# Research on Agricultural Investment Efficiency Based on DEA Model-Taking Anhui Province as an Example

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ABSTRACT. *The development of modern agriculture situation in Anhui, investment in agriculture, through the DEA model to determine the efficiency of investment in agriculture has reached optimal state. The empirical study found that 10 cities in Anhui are in the same stage of scale return, indicating that 10 cities are optimal allocation; the other 6cities are in the stage of increasing returns to scale, and 14 cities are better than average;However, Huaibei, Fuyang and Huainan,Wuhu and Chizhou have not achieved full scale and effectiveness, and have not reached the optimal state of investment efficiency. Research on the problems existing in agricultural investment, and put forward corresponding countermeasures and suggestions.*

KEYWORDS: *agricultural investment efficiency, DEA model, optimal state*

## 1. Introduction

The 19th National Congress of the Communist Party of China made a major decision-making arrangement for implementing the rural revitalization strategy. Anhui Province took the initiative to adapt to the new normal and accelerated the modernization of agriculture and rural areas according to the general requirements of industrial prosperity, ecological livability, rural civilization, effective governance and affluent life. However, in recent years, the irrationality of the modern agricultural capital investment mechanism in Anhui Province has resulted in unclear rights and responsibilities of investment entities, unreasonable decision-making, and low enthusiasm for social capital investment, which restricts the development of modern agriculture. To this end, it is of great significance to correctly understand and analyze the basic conditions of Anhui's modern agricultural development, to find out the problems of Anhui's agriculture, to formulate improvement measures, and to promote the rapid development of modern agriculture. This paper analyzes the status quo of modern agricultural development and the status quo of agricultural

investment in Anhui Province, in order to comprehensively understand the real situation of modern agricultural development and agricultural investment in Anhui Province, and to study whether the efficiency of agricultural investment in Anhui Province is optimal through empirical research.

## 2. Analysis of the Status Quo of Agricultural Investment

In recent years, Anhui's agricultural investment has fluctuated greatly, and the proportion of investment has declined, but it is still in a reasonable range. Among them, investment in agricultural water conservancy facilities has increased, and investment in leisure agriculture has become a new investment direction. Due to differences in economic development and soft environment, agricultural investment in Anhui cities also differs, and investment advantages in the six central provinces are not strong.

### 2.1 Agricultural investment is highly volatile, and the proportion of investment declines

In recent years, the total amount of agricultural investment in Anhui Province has fluctuated greatly. The total agricultural investment in 2018 was 80.272 billion yuan, an increase of 2.693 billion yuan compared with 2017. The proportion of agriculture is declining year by year. In 2018, the proportion of agriculture reached 2.46%, down by 0.196 percentage points from the previous year. On the whole, agricultural investment has little support for Anhui's agricultural transformation and development, and agricultural facilities and equipment and scientific and technological support are not strong. This is the cyclical, regional and seasonal price of agricultural products. Agricultural investment has great uncertainty, and investment may have losses. Moreover, due to the influence of policy regulation, the direction of industrial structure policy regulation is lower than that of the primary industry, and the proportion of secondary and tertiary industries is increasing. Therefore, agricultural investment is relatively small, and its proportion of total fixed assets investment will also decrease.

### 2.2 The potential for investment in leisure agriculture is large, and the government continues to increase policy support

Leisure agriculture is a new type of agricultural production and management that utilizes agricultural landscape resources and agricultural production conditions to develop tourism, leisure and tourism.leisure agriculture has become a new investment direction for Anhui agriculture. In 2017, Anhui Agricultural Fair implemented 114 contracted projects with a total investment of 47.09 billion yuan. Among them, there are 38 agricultural product processing projects with an investment of 10.38 billion yuan and 36 projects in leisure agriculture with an investment of 17.77 billion yuan. There are 16 projects such as Internet+, agricultural products e-commerce, and integration of the first, second and third

generations, with an investment of 6.1 billion yuan. In 2018, the Agricultural Fair implemented a total of 118 contracted projects with a total investment of 63.844 billion yuan. Among them, 56 leisure agriculture projects were contracted on site, including 22 provincial-level leisure agriculture in Anhui Province.

