

Research on the Efficiency of Chinese Government Public Investment based on Production Function

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Abstract

For a long time, the Chinese government has always paid great attention to the expansion of government public investment to achieve the goal of sustained and stable growth of the regional economy. The problem has seriously affected the efficiency of public investment in our country. Based on the Cobb-Douglas production function, this paper constructs cointegration test and Granger causality test to conduct an empirical analysis on the input-output efficiency of China's public investment from 1982 to 2021. The results show that China's public investment has a significant impact on economic growth. However, the output efficiency of public investment is lower than that of private investment.

Keywords

Public Investment Efficiency; Production Function; Co-integration Test; Granger Causality Test.

1. Introduction

Government public investment is an important means for the country to implement macro-control, optimize resource allocation, and promote the sustainable and coordinated development of the national economy. Improving the efficiency of public investment in various regions of our country is an inevitable requirement for revitalizing the economy and improving people's livelihood. In recent years, my country's economy as a whole has shown a rising trend, but.

Over the years, our country has been developing and progressing continuously. However, looking back at our country's development mode, the local government blindly pursues to expand the scale of investment, which has caused a series of problems, which in turn hindered the sustainable and sound development of the regional social economy. The 20th National Congress of the Communist Party of China puts forward new requirements for the stage of economic development, which means changing the mode of stimulating economic growth through expanding investment to the mode of reducing investment and improving efficiency. In this context, an objective and fair evaluation of my country's public investment efficiency has practical significance for high-quality economic development.

2. Literature Review

At present, there are two completely different conclusions and views on the efficiency of public capital and private capital. One view holds that the output efficiency of public capital is higher than that of private capital. Aschauer (1989) first conducted a pioneering study on the efficiency of public investment. Empirical analysis estimated that the output elasticity of public capital in the United States from 1949 to 1985 was about 0.39 to 0.56, and pointed out that the total factor productivity (TFP) in the United States declined from 1971 to 1985. It is mainly caused by the slowdown in the growth rate of public capital [1]. Munnell (1992) established a

standard production function on this basis and introduced public capital into the model as an input factor. Through empirical analysis, it was estimated that the output elasticity of public capital in 48 states in the United States from 1970 to 1986 was about 0.36. At the same time, it was pointed out that after 1969, due to the decline of the per capita public capital stock, the labor productivity of the United States fell by 78% [2]; the empirical analysis of Otta and Voss (1994) pointed out that the output elasticity of public capital in Australia from 1966 to 1990 was about 0.38~0.45, Its efficiency is much higher than that of private capital. At the same time, another point of view does not believe that the output efficiency of public capital is higher than that of private capital, that is, it believes that in the actual investment policy regulation, more attention should be paid to the role of private investment [3]. Cao Jing and Shen Meiyi (2021) constructed a panel VAR to carry out empirical studies and learned that the crowding of private investment into public investment in my country can promote economic development. Based on this, they proposed to encourage private investment and create good conditions for it [4]. Bah Mamadou (2021) argues that promoting private investment and attracting FDI should accompany any governance reform [5]. Matiur Rahman (2016) used the autoregressive distribution lag and vector error correction model to measure the impact of Bangladesh's public investment and private investment growth on per capita real GDP growth, and found that private investment played a greater role than public investment [6].

Scholars have also conducted research on the efficiency of public investment from different perspectives. From a spatial perspective, Cheng Jinyue (2023) used a two-way fixed-effect spatial Durbin model to explore the impact of public investment on high-quality economic development and its spatial spillover effects, and found that public investment has a significant spillover effect on high-quality economic development, expressed as Public investment in surrounding areas is not conducive to the high-quality development of the local economy [7]. Li Deyu (2020) constructed a panel model from the perspective of industrial structure upgrading and found that there is a long-term dynamic relationship between public investment, industrial structure upgrading, and the level of new urbanization [8]. Cantos Cantos José María (2020) focuses on public investment and investment aid, and finds that there are parallels between investment aid received from European regional development funds and regional public investment, and between aid and regional governments' own resources dedicated to financing public investment. Causality [9].

