

## *Retraction*

# **Retracted: Application Research of Fuzzy Control Comprehensive Model in Agricultural Economic Management**

## **Security and Communication Networks**

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

## **References**

- [1] J. Huang, R. Guo, and X. Wen, "Application Research of Fuzzy Control Comprehensive Model in Agricultural Economic Management," *Security and Communication Networks*, vol. 2022, Article ID 4406336, 11 pages, 2022.

## Research Article

# Application Research of Fuzzy Control Comprehensive Model in Agricultural Economic Management

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Agriculture is the basic industry of the national economy, and the transformation of agricultural economic growth mode is of great significance to ensure the supply of agricultural products and improve the quality of agricultural products. Therefore, it is the only way to solve this problem to change the way of agricultural economic growth through scientific and technological investment, industrial structure adjustment, and other methods. Based on the fuzzy comprehensive evaluation method, this paper analyzes various factors of agricultural economic development and establishes a multilevel fuzzy comprehensive evaluation model of the development status of agricultural economic system. The stochastic frontier production function model of the fuzzy control comprehensive model is applied to decompose the agricultural labor productivity, and the counterfactual thinking and distribution method are used to analyze the influence of these factors on the evolution of provincial agricultural labor productivity differences. The value inequality decomposition method measures the contribution of each factor to the provincial agricultural labor productivity difference as well as the contribution of exogenous explanatory variables to the provincial agricultural technical efficiency difference. It is concluded that the relative contribution rate of nonagricultural activities to the difference in agricultural technical efficiency is the largest, and the average relative contribution rate reaches 74%. The improvement of agricultural labor productivity cannot rely solely on the increase in the input of agricultural material factors, but should rely on science and technology.

## 1. Introduction

Agriculture is faced with the dilemma of less arable land and high demand. How to grow more crops on limited land has become one of the hotly debated issues. Modern agriculture adds some automatic control equipment on the basis of traditional agriculture, which relieves the pressure of agriculture to a certain extent, but there is still great room for improvement [1]. The traditional control theory has gradually been unable to meet people's needs, and the emergence of fuzzy control theory can effectively alleviate and most likely solve this problem. Agricultural labor productivity and per capita net income of farmers are two key indicators to measure the development of agricultural economy, and there is a large contrast between provincial agricultural labor

productivity and per capita net income of farmers, indicating that the improvement of farmers' income is mainly due to the rapid development of nonagricultural economy. The development of the agricultural economy is still relatively lagging behind. If only from the perspective of agricultural labor productivity, the development of the agricultural economy still lags behind in many inland provinces. Agriculture is the foundation and lifeblood of the national economy, and the relative lag of agricultural development will be detrimental to the stable and coordinated development of the economy [2, 3]. In addition, the uncertainty of the current macroeconomic impact restricts the sustained and rapid growth of farmers' nonagricultural income. In the postinternational financial crisis period, the foundation for economic recovery is not yet solid, trade

protectionism is on the rise, and low-cost export-oriented industries in my country's coastal areas are facing structural challenges. Due to the huge pressure of adjustment and industrial upgrading, the room for continuous growth of employment positions and wages of migrant workers will be affected. In this context, studying how to speed up the improvement of agricultural labor productivity is of great significance for increasing farmers' income, curbing the widening income gap between urban and rural residents, promoting the transformation of agricultural economic growth patterns, and developing modern agriculture.

The comprehensive evaluation of fuzzy control means that by using a certain method and according to the conditions given by the problem, an evaluation coefficient is assigned to each evaluation element for evaluation and summarization, and then the optimization is made according to the evaluation results. Through systematic and comprehensive evaluation and optimization, compared with a single evaluation element, the shortcomings of each evaluation element can be identified and then improved, so that it is easier to take effective countermeasures [4]. As the fundamental concept and guideline of evaluation work, the determination of evaluation purpose is the primary condition [5]. To evaluate a certain issue, we must first determine why the evaluation is to be made, that is, what is the purpose of the evaluation, and what aspects of the elements should be evaluated on this issue. The determination of the evaluation target is usually based on the evaluation purpose of the evaluated object. The characteristics of the evaluated object in a certain aspect can usually be reflected by a certain evaluation index. A series of interrelated evaluation indicators constitute the evaluation index system [6, 7]. The evaluation index system reflects the characteristics of the evaluation object in various aspects as a whole by synthesizing the characteristics of the evaluation object reflected by each evaluation index.

Different from traditional agriculture, modern agriculture adds many control devices to the greenhouse to facilitate efficient planting of crops, while precision agriculture based on IoT technology can achieve refined management of agricultural production, save investment, and obtain agricultural economic and environmental benefits. It is an important development direction of agricultural modernization. Fuzzy control is an important branch of intelligent control. In agricultural economic cybernetics, prediction and control models with exogenous policy variables all show that agricultural economic phenomena are regarded as random phenomena, and statistical principles are used for modeling [8]. This article will point out that the total number of agricultural economic phenomena is not only random but also vague. This is because the factors affecting agricultural economic phenomena are often very complex and diverse, and various factors are often entangled together. For agricultural economic phenomena with both randomness and ambiguity, if only randomness is considered and its fuzziness is ignored, the established statistical analysis model will fail [9]. For example, an increase in national income does not necessarily increase the sales of cloth in the market, that is, there is not necessarily a purely statistical correlation

between income and cloth sales, and it is difficult to establish a statistical model at this time.

Chapter arrangement of this paper: the first chapter introduces the related research on fuzzy control theory and agricultural economic management. The second chapter introduces the theoretical basis of the fuzzy control comprehensive model in detail. The hierarchical weights of agricultural economic management are assigned in the third chapter. The fourth chapter makes a detailed analysis of each influencing factor of agricultural economy based on fuzzy control theory. The fifth chapter is the summary of the full text.