Various local governments in Anhui have issued support policies for leisure agriculture, including land policy concessions, capital subsidy dividends, basic supporting facilities, and technical support. The subsidy support is strong. In 2018, Anhui Agricultural Comprehensive Development and Horticulture Production Demonstration Base Project, the supporting funds are generally about 2 million yuan; the Forestry Bureau's comprehensive agricultural development of famous economic forest demonstration projects, supporting funds of about 1.5 to 3 million yuan; the horticultural crops standardized by the Ministry of Agriculture Create a project, support funds in the 5 to 1 million yuan, the Agricultural Bureau of the fruit and vegetable standard park to create a project, support funds between 2 million and 1 million yuan; the Agricultural Bureau's high-yield creation project, support funds of about 5 to 1 million yuan.Second, comparative analysis of agricultural investment in different regions.

## 3. Comparative Analysis of Agricultural Investment in Different Regions

### 3.1 Comparative analysis of agricultural investment in various cities

Due to differences in economic levels and policies, the agricultural development of cities in Anhui Province will vary, and agricultural investment has great uncertainty, and agricultural investment varies greatly from region to region.From the perspective of the region, the agricultural investment of 16 prefecture-level cities is quite different. In 2018, Wuhu agricultural investment accounted for 14.32% oftotal investment, Anqing agricultural investment accounted for 11.32% of total investment, and Hefei, Huainan, Zhangzhou, Maanshan and Suzhou agricultural investment proportions were 8.29%, 9.3%, 6.03%, 6.78% and 5.31%, the proportion of agricultural investment in other cities is less than 5% .

At present, Anhui Province is still dominated by traditional extensive agriculture, the industrial base is relatively weak, the secondary and tertiary industries are underdeveloped, and farmers' income is mainly derived from grain cultivation, so the proportion of agricultural investment is relatively high. The agricultural basic conditions such as the Minjiang Demonstration Zone and the Hefei Experimental Zone are relatively good, the water resources are abundant, the facilities for drought resistance and drainage are good, the transportation facilities are developed, the proportion of non-agricultural industries is high, and the agricultural and sideline products processing industry develops rapidly. More attention will be paid to the investment in the secondary and tertiary industries, and the proportion of agricultural investment will be relatively reduced, thereby transforming the primary industry into the secondary and tertiary industries and promoting the upgrading of industrial structure.

### 3.2 Comparative analysis of investment in agricultural modernization in the six central provinces

Anhui Province has a natural geographical advantage in the six central provinces and has abundant natural resources, laying a good foundation for agricultural economic development. Compared with other provinces in central China, the overall development advantage of Anhui's agricultural economic development is not strong. From the perspective of fiscal expenditure on agriculture, Henan's agricultural expenditure in 2018 was 91.681 billion yuan, ranking first in the six central provinces. Anhui's agricultural expenditure was 68.191 billion yuan, ranking third in the central region. Shanxi's agricultural expenditure was 47.791 billion yuan, with the least expenditure. From the proportion of agricultural expenditures to total fiscal expenditures, Anhui's agricultural expenditures in other five provinces account for a similar proportion of total fiscal expenditures, and basically remain above 10%. It can be seen that Anhui's agricultural economic development has a weak advantage and its investment is relatively small. This is because the Anhui economy is relatively backward compared to Henan, Hubei and Hunan, and the fiscal revenue is relatively small. In addition, the differences in the soft environment of investment in the provinces are not strong.

## 4. Analysis of Anhui Agricultural Investment Efficiency Evaluation

Due to the expansion of Anhui's agricultural investment, the proportion of agricultural investment is declining. For this reason, this paper uses Data Envelopment Analysis (DEA) to measure the efficiency of agricultural comprehensive development investment, that is, to exchange the least economic value for the least. Analyze and evaluate whether the efficiency of agricultural investment in Anhui Province is optimal.

