dK}{dt} + \frac{\partial F}{\partial N} \cdot \frac{dN}{dt} + \frac{\partial F}{\partial G} \cdot \frac{dG}{dt}
\]

(1)

divide the both sides by \( Y \):

\[
\frac{dY/dt}{Y} = \frac{\partial F}{\partial K} \cdot \frac{K}{Y} \cdot 1 + \frac{\partial F}{\partial N} \cdot \frac{N}{Y} \cdot 1 + \frac{\partial F}{\partial G} \cdot \frac{G}{Y} \cdot 1
\]

(2)

set \( \beta_1 = \frac{\partial F}{\partial K} \cdot \frac{K}{Y} \), \( \beta_2 = \frac{\partial F}{\partial N} \cdot \frac{N}{Y} \), \( \beta_3 = \frac{\partial F}{\partial G} \cdot \frac{G}{Y} \), then get:

\[
\frac{dY/dt}{Y} = \beta_1 \cdot \frac{dK/dt}{K} + \beta_2 \cdot \frac{dN/dt}{N} + \beta_3 \cdot \frac{dG/dt}{G}
\]

(3)

make it into the discrete form, and set \( \Delta t = 1(\alpha) \), then get

\[
\frac{\Delta Y}{Y} = \beta_1 \cdot \frac{\Delta K}{K} + \beta_2 \cdot \frac{\Delta N}{N} + \beta_3 \cdot \frac{\Delta G}{G}
\]

(4)

From the equation (4), Economic growth can be explained by the growth rate of capital, labor, and government expenditure. \( \beta_1 \) is the output elasticity of capital, and \( \beta_2 \) is the output elasticity of labor, and \( \beta_3 \) is the output elasticity of government expenditure.

VAR Model. The normal mathematical function of Vector Autoregressive Model (VAR) is

\[
y_t = A_0y_{t-1} + \cdots + A_p y_{t-p} + B_1 x_t + \cdots + B_r x_{t-r} + \epsilon_t
\]

(5)

In this function, \( y_t \) is m dimensional endogenous variable vector, \( x_t \) is d dimensional exogenous variable vector, \( A_1 \cdots A_p \) and \( B_1 \cdots B_r \) is parameter matrix to be estimated. Endogenous variable and exogenous variable have lag stage for \( p, r \) respectively, and \( \epsilon_t \) is random disturbances. The elements at the same moment can be related but they cannot be related with lagged value and the variables on the right side of the function.

We use Bivariate Vector Autoregressive Model of fiscal expenditure and economic growth:

\[
Z_t = A_0 Z_{t-1} + \cdots + A_p Z_{t-p} + \epsilon_t
\]

(6)
while $Z = (G_{t}, G_{i})$, GDP is the Gross Domestic Product of Shanghai, and $G$ is government expenditure.

**Empirical Study**

The paper will analyze the data from 1978 to 2016, including Shanghai’s fiscal expenditure and GDP every year.

Table 1. GDP and Fiscal Expenditures (G) from 1978 to 2016 in Shanghai (unit: 100 million RMB).

| Year | GDP   | G      | Year | GDP   | G      | Year | GDP   | G      |
|------|-------|--------|------|-------|--------|------|-------|--------|
| 1978 | 272.81| 26.01  | 1991 | 893.77| 86.05  | 2004 | 8072.83| 1395.69|
| 1979 | 286.43| 27.06  | 1992 | 1114.32| 94.99 | 2005 | 9247.66| 1660.32|
| 1980 | 311.89| 19.18  | 1993 | 1519.23| 129.26| 2006 | 10572.24| 1813.80|
| 1981 | 324.76| 19.06  | 1994 | 1990.86| 196.98| 2007 | 12494.01| 2201.92|
| 1982 | 337.07| 20.68  | 1995 | 2499.43| 267.89| 2008 | 14069.87| 2617.68|
| 1983 | 351.81| 22.39  | 1996 | 2957.55| 342.66| 2009 | 15046.45| 2989.65|
| 1984 | 390.85| 30.32  | 1997 | 3438.79| 428.92| 2010 | 17165.98| 3302.89|
| 1985 | 466.75| 46.07  | 1998 | 3801.09| 480.70| 2011 | 19195.69| 3914.88|
| 1986 | 490.83| 59.08  | 1999 | 4188.73| 546.38| 2012 | 20181.72| 4184.02|
| 1987 | 545.46| 53.85  | 2000 | 4771.17| 622.84| 2013 | 21818.15| 4528.61|
| 1988 | 648.30| 65.88  | 2001 | 5210.12| 726.38| 2014 | 23567.70| 5182.65|
| 1989 | 696.54| 73.31  | 2002 | 5741.03| 877.84| 2015 | 25123.45| 6191.56|
| 1990 | 781.66| 75.56  | 2003 | 6694.23| 1102.64| 2016 | 27466.15| 6918.94|

The Fig.2 (a) shows the time series of Shanghai’s fiscal expenditure and GDP from 1978 to 2016, and the Fig.2 (b) shows the changes in the proportion of Shanghai’s fiscal expenditure in GDP over the years. As it shows in the Fig.2 (b), the proportion of Shanghai’s fiscal expenditure on the GDP continuously increased since 1994. To make sure if its fiscal expenditure and economic growth are related, the paper does the correlation analysis on them and find that the fiscal expenditure and economic growth are highly correlated, while its relatedness is 0.989776.

