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Financial management optimization of agricultural wastewater treatment enterprises based on fuzzy control

Ying Luo[a], Liangcai Xiong[b,*]

[a]*School of Economics and Management, Guangxi Vocational University of Agriculture, Nanning 530000, China*
[b]*Guangxi Investment Guide Fund Co., Ltd., Nanning 530000, China, email: liangcai_xiong@outlook.com*

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ABSTRACT

With the increasing prosperity of agricultural activities, the financial management of agricultural sewage treatment enterprises has become an increasingly prominent problem. The purpose of this study is to optimize the financial management decision-making process of agricultural wastewater treatment enterprises using fuzzy control theory. Firstly, the current situation and existing problems of financial management of agricultural sewage treatment enterprises are comprehensively understood, and the optimization model of financial management is built on this basis. The model fully considers the uncertainty and fuzziness in the decision-making process and provides more effective decision support. Then, according to the practical application of the model, the corresponding solution strategies are designed, and the practicability of these strategies is demonstrated through the analysis of examples. Finally, the results of this study are summarized, and the future research direction is proposed. It is expected that this research can help agricultural wastewater treatment enterprises to better manage their finances, improve their operational efficiency and reduce their financial risks.

Keywords: Agricultural sewage treatment; Financial management; Fuzzy control theory; Decision optimization

1. Introduction

With the development of the global economy and the improvement of environmental protection awareness, the problem of agricultural sewage treatment has become increasingly prominent, especially in large-scale agricultural production, how to effectively manage and dispose of agricultural sewage has become a common concern of society. In this context, the role of agricultural wastewater treatment enterprises is becoming more and more important, they play a central role in the treatment of agricultural waste, protecting the environment and water sources. However, these enterprises face many financial management challenges in the process of fulfilling their social responsibilities. First of all, due to the technical and complex nature of agricultural sewage treatment, these enterprises need a lot of funds in research and development, equipment investment and operation management, and the efficiency of fund raising and use requires a scientific and applicable financial management system to guarantee. Secondly, with the increasingly strict environmental regulations and policies, the operational risks of agricultural sewage treatment enterprises are also increasing, and how to optimize financial management to reduce risks and improve the anti-risk ability of enterprises is also an urgent problem to be solved. In recent years, decision optimization method based on fuzzy control has been widely used in many fields, such as supply chain management, production scheduling, logistics distribution and so on. However, in the financial management optimization of agricultural wastewater treatment enterprises, the method based on fuzzy control has not been fully researched and applied. Although some relevant studies have begun to

* Corresponding author.

explore this field, the application of fuzzy control in the financial management optimization of agricultural wastewater treatment enterprises is still lacking in depth research. Therefore, how to use fuzzy control theory to optimize the financial management of agricultural wastewater treatment enterprises to improve their operational efficiency and anti-risk ability is an important direction of current research in this field, and it is also a question that this study tries to answer.

The importance of agricultural sewage treatment is self-evident, and in the enterprises of agricultural sewage treatment, the efficiency and accuracy of financial management determine the operational efficiency and quality of these enterprises. Previous studies have focused on how to improve agricultural wastewater treatment technology and improve its efficiency, but there are still many problems to be solved on how to optimize the financial management of these enterprises to improve their operational efficiency and reduce financial risks. Saiz-Rubio and Rovira-Más [1] conducted a comprehensive review of the development of agricultural data management and proposed the concept of Agriculture 5.0, which provides new thinking and possibilities for the financial management of agricultural wastewater treatment enterprises. With the development of data technology, financial management has also entered a new era driven by data. However, how to effectively use this data to make decisions, especially in the face of uncertainty and ambiguity, is a challenge. At this time, the advantages of fuzzy control theory appear. Fuzzy control theory can deal with uncertainty and fuzziness and provide strong support for financial management decision-making. For example, Li et al. [2] used fuzzy logic to evaluate the sustainability of public-private partnership projects in urban water environment treatment, and confirmed the effectiveness of fuzzy logic in dealing with uncertainty and ambiguity. Similarly, Rustum et al. [3] also used the Mamdani fuzzy logic reasoning system to rank the sustainability of desalination plants. The application of this fuzzy control theory has achieved some success in the construction of financial management optimization model of agricultural sewage treatment enterprises. For example, Liu et al. [4] proposed a coupled multi-criteria decision-making model to optimize the selection of regional wastewater treatment technologies in small towns. Ciric et al. [5] proposed an agricultural technology innovation model based on intuitionistic fuzzy sets. These studies show that fuzzy control theory has great potential in optimizing financial management decisions of enterprises. However, although fuzzy control theory has achieved some success in the construction of financial management optimization model of agricultural wastewater treatment enterprises, there are still many problems and challenges. For example, the assumptions of the model may not be completely consistent with the reality, and there may be errors in data acquisition and processing [6,7]. Future research should further improve the model to improve its applicability and effectiveness in practice. In general, for the financial management of agricultural sewage treatment enterprises, fuzzy control theory provides a new way and possibility for its optimization. By constructing the financial management optimization model based on fuzzy control, the uncertainty and fuzziness can be better handled, the efficiency and accuracy of financial management can be improved, and the operation efficiency of enterprises can be improved and the financial risk can be reduced.