The innovation of this paper: this paper unifies the difference decomposition of the fuzzy control model, the Sharpley value inequality decomposition method, and the growth decomposition into the same analytical framework based on the stochastic frontier model to quantify the contribution of relevant factors to the difference in agricultural labor productivity. In this way, the robustness and internal consistency of the research conclusions can be ensured. Finally, this paper uses micropanel data, which reduces the loss of information when macrodata is aggregated, and can overcome the estimation inconsistency of cross-sectional data.

## 2. Related Work

The fuzzy comprehensive evaluation method was put forward in the early 1980s. From the single-factor comprehensive evaluation model to the multifactor and multilevel comprehensive evaluation model, the theory and methods have been continuously improved and have been widely used in various fields. There are generally the following methods for comprehensive evaluation using fuzzy mathematics: the fuzzy comprehensive evaluation model established by the compound operation of the fuzzy relation, the comprehensive evaluation model established by the fuzzy test and the fuzzy integral, the comprehensive evaluation model established by the evaluation function, and the abovementioned comprehensive evaluation model. The application of these methods provides an effective tool for fields that cannot be evaluated by mathematical methods in the past [10].

Faran and Kemal made an attempt of fuzzy control for pressure and speed control of steam engine, and the result obtained better control performance than PID control [11]. Nguen and Chan believe that the biggest feature of fuzzy control is to express the control experience and knowledge of experts as language control rules, and then use these rules to control the system. Therefore, fuzzy control is especially suitable for simulation experts to control complex, nonlinear systems whose mathematical models are unknown [12]. Yan et al. believe that fuzzy control is a macro method of system control, the core of which is the control rules described in the language [13]. Wang et al. designed the corresponding index evaluation system according to the specific content of the effect of economic growth mode transformation, and used

the comprehensive index method and discrete coefficient method to measure and evaluate the transformation effect of economic growth mode [14]. On the basis of analyzing the theory of agricultural economic growth, Cheng and López use the arithmetic index method to obtain the total factor productivity of agriculture. Based on the total factor productivity, this paper makes a quantitative description of the growth mode since the agricultural reform. From the perspective of empirical analysis, it examines the growth of various factor inputs and their contribution to agricultural economic growth and measures the status and role of scientific and technological progress in agricultural production. Then, the evolution process of agricultural economic growth mode is described [15]. According to the content of the transformation of agricultural economic growth mode, Zhang sets up an index system to evaluate the effect of the transformation of economic growth mode. On the premise of following the design principles of the index system, it starts from three aspects: factor allocation and use, factor utilization efficiency, and economic structure transformation. It is believed that multiple indicators should be used to measure the transformation of economic growth mode, which is a multi-index evaluation problem, and the weighted rank sum ratio method can be used for comprehensive evaluation [16]. On the basis of scientifically defining the connotation of the transformation of agricultural growth mode, Tang established an index system to evaluate the degree and progress of the transformation of agricultural growth mode and took the statistical data of Hebei province as an example to verify its use effect [17]. Liu et al. believe that the transformation of agricultural economic growth mode from extensive to intensive is a gradual and dynamic process. Under the premise of a given base period, the transformation reflects the relative degree of change. A method to measure the degree of transformation of agricultural economic growth mode is given: the influencing factors of the realization degree of agricultural economic growth mode are divided into productivity, material input, farmers' living standard, industrial structure, modernization level, and agricultural commodity rate [18]. Based on the research perspective of economics, within the framework of economic growth accounting and total factor productivity, Zhukov et al. analyze the unsustainability of the current agricultural development mode from the sources of economic growth, increasing factor inputs and improving productivity. The specific realization ways to transform the agricultural development mode are put forward: economical use of traditional production factors, environmental friendliness, technological progress, technological efficiency improvement, total factor productivity growth caused by human capital investment and institutional innovation factors [19]. Song et al. believes that the difficulty in expanding the average arable land has become a fundamental bottleneck in agricultural development. Fertilizer input is an important factor in increasing agricultural output. Structural adjustment coefficient has a significant impact on agricultural output. Technological progress is the most important factor in per capita output growth [20]. Wan took effective agricultural output as the research object of

agricultural labor productivity and used the above method to analyze and recognized the important influence of cultivated land, result adjustment coefficient, and technological progress on agricultural labor productivity [21]. Meng and Zhu research shows that the advantages of agricultural labor productivity are mainly due to its advantages in structural transformation and capital deepening. Structural transformation between industries and within industries, and capital deepening within and outside agriculture have improved Shanghai's agricultural labor productivity [22]. Based on the fuzzy comprehensive evaluation model, Bacalla and Vinluan analyzes the changing trend of agricultural labor productivity in a certain place according to the time series and uses the per capita arable land area irrigation rate, labor average chemical fertilizer application amount, structural adjustment coefficient, the proportion of electromechanical irrigation area to the effective irrigation area, and other indicators to construct the impact of agricultural labor. The results show that the adjustment of agricultural industrial structure, per capita fertilizer application, and irrigation rate has a very significant impact on labor productivity [23].

According to the information currently inquired, the existing multilevel fuzzy comprehensive evaluation models group various evaluation factors of complex systems, first establish a single-level evaluation model for each group, and then establish a comprehensive evaluation model for the entire system. This kind of model is not practical for farms, and each layer of the system has a similar management structure, so it is more suitable for the agricultural situation to establish a multilevel fuzzy comprehensive evaluation model according to the organizational level.