### 4.1 Choice of evaluation methods for agricultural investment efficiency

There are many methods for evaluating the efficiency of agricultural investment. Only the most representative ones are introduced here: the evaluation index system analysis method and the input-output method. Compared with the evaluation index system analysis method, the advantage of adopting the input-output analysis method is that it can grasp the general law of agricultural production from the overall situation, and can also study the impact of the overall input on individual production while examining the impact of individual inputs on the system. Compared with the evaluation index system analysis method, the input-output analysis method is more objective, the principle is easy to understand, and the result is more intuitive. Therefore, the paper will use the input-output method to measure the efficiency of agricultural investment.

### 4.2 Evaluation index and data processing of agricultural investment efficiency

This paper regards the total output value of agriculture as the agricultural economic output, and the investment in fixed assets of agriculture, forestry, animal husbandry and fishery as capital input, the amount of agricultural land, the amount of agricultural fertilizer application and agricultural machinery power, agricultural electricity consumption and agricultural water consumption are regarded as The input of resources, the proportion of employees engaged in agriculture, forestry, animal husbandry and fishery at the end of the year is regarded as the input of labor. This paper uses the relevant data of agricultural output value, fixed assets investment in agriculture, forestry, animal husbandry and fishery in 16 prefecture-level cities in Anhui Province in 2018 for empirical research.

Using 2017 as the base period, the relative values of the variables are calculated. Directly comparing the output and input quotient as the research object, the relationship between the variables can not be reflected in this method. Therefore, various improvements have emerged. The data processing method can not only examine the relationship between the dependent variable and the respective variables, but also the interrelationship between the variables. Since the relative values of the variables also have negative values, the data is dimensionlessly processed to eliminate the deviation of the research results caused by the different units. The sample data are from the Anhui Bureau of Statistics.

### 4.3 Model setting

DEA is the abbreviation of Data Envelopment Analysis, which is data envelopment analysis. The DEA validity is equivalent to the pareto efficient solution (or non-dominated solution) of the corresponding multi-objective programming problem. Data envelopment analysis (i.e.DEA) can be regarded as a new method for statistical analysis which is based on a set of input-to estimate the effective production frontier observations output. This paper uses DEA to measure the efficiency of agricultural investment in Anhui Province in 2018, and evaluates and analyzes its investment efficiency [1-3]. The DEA model is as follows:

$$\min = \{\theta\} \tag{1}$$

$$\text{St} \sum \lambda_j = 1, \ X_j\lambda_j \leq \theta X_{j0} \tag{2}$$

$$\sum \lambda_j = 1, \ Y_j\lambda_j \geq Y_{j0} \tag{3}$$

Introducing the relaxation variables S + and S - to the model, then (2) and (3) become:

$$\text{St} \sum \lambda_j = 1, \ X_j\lambda_j + S^- = \theta X_{j0} \tag{4}$$

$$\sum \lambda_j = 1, \quad Y_j \lambda_j - S^+ = Y_{j0} \qquad (5)$$

$\lambda_j \geq 0$, $S^+ \geq 0$, $S^- \geq 0$, $\theta$ free

$X_{j0}$ Expre $j0$ A DMU output vector, $\theta$ Indicates the input reduction ratio, $\lambda$ A coefficient representing the linear combination of decision units, with * indicating the optimal solution.

If $\theta^* = 1, S^{-*} = 0 = S^{+*} = 0$, then $j0$ The unit is valid for DEA;

If $\theta^* = 1, S^{-*}$, $S^{+*}$ If there is a non-zero value, it is called $j0$ The unit is weakly valid for DEA;

If $\theta^* \leq 1$, then $j0$ The unit is invalid for DEA.

### 4.4 Results and analysis of agricultural investment efficiency evaluation

*Table 1 Evaluation results of agricultural investment efficiency in 16 cities in Anhui Province*