Most scholars have done a lot of research on the measurement of government public investment efficiency and its relationship with economic growth. However, the data used in the empirical analysis is relatively old, and it has little reference significance for the current improvement of China's public investment efficiency. Newer data are used to study China's public investment efficiency is very necessary. Secondly, after scholars conducted empirical analysis of my country's public investment, they seldom systematically analyzed the reasons for the empirical conclusions and lacked targeted suggestions based on the current situation. This paper uses the latest data in the empirical analysis, and specifically analyzes the reasons for the low efficiency of public investment in my country, and proposes an optimization path accordingly.

3. Empirical Analysis of Public Investment Output Efficiency

3.1. Model Setting

The production function method can directly reflect the relationship between various elements and economic growth, so it is chosen as a research tool by many researchers in our country. This paper also chooses the Cobb-Douglas production function method to study the relationship between public investment and economic growth by estimating and fitting the function coefficients. The traditional production function assumes that the growth of output

can be regarded as the result of the joint action of labor input growth, fixed capital investment growth and technological progress. Technological progress is generalized (neutral), expressed by the Cobb-Douglas production function have:

$$Y_t = A_t K_t^\alpha L_t^\beta \quad (1)$$

Y_t , A_t , K_t , and L_t are the output level, generalized technological progress, fixed capital input, and labor input, respectively, and α , β are the output elasticity of fixed capital input and labor input, respectively. This paper mainly analyzes the impact of public investment and private investment on economic growth, so the fixed capital investment is divided into public investment and private investment, then:

$$Y_t = A_t K_t^\alpha L_t^\beta G_t^\gamma \quad (2)$$

Among them, K_t only refers to non-government investment and no longer represents the overall level of fixed capital investment; G_t refers to public investment; γ refers to the output elasticity of public investment. Take the logarithm on both sides of (2) to get:

$$\ln Y_t = \ln A_t + \alpha \ln K_t + \beta \ln L_t + \gamma \ln G_t \quad (3)$$

3.2. Data Source and Description

Public investment is an investment that provides public goods to meet social public needs. It should be mainly undertaken by the government, and the characteristics of government investment should be reflected in the selection of public investment data. This paper adopts the small-caliber public investment data G_t , and only considers the part of the fixed asset investment of the whole society that comes from the budget. Since the specific data on state budget funds in the Statistical Yearbook only covers 2017, the public investment data from 2018 to 2021 are calculated according to the formula of "state budget funds of the previous year \times (1 + year-on-year growth rate)". Non-government investment K_t is equal to the total social fixed asset investment minus public investment in the China Statistical Yearbook. The output level Y_t is represented by GDP. Since the data in the Statistical Yearbook are continuously updated, this article is based on the latest statistical data. The GDP data for 1982-2021 are all from the 2022 Statistical Yearbook. Human capital is competitive, and it has positive external effects in the production process. Learning and education have an impact on human capital. As far as regional socio-economic development is concerned, government public investment provides public goods such as education, public health and health that are necessary for the production and life of residents in the region. Such public goods are often the bottleneck of regional economic development. Therefore, labor input is one of the extremely important and comprehensive evaluation indicators for measuring the efficiency of government public investment. The variable of labor input L_t in this paper is represented by the number of employed persons from 1982 to 2021 published in the China Statistical Yearbook.

3.3. Regression Analysis

Ordinary least squares (OLS) was used to regress the logarithmic variables. In the regression model, Y , L , G , and K are used to represent the output level (Y_t), labor input (L_t), public investment (G_t) and private investment (K_t), and \ln is used as the logarithmic symbol, and D is the difference symbol. See Table 1 for the estimated results.