### 3. Fuzzy Control Comprehensive Model Theory

Everything in the world has its laws of motion, and the motion laws of some things can be modeled, simulated, and realized by existing mathematical models, but some hard-to-find laws require a lot of human and material resources. At this time, we usually use a method called "experience" to control it, and fuzzy control is a control theory based on experience. Different from the traditional precise control, fuzzy control does not establish an accurate mathematical model, but through the method of membership, the collected precise data is fuzzified by quantification factors, and the fuzzy data is subjected to fuzzy inference by fuzzy rules, and the result is obtained. The fuzzy output is finally defuzzified (precise) through the scale factor to obtain accurate control results [24]. The process is similar to how a person manipulates a piece of equipment through their own experience. Its basic control idea is shown in Figure 1.

This step may be referred to as defuzzification. To sum up, the fuzzy control process can be summarized as the following steps: compare and calculate the measured data with the given value of the system and obtain the precise value of the system input. The fuzzy input value is combined with the fuzzy rules to carry out fuzzy inference, and the fuzzy output value is obtained. The obtained fuzzy output value is defuzzified to obtain the precise value of the output control quantity, and the controlled equipment is controlled.

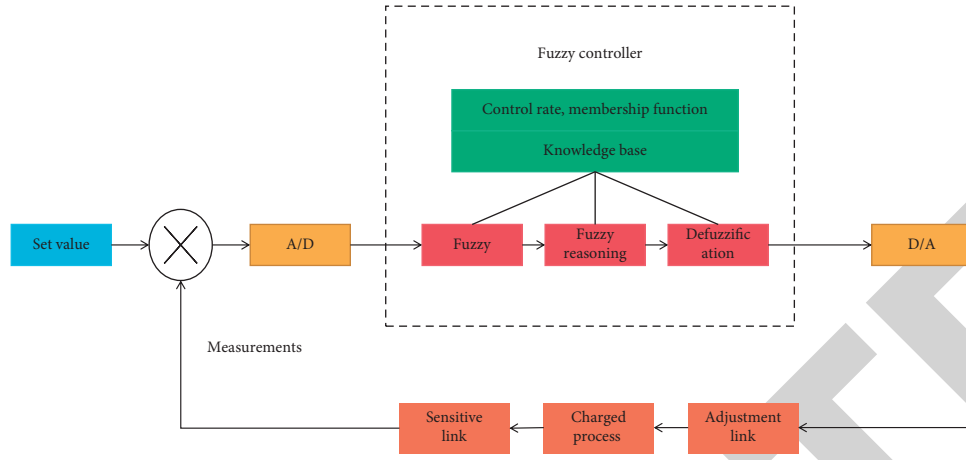


FIGURE 1: Fuzzy control principle diagram.

First, the fuzzy controller receives the parameter information of the controlled object collected by the sensor, calculates the precise value of the input variable by comparing it with the given value, and then fuzzifies the precise input value through the appropriate quantization factor to obtain the fuzzy value, that is, Fuzzy input variables of the fuzzy controller. Then it is brought into the inference engine of the fuzzy controller, and it is reasoned and analyzed in combination with the knowledge base, that is, fuzzy inference, and the fuzzy output variable of the fuzzy controller is obtained. Finally, it is defuzzified by the scale factor, that is, clear, and the precise output value of the fuzzy controller is obtained to control the controlled object. According to the above control process, it can be found that the core link of designing a fuzzy controller is to design the most ideal fuzzy rules through the knowledge base, and then determine the input and output variables of the fuzzy controller on this basis to complete the final design task. The basic composition block diagram of the fuzzy controller is shown in Figure 2.

In this paper, the advanced intelligent control technology of fuzzy control is applied in modern agriculture. If  $x_1, x_2, \dots, x_n$  is the evaluation index of the system, then the set is the set of system evaluation index, as shown in the following formula:

$$U = \{x_1, x_2, \dots, x_n\}. \quad (1)$$

Suppose  $y_1, y_2, \dots, y_n$  is the evaluation result of the system, then the set is called the evaluation conclusion set, as shown in the following formula:

$$V = \{y_1, y_2, \dots, y_n\}. \quad (2)$$

The development evaluation index of agricultural economic system varies with different regions. The main task of this paper is to analyze and abstractly reflect the common index of this kind of system. From a macro perspective, the development status of an agricultural economy can be reflected in the following four categories of indicators.

The total agricultural output value of a farm reflects the overall scale and production capacity of an agriculture. The output-input ratio of farm agriculture is an efficiency index,

which can directly reflect the level of agricultural benefits and management. The output-input ratio of agriculture can directly reflect the level of agricultural benefit and management level. The farm's per capita agricultural net income, which can reflect the agricultural development status from the microscopic level, also reflects the contribution of agricultural production to the society. The processing profit of farm agricultural products, this indicator reflects the deep processing of agricultural products and the development of agricultural industrialization to a certain extent. In the development of agricultural economy, in order to better improve its development speed and effectiveness, it is necessary to first explore the theoretical guiding role of agricultural economic management. Only by ensuring that it can provide strong theoretical guidance and point out the direction for agricultural economic development, and then can show a strong development effect.