The main purpose of this study is to construct and demonstrate an optimization model of financial management of agricultural wastewater treatment enterprises based on fuzzy control. Fuzzy control theory is widely praised for its ability to deal with fuzzy and uncertain situations. In financial management, companies often need to make decisions in an environment full of uncertainty and ambiguity, such as future revenue forecasts, return on investment, exchange rate movements, etc. Therefore, the application of fuzzy control theory to financial decision-making may have its unique advantages. In the agricultural sewage treatment enterprises, there are a lot of uncertainties and fuzziness. For example, the costs and benefits of agricultural sewage treatment, changes in policies and regulations, and uncertainties in technology research and development. Therefore, building a financial management optimization model based on fuzzy control may help these enterprises to make more scientific and accurate decisions in the face of complex, fuzzy and uncertain situations, so as to improve the efficiency of financial management, reduce operational risks and improve the overall competitiveness of enterprises. In addition, this study also has its profound theoretical significance. Although fuzzy control theory has been widely used in many fields, the relevant theoretical research on the financial management optimization of agricultural wastewater treatment enterprises is still quite limited. Therefore, this study may not only provide a new and effective tool for financial management optimization, but also provide a deeper understanding and enlightenment for the application of fuzzy control theory in the field of financial management. At the same time, the results of this study may also provide reference for other related enterprises or fields.

This study focuses on the financial management of agricultural wastewater treatment enterprises, and provides an optimal solution to the problem through fuzzy control theory. First of all, in-depth understanding of the current situation and problems of financial management of agricultural sewage treatment enterprises provides a theoretical basis for the subsequent model construction. Then, based on fuzzy control theory, an optimization model for financial management of agricultural wastewater treatment enterprises is constructed. This model can effectively deal with the uncertainty and fuzziness of financial management, and provide strong support for decision-making. Its validity and practicability are confirmed by theoretical deduction and empirical analysis. Solutions are also designed for the practical application of the model, including data collection, processing, model operation and optimization, as well as the final decision implementation process, and the practical application effect of these strategies is verified through the analysis of examples. Finally, the paper summarizes the research and looks into the future, analyzes the advantages and limitations of the financial management optimization model, and puts forward the future research direction. This study aims to provide a new perspective and solution for the financial management of agricultural wastewater treatment enterprises through the application of fuzzy control theory, so as to improve operational efficiency and reduce financial risks.

2. Financial management of agricultural sewage treatment enterprises based on fuzzy control

2.1. Financial management challenges

The financial management of agricultural wastewater treatment enterprises is faced with many challenges, including but not limited to capital raising and utilization, risk management, cost control, income forecasting and decision optimization [8]. The complexity and uncertainty of these issues further increase the difficulty of financial management.

First of all, capital raising is the primary task of financial management of agricultural sewage treatment enterprises. Such enterprises require a large amount of capital investment, including equipment procurement, facility construction, technology research and development, personnel training and other aspects of investment, and these investments often require a long payback period and high risks. However, the current capital market and financial system cannot fully meet the capital needs of agricultural sewage treatment enterprises. On the one hand, traditional ways of raising capital, such as bank loans and public offerings, are often affected by a variety of factors, including financial policy, market conditions and corporate creditworthiness. On the other hand, new capital raising methods such as government subsidies and green funds, although they have certain advantages, also have problems such as long financing cycle, harsh conditions and large uncertainties [9,10].