Table 1. OLS estimation of my country's public investment, private investment and economic growth

variable	coefficient	Sd	T	P
C	-4.256526	3.213985	-1.324376	0.1937
LNG	0.106705	0.041494	2.571582	0.0144
LNK	0.697156	0.057328	12.16090	0.0000
LNL	0.687858	0.314718	2.185631	0.0354
R-squared		0.997839		
Adjusted R-squared		0.997659		
Durbin-Watson stat		0.603615		
F-statistic		5542.151		
Prob(F-statistic)		0.000000		

The regression equation can be obtained from the above table:

$$\begin{aligned}
 \ln Y_t &= -4.256526 + 0.697156 \ln K_t + 0.687858 \ln L_t + 0.106705 \ln G_t \text{ (Equation 1)} \\
 &\quad (3.2140) \quad (0.0573) \quad (0.3147) \quad (0.0415) \\
 &\quad t=(-1.3244) \quad (12.1609) \quad (2.1856) \quad (2.5716) \\
 R^2 &= 0.9978 \quad \bar{R}^2 = 0.9977 \quad F = 5542.151 \quad DW = 0.603615
 \end{aligned}$$

The goodness of fit $R^2 = 0.9978$ of the model is close to 1, indicating that the fitting degree of the regression model is quite high, and 99.78% of the changes in the variable Y can be explained by K, L, and G (model). The F statistic is 5542.151 greater than the zero threshold $F_{\alpha}(k, n - k - 1) = F_{0.05}(3, 40 - 3 - 1) = 2.866$, and the accompanying probability prob(F) is 0, rejecting the null hypothesis, indicating that at least one of the regression coefficients α , β , and γ is significantly different from 0, and the linear relationship of the model is significant, indicating that the common The total impact of investment G, non-government investment K, and labor input L on output function Y is significant. The absolute values of the t-statistics of the explanatory variables public investment G, non-government investment K, and labor input L are 2.5716, 12.1609, and 2.1856, respectively, which are smaller than the critical value $t_{\alpha/2}(n - k - 1) = t_{0.025}(40 - 3 - 1) = 2.028$. The corresponding prob(t) values are 0.0144, 0, and 0.0354, respectively. Less than $\alpha=0.05$, indicating that these explanatory variables have a significant impact on the explained variables. Only the DW value is slightly smaller, and the test effect is uncertain. The overall regression results are good. Among them, the output elasticity of public investment is 0.106705, which has a more significant role in promoting economic growth, but its output elasticity is smaller than 0.697156 of private investment, which shows that in the contribution to economic growth, the public The role of investment is smaller than that of private investment, and the output efficiency of public investment is lower than that of private investment.

3.4. Cointegration Test

3.4.1. Unit Root Test

When ordinary OLS regresses the model, it is generally assumed that the time series of economic variables is stationary. In the operation of the actual economy, economic variables are rarely stable, so the regression test done on the premise that the economy is stable, the regression results obtained are likely to lead to spurious regression, and the results of OLS regression may be meaningless. Therefore, the unit root test of time series stationarity must be carried out on variables. In this paper, the ADF unit root test is adopted, and the lag item is determined by the criterion of minimizing AIC and SC, and the empirical test is carried out by selecting both the constant item and the time trend item. The test results are shown in Table 2.

Table 2. ADF unit root test of variables

variable	inspection form(c, t, n)	ADF	5% critical value	AIC	SC	test result
LNY	(c, t, 4)	-1.092742	-3.544284	-3.571455	-3.260386	non-stationary
LNL	(c, t, 0)	-1.520396	-3.529758	-4.724548	-4.596582	non-stationary
LNG	(c, t, 0)	-1.803098	-3.529758	-0.791565	-0.663598	non-stationary
LNK	(c, t, 1)	-2.117623	-3.533083	-1.962974	-1.790596	non-stationary
ΔLNY	(c, t, 3)	-4.230547	-3.544284*	-3.586837	-3.320206	smooth
ΔLNL	(c, t, 0)	-6.639993	-3.533083*	-4.652455	-4.523172	smooth
ΔLNG	(c, t, 0)	-4.800306	-3.533083*	-0.720855	-0.591571	smooth
ΔLNK	(c, t, 1)	-4.134513	-3.536601*	-1.943493	-1.769340	smooth

Note: (c, t, n) is the form of ADF test, where c means with a constant item, t means with a trend item, n is the number of lag periods, determined by the SIC criterion, "*" means a significant level of 5%, Δ represents the first order difference.