#### 4. Calculation Weight of Agricultural Economic Hierarchy Model Based on Fuzzy Comprehensive Theory

The commonly used production function in the fuzzy control comprehensive model analysis is simple in form, which is easy to estimate and decompose, but it is assumed that the technical level and output elasticity are unchanged. Considering the research purpose of this paper, the production function is set as shown in the following formula:

$$Y_{it} = \exp(\beta_0 + \beta_1 t) K_{it}^{\beta} \exp(v_{it} - u_{it}). \quad (3)$$

Among them,  $K$  represents the agricultural material cost input,  $Y$  represents the agricultural land area, and  $\beta$  represents the agricultural labor force. Agricultural material cost: this article regulates agricultural material cost input as the material cost of planting production and operation (including seed cost, seedling cost, farmyard manure discount, chemical fertilizer cost, agricultural film cost, pesticide cost, water, electricity and irrigation cost, other material cost, animal power costs, mechanical operation costs, fixed assets depreciation and repair costs, small farm implement purchase costs, labor costs, and other indirect costs), animal

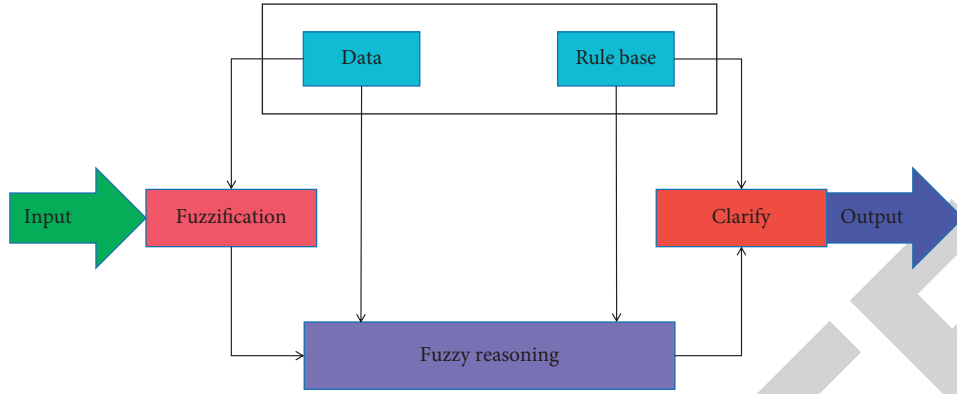


FIGURE 2: The basic composition block diagram of the fuzzy controller.

husbandry, aquaculture production, and operation costs (including young animal seedling costs, feed costs, fixed assets depreciation costs, labor costs, other production, and operation costs). This paper regards the total agricultural output of farmers as the sum of the total income of planting, animal husbandry, and aquaculture. Among them, the total income of planting industry is food crops (such as wheat, rice, corn, soybeans, and potatoes), economic crops (such as cotton, oilseeds, sugar, hemp, tobacco, and vegetables), garden crops (such as fruits). The total revenue of animal husbandry is the sum of the operating revenue of live pigs, beef cattle, mutton sheep, meat poultry, poultry eggs, and fresh milk. The total revenue of the aquaculture industry is the sum of the operating revenue of freshwater products and marine products. The agricultural labor variable refers to the number of agricultural laborers in a household.

The goal of the AHP model in this paper is to determine the strength of strength, strength of weakness, strength of opportunity, and strength of threat. The influencing factors of the strength of advantage include: the natural environment and resources are suitable for agricultural development, the foundation of social economy and traditional agricultural development is good, the characteristic agriculture develops rapidly, and the advantages of agricultural science and technology service promotion. The influencing factors of inferior power include: limited land resources, lack of high-quality talents, financial disadvantage, and small farmers' economic awareness is still relatively strong. The influencing factors of the opportunity strength mainly include: the requirements of the ecological environment, the requirements of sustainable social and economic development, the opportunities of economic globalization, and the support of national policies. The influencing factors of the threat include: the challenge of economic globalization to the development of agricultural economy, the intensification of competition in the domestic agricultural market, and the imperfection of the market economic system. The influencing factors of these subdivisions are the criterion layers.

The maximum eigenvector corresponding to the maximum eigenvalue of the judgment matrix is calculated and the weight vector of each criterion layer factor is obtained. The judgment matrix is obtained by the arithmetic mean of the scores in the valid questionnaires. The judgment matrix

and weight distribution of the influence of each factor are shown in Table 1.

In order to determine the weight of each index by AHP, it is necessary to check the consistency of the judgment matrix based on it, and define the consistency index ACLI. The calculation formula is shown as follows:

$$ACLI = \frac{\lambda_{\max} - n}{n - 1}. \quad (4)$$

Among them,  $\lambda_{\max}$  is the largest characteristic root of the judgment matrix and  $n$  is the order of the judgment matrix. The given average random consistency index is shown in Table 2.

Intensive growth of agricultural economy is often accompanied by large-scale capital investment, such as agricultural mechanization and precise use of chemical fertilizers. In order to realize the smooth transformation of agricultural economic growth mode, we must increase the investment of agricultural funds, strengthen the construction of agricultural economic infrastructure, and strive to improve the comprehensive agricultural production capacity. On the one hand, it is necessary to increase investment in agriculture and broaden the sources of agricultural funds. On the other hand, it is necessary to improve the use efficiency of agricultural funds. The positive role of agricultural economic management in agricultural economic development is also reflected in specific systems and policies. This institutional guarantee is also an important condition for promoting agricultural economic development. We should pay great attention to the agricultural economic management, gradually improve the agricultural economic development system, and create more ideal development conditions. The output level can be decomposed into three parts: factor input, frontier technology level, and technical efficiency, as shown in the following formula:

$$\ln Y_{it} = \varepsilon_{it} \ln X_{it} + \ln FT_{it} + \ln TE_{it}. \quad (5)$$

If  $y_{it} = Y_{it}/L_{it}$  represents labor productivity,  $x_{it} = X_{it}/L_{it}$  represents factor input per labor, and  $L_{it}$  represents labor quantity, labor productivity can be decomposed into four parts: labor input per factor, labor quantity, frontier technology level, and technical efficiency, as shown in the following formula:

TABLE 1: Judgment matrix of strength.

Dominant strength	Environment and resources	Economic base	Characteristic agriculture	Science and technology	Weight
Environment and resources	1	1/2	1/3	1/3	0.16
Economic base	1/4	1	2/7	8/5	0.39
Characteristic agriculture	2	4/5	1	3/4	0.22
Science and technology	2/3	5/8	3/2	1	0.31

TABLE 2: Stochastic consistency indicators.