Secondly, risk management is also an important task of financial management of agricultural sewage treatment enterprises. Such enterprises need to face a variety of risks, including but not limited to market risk, policy risk, technological risk and environmental risk. For example, the demand and price of the agricultural sewage treatment market are often affected by a variety of factors such as agricultural production, consumer perception, government policies and public opinion, and changes in these factors are often difficult to predict [11]. At the same time, the research and development and application of agricultural sewage treatment technology also need to face great risks, including technical failure, the effect is not up to expectations, and new environmental problems.

Thirdly, cost control is also the key task of financial management of agricultural sewage treatment enterprises. Due to the complexity and professionalism of agricultural wastewater treatment technology, the cost control of such enterprises is often more difficult than that of ordinary enterprises. On the one hand, the cost of equipment procurement, facility construction, technology research and development, etc., is often high and difficult to reduce. On the other hand, the costs of operation management, personnel training, service provision, etc., are also high and difficult to control. At the same time, the cost control of agricultural sewage treatment enterprises also needs to take into account environmental regulations, social responsibility and corporate reputation and other factors, which further increases the complexity and difficulty of cost control.

In addition, income forecasting and decision optimization are also important tasks for financial management of agricultural wastewater treatment enterprises. Due to the complexity and uncertainty of the agricultural wastewater treatment market, the earnings forecast of such enterprises often needs to take into account a variety of factors, including but not limited to market demand, market prices, government policies, technological effects, environmental regulations and corporate reputation [12]. The changes of these factors are often difficult to predict, which requires enterprises to carry out scientific decision optimization to cope with uncertainty and ambiguity.

In summary, the financial management optimization model of agricultural wastewater treatment enterprises based on fuzzy control may provide new theories and methods to solve the above financial management challenges, and has important theoretical significance and practical value.

2.2. Fuzzy control theory and its advantages

Fuzzy control theory is a control method based on fuzzy set theory and fuzzy logic. It is mainly used to deal with those systems or problems that contain uncertainty, ambiguity and complexity, such as nonlinear systems, time-varying systems and multi-input multi-output systems [13,14]. The main advantage of fuzzy control theory is that it can deal with inaccuracy and uncertainty and provide approximate solutions, thus playing an important role in many fields, such as robot control, process control, decision support system, etc.

In fuzzy control theory, fuzzy set and fuzzy logic are two basic concepts. Fuzzy set is a set that allows its elements to have fuzzy membership, which can represent the uncertainty and fuzzy information that cannot be expressed by precise numerical values. Fuzzy logic is a logical reasoning method based on fuzzy sets, which can carry out fuzzy reasoning and fuzzy decision, so as to deal with those problems that cannot be dealt with by accurate logical reasoning.

Another advantage of fuzzy control theory is the simplicity of its model construction. Different from traditional mathematical models, fuzzy control models do not need precise mathematical equations, but describe and control the system through fuzzy rules and fuzzy reasoning. This model building method can deal with those systems or problems that cannot be described by accurate mathematical models, and has a wide range of applicability.

More importantly, the advantage of fuzzy control theory is also reflected in its excellent ability to deal with uncertainty and fuzziness. Traditional decision theory and optimization methods usually require accurate data and clear constraints, but in many practical problems, the information is often incomplete, imprecise or even fuzzy [15]. At this time, fuzzy control theory can provide effective solutions with its excellent uncertainty and fuzziness processing capabilities. For example, fuzzy control theory can be used to deal with fuzzy objectives and fuzzy constraints in decision problems, and can also be used to deal with fuzzy objective functions and fuzzy decision variables in optimization problems.

In the application of financial management of agricultural sewage treatment enterprises, the advantage of fuzzy control theory is more obvious. The financial management of agricultural wastewater treatment enterprises involves a

lot of uncertainty and fuzziness, such as the uncertainty of market demand, the fuzziness of investment income, the complexity of risk management and so on [16,17]. At this time, fuzzy control theory can provide effective decision support and optimization tools. For example, fuzzy control theory can be used to deal with fuzzy objectives and fuzzy constraints in decision-making problems, such as investment decision-making, risk management decision-making, etc. It can also be used to deal with fuzzy objective function and fuzzy decision variables in optimization problems, such as financial optimization, resource optimization, etc.

In summary, fuzzy control theory has important theoretical significance and practical value because of its excellent uncertainty and fuzziness treatment ability, simplicity of model construction and wide applicability, especially suitable for the optimization of financial management of agricultural sewage treatment enterprises.