It can be seen from the test results that the ADF statistics of output level, labor input, public investment and private investment (LNY, LNL, LNG, LNK) are all greater than the 5% critical value, and there is a unit root, that is, the four All variables are not stationary in the time series, and there may be "pseudo-regression" in the least squares estimation for them. However, even if the variables are not stationary, if there is a long-term equilibrium relationship between the variables, their linear combination may be stationary. Therefore, if there is a co-integration relationship between variables, its linear regression can also explain the economic relationship. After performing the first-order difference on the logarithmic values of each variable, the ADF test is performed, and it is found that the ADF values of ΔLNY , ΔLNL , ΔLNG , and ΔLNK are all less than the critical value at the 5% confidence level, and the sequence is stable, that is LNY, LNL, LNG, and LNK all belong to the first-order integrated sequence, that is, I(1). Cointegration test can be carried out if the conditions of cointegration test are met.

3.4.2. Johansen Cointegration Test

The basic idea of co-integration test is that if two or more time series variables are non-stationary, but a certain linear combination of them is stable, then there is a long-term stable equilibrium relationship between these variables, that is, there is a co-integration relationship. whole relationship. The economic significance is that, for two or more variables with their own long-term fluctuation laws, if they are co-integrated, there is a long-term equilibrium relationship between them. Conversely, if these two or more variables are not co-integrated, there is no long-term equilibrium relationship between them.

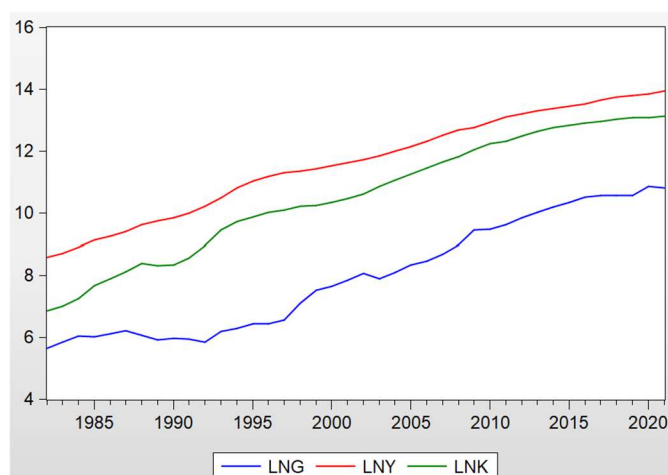


Figure 1. Time series of LNG, LNY, LNK (1982-2021)

Figure 1 shows that there is an obvious equilibrium relationship among LNY, LNK and LNG. First, use the VAR model to determine the optimal lag order, as shown in Table 3, we can see that the optimal lag order is 2nd order.

Table 3. Lag order test

Lag	LogL	LR	FPE	AIC	SC	HQ
1	227.6239	NA	1.27e-10	-11.43913	-10.74251*	-11.19354
2	250.8099	36.34570*	8.82e-11*	-11.82756*	-10.43434	-11.33639*
3	264.1531	18.03133	1.09e-10	-11.68395	-9.594112	-10.94719

Perform the Johansen cointegration test on the logarithmic values of the four variables LNY, LNL, LNK, and LNG, and select the "intercept(no trend) in CE and test VAR" method, that is, the sequence LNY has a definite linear trend, and the cointegration equation only has an intercept item. The trace test results are shown in Table 4:

Table 4. Trace inspection results

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.580210	67.96018	47.85613	0.0002
At most 1 *	0.457986	34.97612	29.79707	0.0116
At most 2	0.211966	11.70249	15.49471	0.1718
At most 3	0.067369	2.650355	3.841466	0.1035

In Table 4, the values of 2 trace statistics are greater than the critical value of the 5% significance level, rejecting the null hypothesis "there is no co-integration relationship in the sequence", indicating that there is a co-integration relationship among LNY, LNL, LNG, and LNK, and at least Shows 2 co-integration equations.