Order	1	2	3	4	5	6	7	8	9	10
Consistency index	0.00	0.04	0.59	0.91	1.13	1.25	1.33	1.42	1.46	1.50

$$\ln y_{it} = \varepsilon_{it} \ln x_{it} + \ln s_{it} + \ln TE_{it} + \ln FT_{it}. \quad (6)$$

The second term represents the impact of changes in labor structure on output growth, and the third and fourth terms represent changes in optimal frontier technology and relative technical efficiency, respectively. The sum of the two represents the contribution of changes in total factor productivity to output growth. In order to investigate the influence of relevant factors on the distribution of labor productivity growth, the research idea of fuzzy comprehensive evaluation is used. Assuming other factors remain unchanged, construct the virtual growth of labor productivity under the combined effect of one or several factors. Assuming that other factors remain unchanged, the joint effect of different factor combinations is examined. The joint effect of factor input and technical efficiency is shown in the following formula:

$$\ln y_{it} = \ln y_{it} + (\varepsilon \ln x_{it} + \varepsilon \ln y_{it}) + (\ln FT_{it} - \ln TE_{it}). \quad (7)$$

Similarly, the virtual labor productivity growth under the action of other multifactors can be similarly constructed according to the fuzzy control theory.

## 5. Application Analysis of Agricultural Economic Management Based on Fuzzy Control Theory

*5.1. Differences in Agricultural Labor Productivity.* This paper uses fuzzy control inequality indicators to study economic problems in the field of agricultural economy and introduces these inequality indicators into the study of economic problems in the microfield to describe the current situation of agricultural labor productivity differences. Absolute disparity methods include average difference, standard deviation, dispersion, and range, but these methods cannot fully reflect the structural characteristics of regional disparities. Relative disparity analysis methods mainly include coefficient of variation, Gini coefficient, and Theil index indicators, which can reflect the structural characteristics of regional disparities in detail. In order to accurately grasp the difference and trend of agricultural labor productivity and ensure the robustness of the analysis, this paper uses three inequality indicators: Gini coefficient, Theil (0) index, and Theil (1) index to measure the difference in agricultural labor

productivity. The six-year changes in the three inequality indicators of agricultural labor productivity in the same region are shown in Figure 3.

As shown in Figure 3, the values of the Gini coefficient, Theil (0) index, and Theil (1) index of agricultural labor productivity in six years show that there is a large difference in agricultural labor productivity among farmers in six years. And in the past six years, the values of the three inequality indicators of agricultural labor productivity all showed a first decline and then an increase, and an overall upward trend. It can be seen that in the past six years, the gap in agricultural labor productivity between different farmers has experienced a process of first decreasing and then increasing, and on the whole, this gap has a tendency to widen. It also shows that this analysis of trends in agricultural labor productivity is robust and has nothing to do with which inequality indicator is chosen to measure. The distribution of agricultural labor productivity presents a bimodal feature and gradually evolves from the peak of the left high and the right low to the left low and the right high, which means that the number of farmers with low agricultural labor productivity decreases and the number of farmers with high agricultural labor productivity increases during this period. The distribution of agricultural labor productivity shifts to the right, indicating that the overall level of agricultural labor productivity has increased. The opening of the distribution of agricultural labor productivity has become larger, indicating that the difference in agricultural labor productivity among farmers has expanded.

*5.2. Analysis of Influencing Factors of Agricultural Labor Productivity Growth Distribution.* Based on the stochastic frontier production function model of fuzzy theory, this chapter uses counterfactual analysis to construct a virtual agricultural labor productivity growth distribution. By comparing the difference between the virtual distribution and the real distribution, it analyzes and judges the influence of various factors on the evolution of agricultural labor productivity growth distribution.

When one influencing factor changes and the other influencing factors remain unchanged, the opening of the virtual distribution becomes larger, which means that the difference in agricultural labor productivity has expanded. The peak height has changed significantly, the left peak is lower, and the right peak is higher, which means that

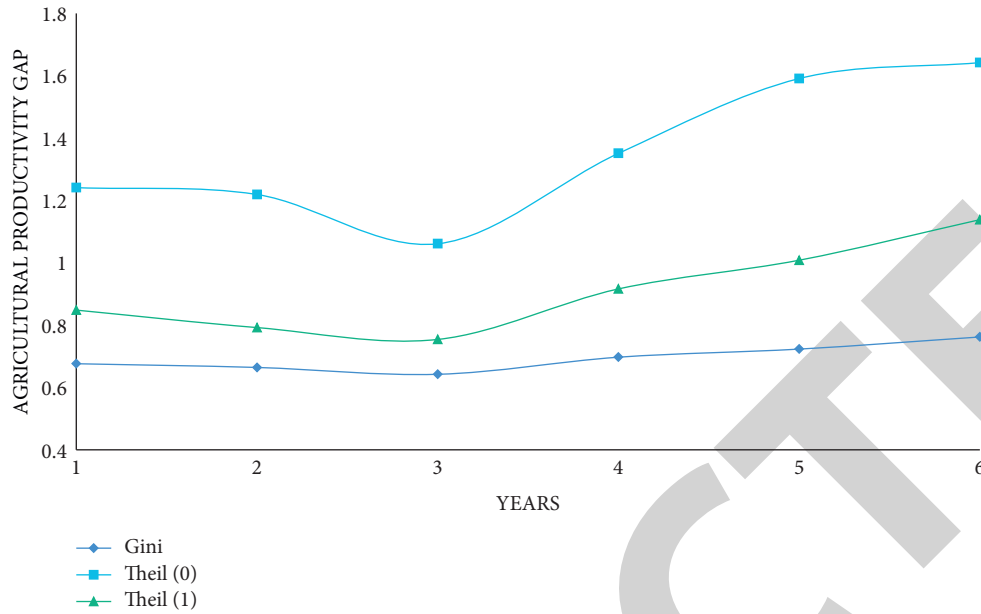


FIGURE 3: Change curve of agricultural labor productivity gap.