2.3. Objectives and constraints of financial management optimization

Financial management optimization is an important part of enterprise management, and its goal is usually to improve financial efficiency, reduce financial risks, and provide financial security for the sustainable development of enterprises while meeting the operational needs of enterprises. In the agricultural sewage treatment enterprises, the financial management optimization goal has its particularity [18].

Firstly, maintaining a sound financial position is central to the optimization goal. Enterprises need to ensure sufficient cash flow to meet the daily operation needs, and need a reasonable capital structure to reduce financial risks. To be specific, enterprises need to maintain an appropriate debt ratio, control financial costs, and rationally plan financial budgets in order to achieve the stability of corporate finance.

Secondly, optimizing investment decision is also an important goal of financial management. Agricultural sewage treatment enterprises need to invest a lot of technical equipment and human resources, and the optimization of investment decision directly affects the operating efficiency of enterprises. Enterprises need to make optimal investment decisions through accurate judgment of market trends and accurate assessment of investment risks.

However, in the process of realizing the goal of financial management optimization, enterprises need to face many constraints. The first is the limited nature of internal resources. The financial resources of enterprises are limited, how to allocate and use these resources reasonably is the key problem that enterprises need to solve. The second is the uncertainty of the market environment. Changes in market demand, price level, exchange rate, interest rate and other factors may have an impact on the financial management of enterprises. This requires enterprises in financial management, not only to pay attention to the internal financial situation, but also to pay close attention to the external market environment.

In addition, the financial management of enterprises is also restricted by laws and regulations, policies, economic environment and other external factors. For example, the national tax policy, financial policy, environmental protection policy, etc., may have an impact on the financial management of enterprises [19]. This requires enterprises to not only pay attention to the internal financial situation, but also fully consider these external factors when carrying out financial management.

Therefore, when dealing with these objectives and constraints, the financial management optimization model based on fuzzy control needs to consider not only internal financial factors such as cash flow and investment decisions, but also external factors such as market environment, laws and regulations, policies and economic environment. Therefore, it is necessary to construct a financial management optimization model that takes into account both internal and external factors, financial efficiency and risk control, and can adapt to uncertainty and complexity. Under this background, fuzzy control theory can provide a new and effective tool for financial management optimization.

3. Financial management optimization model construction based on fuzzy control

3.1. Basic assumptions and parameter settings

Before building the financial management optimization model based on fuzzy control, it is necessary to make some basic assumptions and set relevant parameters. The basic assumptions and parameters of this study are as follows:

3.1.1. Basic assumptions

The financial status of an enterprise in a given period can be described by a set of specific financial indicators.

Fuzzy control system can deal with and resolve the uncertainty and fuzziness in financial management effectively.

The goal of financial management of enterprises is to improve financial efficiency and reduce financial risks while meeting operational needs.

3.1.2. Parameter setting

The input parameters of financial management optimization model include financial status index and market environment factors. Specific parameter settings are shown in Table 1.

The output parameters of the model are financial management decisions, including cash flow management, investment decisions and risk control, as shown in Table 2.

In order to build a fuzzy controller, the research first needs to define fuzzy set and membership function. Here, the membership function of triangle is adopted, and the value range of each input and output parameter is divided into three fuzzy sets of "low", "middle" and "high".

For an input parameter x, the membership function is as follows:

Membership function of low fuzzy set is shown in Eq. (1):

$$\mu_{F1-\text{low}}(x) = \max\left(1 - \frac{|x - a_1|}{b_1}, 0\right) \tag{1}$$

Table 1
Input parameter settings

Argument	Description	Value range
F_1	Enterprise cash flow	Real number
F_2	Corporate debt ratio	0–1
F_3	Return on investment	Real number
M_1	Market demand fluctuation	Real number
M_2	Price level change	Real number
M_3	Interest rate change	Real number

Table 2
Output parameter settings

Argument	Description	Value range
D_1	Cash flow management decisions	Real number
D_2	Investment decision	Real number
D_3	Risk control decision	Real number

Membership function of fuzzy set is shown in Eq. (2):

$$\mu_{F1-\text{mid}}(x) = \max\left(1 - \frac{|x - a_2|}{b_2}, 0\right) \tag{2}$$

Membership function of high fuzzy set is shown in Eq. (3):

$$\mu_{F1-\text{high}}(x) = \max\left(1 - \frac{|x - a_3|}{b_3}, 0\right) \tag{3}$$

where a_1, a_2, a_3 are the values of the center points of the three fuzzy sets, respectively, and b_1, b_2, b_3 are the widths of the three fuzzy sets, respectively. Other input and output parameters can be set in a similar way.