Table 5. Standardized Cointegration Coefficients

LNY	LNL	LNK	LNG	C
1.000000	-0.775801	-0.556554	-0.144627	4.057714
	(0.58392)	(0.11226)	(0.08139)	

Combining the standardized cointegration coefficients in Table 5 and the constants in the vector error correction model, the long-term relationship of the four variables can be obtained as:

$$LNY=0.775801LNL+0.556554LNK+0.144627LNG-4.057714 \text{ (equation 2)}$$

$$(0.58392) (0.11226) (0.08139)$$

It can be concluded from Equation 2 that the coefficient of public investment is 0.144627, which has a certain promoting effect on economic growth, but the coefficient is smaller than that of private investment (0.556554). The estimated result is similar to Equation 1, and the effect of public investment on economic growth is smaller than that of private investment.

3.5. Granger Causality Test

The cointegration test results tell us that there is a long-term equilibrium relationship between public investment and other variables and economic growth (output efficiency), but whether this equilibrium relationship constitutes a causal relationship, that is, economic growth is brought about by the expansion of public investment, or is it The expansion of public investment brought about by economic growth needs further examination.

The Granger causality test is to test whether the lag value (past information) of a variable has the predictive ability to the information of the explained variable. If the variable x helps to predict the variable y, that is, when autoregressing y according to the past value of y, if adding the past value of x can significantly enhance the explanatory power of the regression, then x is said to be the Granger of y cause; otherwise, a non-Granger cause.

Table 6. Granger causality test results

hypothesis	F	P
LNG does not Granger Cause LNY	1.15450	0.3276
LNY does not Granger Cause LNG	3.77088	0.0335*
LNK does not Granger Cause LNY	3.54464	0.0403*
LNY does not Granger Cause LNK	4.84116	0.0143*
LNL does not Granger Cause LNY	0.56900	0.5715
LNY does not Granger Cause LNL	0.79352	0.4607

Note: * means significant at the 5% level.

Table 6 shows that in the entire sample interval, the change of public investment G is not the Granger cause of the change of output level Y, but the change of output level Y is the Granger cause of the change of public investment G, that is, the difference between the two There is only one-way causality from the output level Y to the public investment G; the change of non-government investment K is the Granger cause of the change of output level Y, and the change

of output level Y is also the graticule of the change of non-government investment K There is a two-way causality between the two variables; the change of labor input L is not the Granger cause of the change of output level Y, and the change of output level Y is not the Granger cause of the change of labor input L. There is no Granger causality between the variables.

4. Conclusion Analysis and Policy Suggestions

4.1. Conclusion Analysis

Through the least squares estimation, unit root test, and co-integration analysis on the data of my country's output level, labor input, public investment and private investment from 1982 to 2021, it is found that my country's output level, labor input, public investment and private investment There is a co-integration relationship between them, and the result is similar to the least squares estimation. It shows that my country's public investment has a certain role in promoting economic growth, but its output elasticity is smaller than that of private investment, that is, the output efficiency of public investment is lower than that of private investment. Through the Granger causality test, it is found that the change of public investment is not the Granger cause of the change of output level, but the change of output level is the Granger cause of the change of public investment; there is a two-way causality between non-government investment and output level . After careful exploration, the current slow efficiency of public investment in my country may be due to the following reasons:

4.1.1. The System of Laws and Regulations in the Field of Public Investment is Not Perfect

Strictly speaking, some current laws and regulations in our country are not systematic and complete legislation in the field of public investment, but regulate a certain link. Due to the lack of systematic and standardized special legislation and detailed supporting explanatory documents, there are disadvantages in the field of public investment such as unclear definition of operating procedures, strong accountability, and weak incentive and restraint mechanisms.

4.1.2. The Boundaries of Public Investment are Blurred and the Scale is Expanding

At present, governments at all levels in our country are facing the challenges of intergovernmental competition and the official promotion mechanism based on the "political tournament" model. Only government officials who respond properly can win public opinion and win the competition for official promotion. The most convenient way for officials to produce political achievements is to expand the scale of public investment, rapidly increase GDP in a short period of time, improve the welfare of local residents, and win public support.