agricultural labor, the number of farmers with low productivity decreases, and the number of farmers with high agricultural labor productivity increases. The virtual distribution shifts to the right, which means that the overall level of agricultural labor productivity increases. This shows that the agricultural material cost input per labor is an important factor that leads to the growth of agricultural labor productivity and the expansion of differences in the past six years. However, the virtual distribution has a certain distance from the actual growth distribution in both form and location, indicating that the agricultural material cost input per labor is not the only factor affecting the growth of agricultural labor productivity and the widening of differences in agricultural labor productivity. Agricultural technical efficiency also has a greater impact on the location and shape of agricultural labor productivity growth, as shown in Figure 4.

Compared with the actual growth distribution, the virtual distribution shifts to the right and shows a unimodal characteristic, which means that the agricultural technical efficiency has improved the overall level of agricultural labor productivity, promoted the increase in the number of farmers with moderate agricultural labor productivity, and alleviated the polarization of labor. However, the impact on the widening of differences in agricultural labor productivity is not as significant as the input of agricultural material costs per labor. This shows that agricultural technical efficiency is also an important reason for the growth of agricultural labor productivity. The land area per labor and the number of agricultural labor hardly change the location and shape of the actual difference distribution, which means that the two are not the main reasons for the growth of agricultural labor productivity and the widening of agricultural labor productivity differences.

5.3. *The Combined Effect of Two Factors.* The combined effect of agricultural material cost input per labor and agricultural technical efficiency is shown in Figure 5.

Not only does the distribution change in shape, it also moves substantially in position and is very close to the actual growth distribution. This shows that the combined effect of these two factors has a great impact on agricultural labor productivity: first, the two-factor effect causes the number of farmers with low agricultural labor productivity to decline and the number of farmers with high agricultural labor productivity to increase. Second, the two-factor effect has greatly improved the overall level of agricultural labor productivity. Again, the two-factor effect has led to the expansion of agricultural labor productivity differences.

The combined effect of agricultural technical efficiency and land per labor is shown in Figure 6.

These virtual growth distributions all show the characteristics of “single peak.” It shows that these two-factor effects have a significant impact on the distribution of agricultural labor productivity, which means that the two-factor effect of agricultural technical efficiency can improve the overall level of agricultural labor productivity, and can increase the number of farmers with moderate agricultural labor productivity. The combined effect of frontier technology and agricultural technology efficiency has an extremely important impact on the shape of the growth distribution of agricultural labor productivity, making the “bimodal” distribution completely transformed into a “unimodal” distribution. The effect of the expansion of differences in agricultural labor productivity is not obvious, which shows that although the combined effect of the two cannot greatly improve the overall level of agricultural labor productivity as much as the input of agricultural material costs per labor, it is of great significance for narrowing the differences in agricultural labor productivity. Figure 7 shows



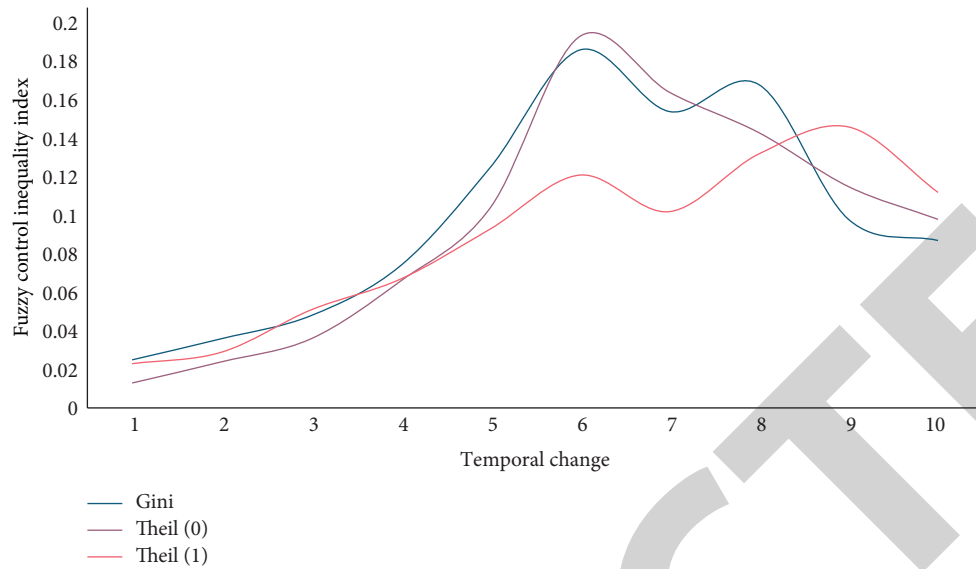


FIGURE 4: The impact of agricultural technical efficiency on agricultural economy.