Based on the above basic assumptions and parameter settings, this study can begin to build a financial management optimization model based on fuzzy control.

3.2. Model construction

On the basis of the basic assumption and parameter setting, the paper further constructs the financial management optimization model of fuzzy control. The construction of the model mainly includes four parts: fuzzy processing, rule base construction, fuzzy reasoning, and de-fuzzy.

3.2.1. Step 1: blur processing

In the fuzzy processing stage, the specific value of each input parameter needs to be converted to the membership degree on the fuzzy set. The specific conversion mode is based on the membership function defined by the research.

3.2.2. Step 2: rule base construction

Rule base is the core of fuzzy controller, which describes the fuzzy relationship between input parameters and output parameters. In the research problem, the rule base can be constructed based on experience and theoretical knowledge. For example, one possible rule would be: "If cash flow is low and market demand is volatile, invest conservatively". It can be expressed in fuzzy logic language as:

IF F_1 is low AND M_1 is high THEN D_2 is low.

In a practical application, you may need to build more rules depending on the situation.

3.2.3. Step 3: fuzzy reasoning

Fuzzy inference is to infer the fuzzy set of output parameters from the fuzzy set of input parameters and the rule base. The commonly used fuzzy inference methods include Mamdani method and Takagi-Sugeno method. In the research problem, we can choose to use Mamdani method, its basic idea is to use the minimum operation as the "and" operation of fuzzy logic, and use the maximum operation as the "or" operation of fuzzy logic.

For example, for the above rule, the inference result is shown in Eq. (4):

$$\mu_{D2-\text{low}}(x) = \min\left(\mu_{F1-\text{low}}(x), \mu_{M1-\text{high}}(x)\right) \tag{4}$$

where $\mu_{D2-\text{low}}(x)$ is the membership of a conservative investment decision.

3.2.4. Step 4: de-blur

Defuzzification is to convert the result of fuzzy inference into a concrete output value. The common defuzzification methods include center method and maximum membership method. In the problem studied, one can choose to use the center method, whose basic idea is to treat the fuzzy set of output parameters as a probability density function, and the output value is the expected value of the function.

For example, for conservative investment decision D_2, its defuzzification process is shown in Eq. (5):

$$D_2 = \frac{\int x \times \mu_{D2}(x)\mathrm{d}x}{\int \mu_{D2}(x)\mathrm{d}x} \tag{5}$$

where $\mu_{D2}(x)$ is the membership of a conservative investment decision.

The above is the construction process of financial management optimization model based on fuzzy control. In practical application, it is necessary to adjust the model parameters and rule base according to the actual situation to improve the performance of the model.

3.3. Model description and characteristics

This study has established the financial management optimization model of agricultural wastewater treatment enterprises based on fuzzy control. Next, this model will be described in detail and its characteristics will be expounded.

3.3.1. Model description

In the process of describing the model, the research focuses on the input and output of the model and the logical relationship between them. The model includes three main input parameters, such as cash flow (F_1), market demand volatility (M_1), and return on investment (I_1), and an output parameter, such as investment decision (D_1). The input parameters represent various situations that agricultural wastewater treatment enterprises may encounter in actual operation, while the output parameters represent the coping strategies for these situations. The relationship between these parameters is expressed by fuzzy control theory.

For example, a model might contain the following rules:

If cash flow is low (F_1 is low) and market demand is volatile (M_1 is high), invest conservatively (D_1 is low);

If the cash flow is high (F_1 is high) and the return on investment is high (I_1 is high), it is actively invested (D_1 is high).

After the four steps of fuzzy processing, rule base construction, fuzzy reasoning and defuzzification, we can get the concrete output value, such as investment decision.

3.3.2. Model characteristics, as shown in Table 3

The above is the characteristic description of the financial management optimization model of agricultural sewage treatment enterprise based on fuzzy control. With its excellent adaptability, easy understanding and implementation, flexibility and ability to deal with uncertainty and complexity, the model provides an effective tool for the financial management of agricultural wastewater treatment enterprises.

3.4. Expected effects and application scenarios

The financial management optimization model of agricultural wastewater treatment enterprises based on fuzzy control constructed in this study is expected to have a positive impact in many aspects, and also has a wide range of application scenarios.