| Area | crste | vrste | scale | Scale remuneration |
|---|---|---|---|---|
| Hefei | 1.00 | 1.00 | 1.00 | --- |
| Huaibei | 0.71 | 0.88 | 0.81 | irs |
| Quzhou | 1.00 | 1.00 | 1.00 | --- |
| Suzhou | 1.00 | 1.00 | 1.00 | --- |
| Bengbu | 1.00 | 1.00 | 1.00 | irs |
| Fuyang | 0.80 | 1.00 | 0.80 | irs |
| Huainan | 0.83 | 1.00 | 0.83 | irs |
| Quzhou | 1.00 | 1.00 | 1.00 | --- |
| Lu'an | 1.00 | 1.00 | 1.00 | --- |
| Maanshan | 1.00 | 1.00 | 1.00 | --- |
| Wuhu | 0.91 | 1.00 | 0.91 | --- |
| Xuancheng | 1.00 | 1.00 | 1.00 | --- |
| Tongling | 1.00 | 1.00 | 1.00 | irs |
| Chizhou | 0.85 | 0.884 | 0.96 | irs |
| Anqing | 1.00 | 1.00 | 1.00 | --- |
| Huangshan | 1.00 | 1.00 | 1.00 | --- |
| Mean | 0.945 | 0.98 | 0.958 | |

*Note:* The technical efficiency value is equal to the product of pure technical efficiency and scale efficiency,---,irs represent constant and incremental

Using DEAP2.1 software and input-oriented BCC model, the relevant data of input and output indicators of 16 cities in Anhui Province will be brought into solution in 2018. The technical efficiency, pure technical efficiency and scale of each city will be obtained through DEA calculation and analysis. Efficiency and scale of remuneration, a cross-sectional analysis of the efficiency of agricultural investment in cities in 2018. Among them, the technical efficiency reflects the level of agricultural investment efficiency in each city. The pure technical efficiency is reflected in the level of agricultural investment efficiency under the condition of variable returns to scale. The scale efficiency reflects the scale of agricultural investment in each city. The scale return reflects the agriculture caused by the change of scale. Changes in investment efficiency. The results of the evaluation of agricultural investment efficiency in 16 cities in Anhui Province in 2018 are shown in Table 1.

It can be seen from Table 1 that the average technical efficiency of 16 cities in Anhui in 2018 is 0.945 , the average technical efficiency is 0.98 , and the average efficiency of scale is 0.958 . Among them, 10 cities are in the stage of constant returns to scale, indicating that 10 cities are optimal allocation; the other 6 cities are in the stage of increasing returns to scale, that is, the appropriate increase in the scale of agricultural investment in these cities can improve the efficiency of agricultural investment, and agriculture also has A lot of room for development. For the cities that are at the optimal stage of agricultural investment, the corresponding proportion of agricultural investment should be maintained to maintain the optimal agricultural investment efficiency. For the cities and towns that are in the stage of increasing returns to agricultural investment, they should increase investment in agriculture and expand the scale of investment to improve the efficiency of agricultural investment.

In 2018, the overall level of agricultural investment efficiency in Anhui was moderate, showing a good development trend. In terms of technical efficiency,that is, overall efficiency, among the 16 cities analyzed, there are 11 cities with an overall efficiency of 1 , accounting for more than half of all evaluated cities. From the perspective of pure technical efficiency, there are 16 cities in Anhui. 14 cities are better than the average level; from the perspective of scale efficiency, Huaibei, Fuyang, Huainan, Wuhu and Chizhou have not reached full scale and efficiency, and the scale efficiency is closer to 1, indicating that the scale is more appropriate.

## 5. The Main Problems of Agricultural Investment

It can be seen from the above analysis that in recent years, Anhui's agricultural investment has been increasing and the agricultural investment structure has been continuously optimized, but there are still many problems in agricultural investment. This section analyzes the main problems of Anhui agricultural investment and gives countermeasures.

### 5.1 Agricultural investment is highly volatile, and investment management is not in place

In recent years, Anhui's agricultural investment has gradually increased, but agricultural investment is still insufficient, and volatility is large, and the proportion of agricultural investment in total investment is declining year by year. Due to constructive financial appropriations, special financial poverty alleviation funds, and small-scale public welfare funds directly arranged by the Ministry of Finance for rural production, there are many investment channels for investment, and there are correspondingly more investment management departments, resulting in the need for multiple approvals and mutual disharmony, resulting in diversified funds. Resources are lost, it is difficult to form synergy, and there are also problems such as repeated construction and omission in the direction of use and project arrangement. In terms of fund management, the government's management of agricultural special support funds is not in place [4]. The statutory budget is often adjusted and changed without legal procedures due to certain human factors, resulting in funds not being fully and in place on time, affecting financial special fund subsidies. Play a role.