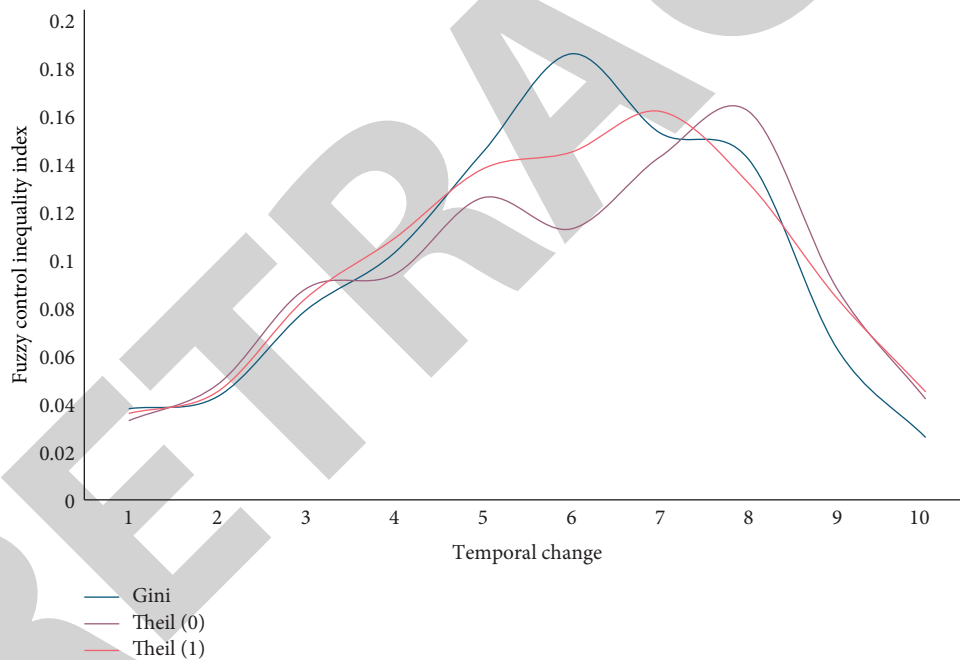


FIGURE 5: Agricultural material cost input per labor and agricultural technical efficiency.

the joint effects of cutting-edge technologies and land area per labor.

It can be seen from the figure that there is a certain difference between the two distributions of the combined effect of the number of agricultural labor forces and the actual growth distribution, and there is no evolution to the shape and displacement direction of the actual growth distribution. It shows that the combined effect of the two factors not only cannot promote the improvement of agricultural labor productivity, but also increases the number of farmers with low agricultural labor productivity. Compared with the actual growth distribution, its distribution

shape and location have not changed significantly, indicating that the combined effect of the two factors has little impact on the growth and disparity expansion of agricultural labor productivity.

Combining the above two-factor effect analysis, it can be found that the conclusions obtained are consistent with the conclusions of the single-factor analysis, and the combination of the two factors of agricultural material cost input per labor and agricultural technical efficiency has a greater impact on the growth distribution than the single-factor agricultural material cost input per labor. The influence of factors is more obvious. For the effective promotion of

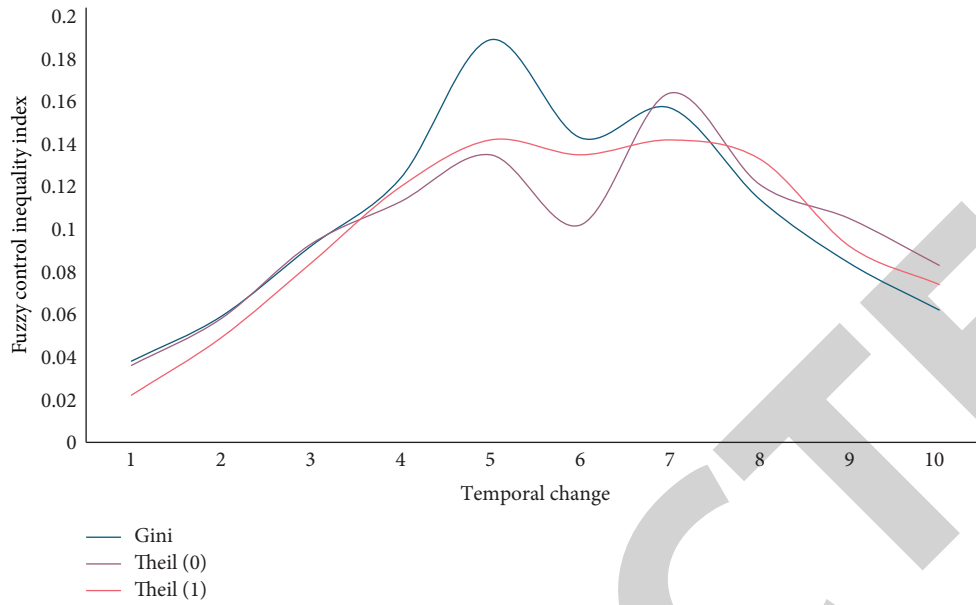


FIGURE 6: Agricultural material cost input per labor and land area per labor.

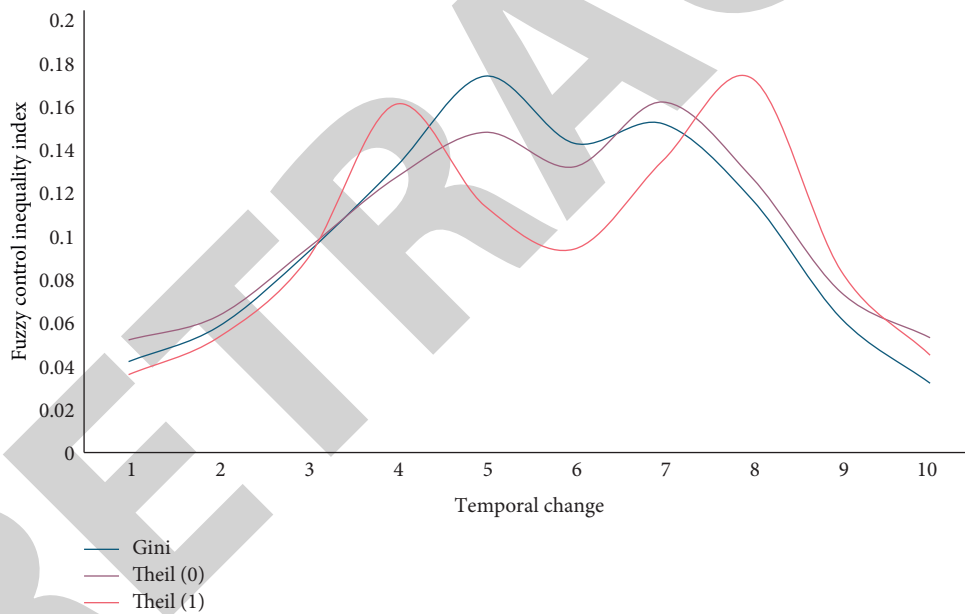


FIGURE 7: Frontier technology and land area per labor.