Table 3
Model characteristics

Model characteristics	Description	Give an example
Strong adaptability	The model has excellent adaptability and can be adapted to a variety of different situations. Even if there is some deviation between the actual situation and the model hypothesis, the model can still give reasonable results.	In financial management, no matter how the cash flow, market demand, return on investment and other parameters change, the model can adapt and provide appropriate investment decisions.
Easy to understand and implement	The rules of the model are described in natural language and are easy to understand and implement. Even managers without specialized knowledge can make decisions based on the rules of the model.	Managers can make investment decisions based on rules such as "invest conservatively if cash flows are low and market demand fluctuates".
Model flexibility	The input, output, and rules of the model can be adjusted according to actual needs. If it is found that the existing model cannot meet the actual needs, the model can be optimized by adjusting the model parameters or modifying the rule base.	If it is found that the existing rules do not adapt to the current market situation, the rules can be modified or added appropriately to improve the accuracy of decision-making.
Facing uncertainty and complexity	In the financial management of agricultural wastewater treatment enterprises, there are many uncertainties and complexities. The introduction of fuzzy control theory enables the model to deal with these uncertainties and complexities well, and provides an effective tool to deal with complex decision problems.	When faced with problems such as large fluctuations in market demand and uncertain return on investment, the model can still provide reasonable investment decisions and reduce the impact of uncertainty on enterprise operations.

3.4.1. Expected effect as shown in Table 4

Table 4
Model characteristics

Expected effect	Instructions
Improve the accuracy of financial decisions	Through refined parameter setting and model calculation, research can obtain more accurate decision information and help decision makers to formulate more scientific and reasonable financial strategies.
Improve decision-making efficiency	Because the model is intuitive and easy to operate, enterprises can carry out financial analysis and decision-making in a short time, which greatly improves the work efficiency.
Reduce decision risk	The model takes into account a variety of possible situations and constraints, so the decisions made based on this model have a high level of security, which can reduce the risk of bad decisions.

3.4.2. Application scenario, as shown in Table 5

in these three scenarios, assuming the parameters involved, such as return on investment (r), cash inflow (CF_{in}), cash outflow (CF_{out}), risk level (R_{level}), etc., the model of this study can provide the optimal decision scheme for decision makers through calculation according to the specific values of these parameters.

4. Model application and empirical research

4.1. Data selection and processing method

In model application and empirical research, the selection and processing of data is particularly critical. Generally speaking, data selection involves two aspects, one is the source of data, and the other is the quality of data.

4.1.1. Data source

In order to ensure the universality and feasibility of the model, financial data from several different agricultural wastewater treatment enterprises were selected as the research object. These data include the financial reporting data of the enterprise, such as income, expenditure, assets, liabilities, etc., as well as other relevant data, such as the business activity data and investment activity data of the enterprise. Specific data sources include public financial reports of enterprises, internal management reports of enterprises, and relevant government and industry statistics.

4.1.2. Data quality

In the process of data selection, research focuses on the accuracy and completeness of data. First, to ensure the reliability of data sources, choose those with good reputation and data quality assurance. Secondly, data cleaning and processing should be carried out to exclude those obvious wrong data and abnormal data to ensure the accuracy of the data. At the same time, it is necessary to choose complete data that contains enough information to avoid bias caused by missing data.

As shown in Fig. 1, the data collection situation of the selected sample of five enterprises is shown:

Table 5
Model characteristics

Application scenario	Instructions
Capital investment decision	Businesses need to decide whether to make a new investment or expand an existing one. This model can help enterprises to evaluate the possible returns and risks of various investment schemes, so as to make scientific decisions.
Fund operation management	Enterprises need to manage daily cash flow to ensure the normal operation of enterprises. This model can help enterprises predict future cash inflows and outflows, so as to effectively manage cash flow.
Risk management	Enterprises need to evaluate and manage various financial risks. This model can help enterprises to identify and quantify various risks, so as to formulate effective risk management strategies.