(a) The Time Series of Shanghai’s Fiscal Expenditure and GDP from 1978 to 2016.
The Proportion of Shanghai’s Fiscal Expenditure on GDP

Figure 2. The Relationship between Shanghai’s Fiscal Expenditure and GDP.

Then the mechanism between fiscal expenditure and economic growth need to be analyzed. To determine whether fiscal expenditure promotes the economic growth, the Granger Causality Test of VAR Model can be used. As there may be stability issues in the time series plot, a stability test on the fiscal expenditure G and GDP should be tested.

Table 3. The Result of ADF Unit Root Test on the Logarithm Sequence of GDP.

| ADF Test Statistic | -2.003355 |
|--------------------|-----------|
| 1% Critical Value  | -4.226815 |
| 5% Critical Value  | -3.536601 |
| 10% Critical Value | -3.200320 |

Table 4. The Result of ADF Unit Root Test on the Logarithm Sequence of G.

| ADF Test Statistic | -4.193809 |
|--------------------|-----------|
| 1% Critical Value  | -4.226815 |
| 5% Critical Value  | -3.536601 |
| 10% Critical Value | -3.200320 |

The Table 3 shows that the statistical value of ADF of the Series is -2.003355, which is higher than the critical values on level 1%, 5% and 10%. So the Series has the unit root. The Table 4 shows that the logarithm sequence of G is nonstationary sequence. The Granger Causality Test may have a wrong result. But if there is co-integration relationship between them, the causality test result has credibility.

The paper uses EG test to determine if fiscal expenditure and economic growth have co-integration relationship between them. Firstly, it is known that the logarithm sequences of GDP and fiscal expenditure are both two-order integrated time series, which satisfy the precondition of co-integration test.

The second step is to build regression equation for the two variables: \( \ln \text{GDP}_t = c + \beta \ln \text{G}_t + \epsilon_t \). \( \ln \text{GDP}_t \) is the logarithm sequence of GDP. \( \ln \text{G}_t \) is the logarithm sequence of fiscal expenditure. We estimated the return model parameter by ordinary least squares (OLS). According to the result shown in Table 5, the model has high goodness-of-fit and the regression coefficients are approved by T.

Finally, ADF unit root test is done on the residual sequence of the regression model. The results show in the Table 6. The residual sequences are stationary because the statistical value of ADF is
-2.998060, smaller than the critical values of 5% and 10%. Therefore, the logarithm sequences of GDP and fiscal expenditure have co-integration.

Table 5. The Regression Results.

| Variable | Coefficient | t-Statistic | Prob. |
|----------|-------------|-------------|-------|
| c        | 3.235449    | 54.26220    | 0.0000|
| lnG      | 0.800837    | 82.57415    | 0.0000|

Table 6. The ADF Test Results of Regression Model’s Residual Sequences.

| ADF Test Statistic | -2.998060 |
|--------------------|-----------|
| 1% Critical Value  | -3.615588 |
| 5% Critical Value  | -2.941145 |
| 10% Critical Value | -2.609066 |

The results of Granger Causality Test on the variables shows in the Table 7, which shows that Shanghai’s fiscal expenditure is not the Granger cause of economic growth, while the economic growth is the Granger cause of fiscal expenditure due to the significance level of 1%.

Table 7. Granger Causality Test Results.

| Null Hypothesis:       | Lags | F- Statistic | Prob. |
|------------------------|------|--------------|-------|
| LNG does not Granger Cause LNGDP | 2    | 0.06238      | 0.9396|
| LNGDP does not Granger Cause LNG | 2    | 12.0657      | 0.0001|

Conclusion

The result shows that Shanghai’s fiscal expenditure is not the Granger cause of economic growth, while the economic growth can be regarded to be the Granger cause of fiscal expenditure due to the significance level of 1%. The increase of Shanghai’s fiscal expenditure causes the decrease of private consumption and investment. Therefore, fiscal expenditure cannot have effect on output. To avoid the crowding-out effect, the government should calculate the optimum expenditure and consider to limit the financing activities of private departments so that private investment will not be crowded out.

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