### 5.2 The agricultural investment in different regions is very different, and the scale of investment is not suitable

The economic development, industrial structure upgrading and investment level of different cities in Anhui are different. The higher the economic level, the more rational the industrial structure, the greater the proportion of agricultural investment in total investment. Conversely, the economic level is not high, the investment level is not high, and agricultural investment The smaller the proportion of total investment. The free flow of resources within and between regions will optimize the allocation of resources. However, due to competition among local governments in Anhui, local governments have introduced preferential policies to create conditions to retain capital and attract external investment. The free flow of resources and capital has been hampered, resulting in large differences in agricultural investment across regions [5].

### 5.3 The efficiency of agricultural investment still needs to be improved, and the level of human capital is not high

Anhui's agricultural investment efficiency is moderate in overall level and has a good development trend. However, there are still phenomena of investment efficiency, non-scale effective and full scale effective. Agricultural investment needs to be improved, and the investment scale has not yet reached the optimal level. At this stage, there are more middle-aged and old-age laborers in rural Anhui , and a large number of young and middle-aged people turn to urban secondary and tertiary industries. The quality of agricultural workers is even lower, the market awareness is weak, and the ability to master new technologies and apply new equipment is insufficient, especially the lack of knowledge and technology needed to produce

quality agricultural products. The level of human capital in rural areas in Anhui is not high, making the process of agricultural promotion very difficult and slow.

## 6. Conclusion and Policy Recommendations for Optimizing Agricultural Investment

Fully understand the significance of investing in agriculture and improve relevant support policies. Further change the concept of investing in agriculture and fully understand the significance of investing in agriculture. First, fully understand the basic status of agriculture, establish the idea of market-driven, and focus on the development strategy of "taking the market as the background, supporting the industry, giving play to the role of enterprises, and optimizing the chain of agricultural industry". To the market, modernization of the agricultural industry through the optimization and integration of various production factors. Second, in order to maintain the enthusiasm of all parties in the industry to invest in agriculture and to prevent and reduce risks and hazards as much as possible, relevant supporting policies should be improved. Third, expand the special construction fund to support the scope and proportion of agriculture, resume the preferential interest policy for agricultural special construction fund projects, and appropriately increase the proportion of interest subsidies, slow down the pressure on the main business of agricultural operations, and effectively solve the problem of expensive loans.

Stabilizing the expansion of government investment and improving the agricultural investment guarantee mechanism. Local governments should increase the total number of agricultural investment projects, increase the total investment plan for agricultural projects, and pay close attention to the start of new agricultural infrastructure projects and stabilize government investment. Given the basic and weak nature of agriculture, the government must implement a higher degree of protection for agriculture. The government should introduce policies to encourage agricultural production, and formulate relevant laws to clearly define the annual agricultural investment quota, source of funds, and input methods in a legal form to ensure that government investment in agriculture is only increasing. In order to effectively play the role of the government in regulating credit funds and collective and individual funds, the government should establish an interest compensation mechanism and incentive mechanism for agricultural investment, and guide farmers to the agricultural foundation through a series of financial interest subsidies, project supporting and agricultural research input. The investment in facilities and advanced agricultural equipment has created favorable conditions for all kinds of funds to enter the agricultural sector.

Increase support for facility agriculture and actively promote the scale of facility agriculture. Anhui Province should take effective measures to increase support for facility agriculture and actively promote the scale of facility agriculture . First , we must increase support for facility agriculture. Concentrated contiguous construction of winter warm sheds or multi-span greenhouses, infrastructure construction of water, electricity and roads in key communities, new high-standard irrigation facilities for farmers, factory nursery facilities, storage and transportation facilities,

and vegetable waste centralized treatment facilities Etc. Different proportions of subsidies are given depending on the project. Second , encourage financial institutions to issue large-scale loans to farmers or cooperatives under the collateral of farmers' land contractual management rights, and carry out insurance business for various risks that farmers may encounter in engaging in facility agriculture. Third , encourage the development of rural cooperative finance, improve the credit information system, and better serve the three rural areas.

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