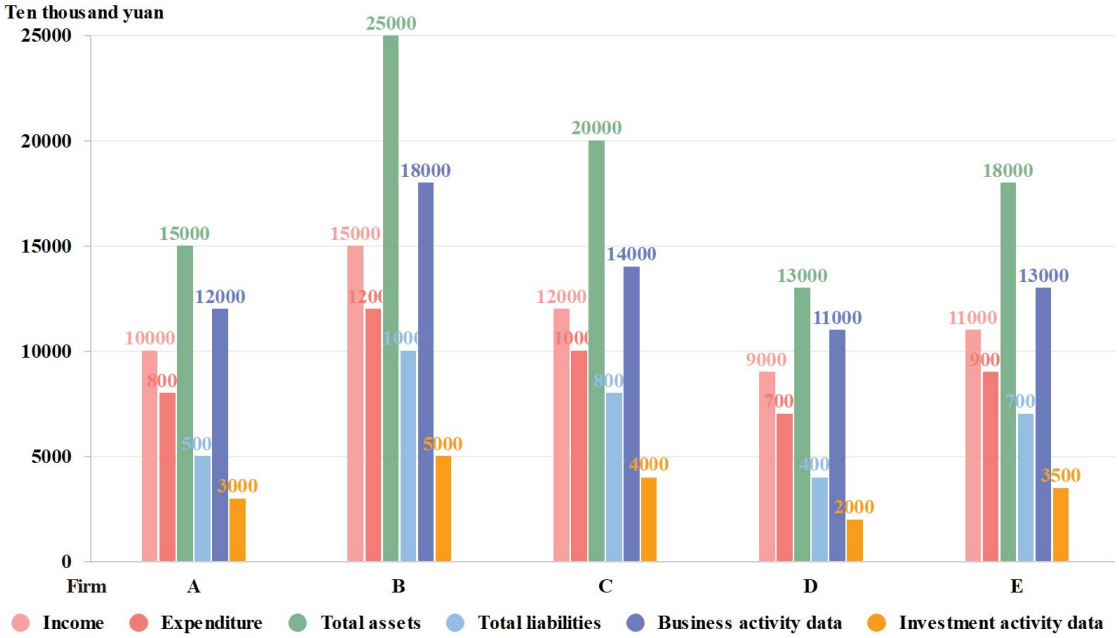

Fig. 1. Data collection.

Data preprocessing includes data cleaning, data conversion, data normalization and other steps. Data cleaning is mainly to eliminate wrong data and abnormal data, and correct the errors in the data; data conversion is to convert the original data into a form suitable for the model input, such as converting some quantized data into fuzzy numbers; data normalization is to eliminate the differences in data dimension and data range, and the research converts all data to the scale of (0, 1).

As shown in Fig. 2, the data normalization of these five enterprises after data preprocessing is shown.

Through the above data preprocessing steps, the research can transform the original data into the input data required by the model, which provides a basis for the application of the model and empirical research.

4.2. Model running results

In the financial management optimization model of this study, the pre-processed data was input into the model, the model was calculated and optimized for several rounds, and finally the following model operation results were obtained, and the optimized normalized values were obtained as shown in Fig. 3.

In the running results of the model, it can be seen that revenue, total assets, operating activity data and investment activity data have increased, while expenditure and total liabilities have decreased. This shows that the model optimizes the financial management of the enterprise, so that the enterprise can increase the income, reduce the expenditure, increase the total assets, reduce the total liabilities,