agricultural economic development, it also needs to be guaranteed from the institutional level. Only when the agricultural economic development system is more perfect and reasonable can the optimization and improvement of the level of agricultural economic development be better achieved. In the development of agricultural economy, the specific promoting role of agricultural economic management is not only reflected in theoretical support and policy guarantee, but also can effectively solve practical problems, gradually optimize the conditions for agricultural economic development, and ensure that agricultural economic development can be developed at a more suitable implementation in the environment.

5.4. Analysis of Influencing Factors of Agricultural Technical Efficiency Differences. From the analysis in the previous section, it can be seen that the difference in agricultural technical efficiency among farmers is the second largest factor affecting the difference in agricultural labor productivity. This section will further examine the impact of related exogenous variables on the difference in agricultural technical efficiency among farmers. Agricultural technical efficiency is the ratio between observed or actual agricultural output and ideal or potential agricultural output. The size of technical efficiency reflects the effective degree of producers using existing technology, and its value is between 0 and 1. The closer it is to 1, the higher the technical efficiency. The

TABLE 3: Decomposition of differences in agricultural technical efficiency.

Years	Gini	Formal education	Nonformal education	Cultivated land	Nonagricultural activities	Random factor
1	0.192	0.009	0.022	0.011	0.147	0.007
2	0.221	0.011	0.025	0.007	0.166	0.017
3	0.193	0.012	0.030	0.008	0.132	0.016
4	0.204	0.011	0.022	0.006	0.155	0.014
5	0.205	0.009	0.021	0.007	0.169	0.004

specific values of random factors were calculated to measure the contribution of the four variables of farmers' formal education, nonformal education, cultivated land fragmentation, and nonagricultural activities to the difference in agricultural productivity. The decomposition results of agricultural technical efficiency differences are shown in Table 3.

From Table 3, it can be found that the relative contribution rate of nonagricultural activities to the difference in agricultural technical efficiency is the largest, and the average relative contribution rate reaches 74%, which is much higher than the impact of other exogenous variables on the difference in agricultural technical efficiency. This means that among the five exogenous variables of farmers' formal education, nonformal education, farmland fragmentation, nonagricultural activities, and random factors, farmers' nonagricultural activities are the most important factors that lead to differences in agricultural technical efficiency. However, nonagricultural activities have a negative effect on agricultural technical efficiency. This means that farmers with a higher proportion of nonagricultural income are more likely to ignore agricultural production, which will lead to a significant reduction in agricultural technical efficiency and widen the gap with other farmers in agricultural technical efficiency. The average relative contribution rate of cultivated land fragmentation is 3%. Among the five exogenous variables of farmers' formal education, nonformal education, cultivated land fragmentation, nonagricultural activities, and random formal education ranks fifth in the impact of differences in agricultural technical efficiency. The reason may be that there is a problem of missing data in the sample data or it may be that the difference in the number of plots between farmers is not large. When the agricultural infrastructure and the degree of agricultural mechanization are relatively close, the situation of land management is also relatively similar, so it is impossible to give the results. Differences in agricultural technical efficiency have significant effects.

## 6. Conclusions

Using the stochastic frontier production function of fuzzy control theory, this paper decomposes the agricultural labor productivity of farmers into five parts, namely agricultural material cost input per labor, land area per labor, agricultural labor force, agricultural technical efficiency, and frontier technology. Using the Shapley value inequality decomposition method to decompose the difference in agricultural labor productivity, the contribution and importance order of each influencing factor to the difference in agricultural labor

productivity are obtained. Using the same decomposition method, this paper decomposes the difference in agricultural technical efficiency. The contribution and importance ranking of each exogenous explanatory variable to the difference in agricultural technical efficiency is obtained. Farmers' agricultural technical efficiency promotes the improvement of provincial farmer's agricultural labor productivity, which is one of the influencing factors for the expansion of provincial farmer's agricultural labor productivity differences, and farmers' agricultural technical efficiency differences are most affected by nonagricultural activities. The farmer's agricultural technical efficiency increases the farmer households in the province's medium-level agricultural labor productivity and improves the overall level of the provincial farmer's agricultural labor productivity.

The government should increase the support of various scientific and technological plans to the agricultural field and improve the guarantee level of the operating funds of agricultural nonprofit scientific research institutions. The publicity and promotion of agricultural science and technology is an important link in the transformation of agricultural science and technology research into real productivity. This link can help farmers master new technologies, apply scientific and technological achievements to agricultural production and management, and promote family management to adopt advanced technology and production methods. Therefore, it is particularly important to strengthen grass-roots agricultural technology extension services. In the construction of the agricultural science and technology extension service system, it is necessary to base on rural cooperative economic organizations, and encourage the participation of agricultural scientific research, education and other units, agriculture-related enterprises and intermediary agencies. According to the different conditions of various places, a comprehensive agricultural technology promotion station or an industrial station can be established, and agricultural technicians can also be dispatched to townships to provide scientific and technological publicity and promotion services.

## Data Availability

The labeled dataset used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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