4.1.3. Irrational Structure of Public Investment

At present, in the industrial structure of public investment, there is too much investment in economic infrastructure such as railways, highways, and airports, and relatively insufficient investment in social infrastructure such as science, education, culture, health, and sports. The latter determines the competitiveness of a country's human capital. long-term sustainable economic growth. In terms of regional structure, the per capita public investment in the eastern region is much higher than that in the central and western regions, and the scarcity of public investment in the eastern region is much lower than that in the central and western regions. While reducing the macro-efficiency of public investment, "the strong will always be strong, and the weak will always be weak". "The Matthew effect is not conducive to the balanced and coordinated development of the regional economy.

4.1.4. The Management System in the Field of Public Investment is Chaotic and Lacks an Authoritative Performance Evaluation System

The management of my country's current public investment field involves multiple departments such as the Development and Reform Commission, finance, auditing, and

construction, and the management efficiency is low. The social benefits of public investment projects are remarkable but the economic benefits are difficult to measure. It is difficult to establish an authoritative performance evaluation system. There is no effective mechanism for the whole process supervision and post-project evaluation of public investment projects. Corrupt officials and powerful capital with huge interests and huge temptations can take advantage of this opportunity.

4.2. Policy Recommendations

At present, my country must attach great importance to and vigorously improve the efficiency of public investment, which can optimize the investment structure, guide the effective allocation of resources, cultivate a good environment for independent innovation, promote scientific and technological progress and industrial upgrading, and ultimately improve the overall quality of the macro economy and accelerate the transformation of my country's growth mode, to promote the sustained and balanced growth of my country's economy in the medium and long term. In order to improve the economic efficiency of public investment and realize the modernization and sustainable development of my country's economy and society, the following policy suggestions are put forward:

4.2.1. Establish and Improve the Legal and Regulatory System in the Field of Public Investment in My Country

Formulate laws and regulations such as the "Regulations on Public Investment", "Regulations on the Implementation of the Tendering and Bidding Law" and "Interim Measures for the Accountability of Government Investments" that are in line with my country's national conditions, draw on international experience, and legislate to clarify that the public has the right to know about public investment project information and the right to participate in decision-making, so that the government's public investment operation can be legalized and institutionalized.

4.2.2. Clarify the Boundary between Public Investment and Private Investment, and Strictly Control the Scale of Public Investment

Drawing on the experience of developed countries, the boundary of our government's public investment should be defined as non-competitive areas, defined in the economic and social areas that are related to national security and where the market cannot effectively allocate resources, and the government in competitive investment areas should benefit the people. The scale of public investment must be strictly controlled to improve the efficiency of public investment. The public investment project approval system, publicity system, expert review system and public participation system should be improved. The implementation of public investment projects is mainly operated by independent market intermediaries, and the government only supervises key links.

4.2.3. Optimizing the Structure of Public Investment

It is necessary to optimize the expenditure structure of public investment, increase public investment in software and hardware such as rural science, education, culture, health, sports and infrastructure, improve the quality and level of rural infrastructure and public services, and encourage and guide the formation of a scientific research mechanism integrating "industry, education and research". Public investment can try to guide investment in strategic industries, guide enterprises to invest in environmental protection, play a leading role in clean energy, water resource protection and sewage treatment, urban public facilities construction, and ecological engineering construction, and contribute to technological innovation and economic and social sustainability. Development provides impetus.

4.2.4. Establish and Improve the Performance Evaluation and Supervision System of My Country's Public Investment Projects

Establish a market access system based on the reputation evaluation system, veto all kinds of institutions with low market reputation, tainted history, and large public opinions, and strictly prohibit entry into various bidding activities in my country's public investment field; build dynamic transparency An efficient government public investment supervision system implements dynamic, multi-level, internal and external supervision over the entire process of public investment projects, strengthens and improves the supervision mechanism of the People's Congress, the public and the media, and clarifies specific supervision institutions to avoid supervision gaps. bit.

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