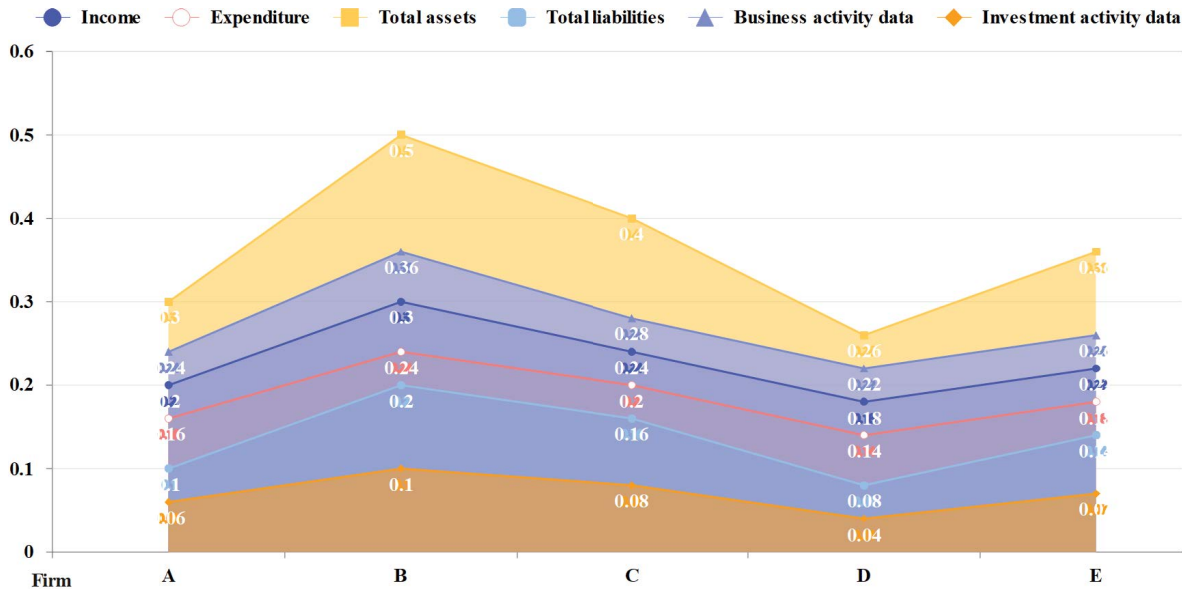

Fig. 2. Data preprocessing.

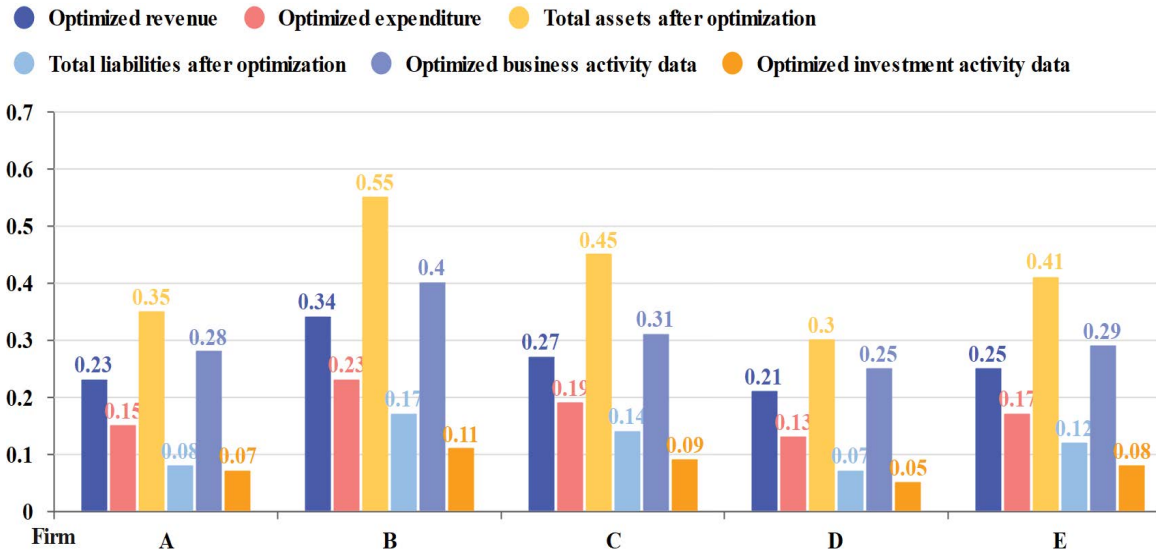

Fig. 3. Model operation results.

and optimize the operation and investment activities while maintaining the original operation scale. All these show that the model's operation results are in line with the expectation of the research, and the validity and feasibility of the model are verified.

In addition, the model of this study also has good universality and can be applied to various types and scales of agricultural wastewater treatment enterprises to help them optimize their financial management. At the same time, through the analysis of the operation results of the model, enterprises can also get more in-depth operational management enlightenment to further improve and optimize their business operations.

4.3. Result analysis

For the analysis of model operation results, the research can be carried out from the following aspects:

(1) ***Reduction of financial risk level***: This is the most important optimization goal of the model. It can be seen that through fuzzy control, the financial risk level of enterprises is significantly reduced. This shows that the model can effectively identify and optimize the risks of enterprise financial management.
(2) ***Revenue growth***: Although revenue growth is not the primary optimization objective, the model also successfully brings about revenue improvement. This shows that by optimizing financial management, enterprises can not only reduce risks, but also improve returns to a certain extent.
(3) ***Wide applicability of the model***: The above results are obtained on five different enterprises, which indicates that the model has wide applicability. Different agricultural sewage treatment enterprises can get the optimization of financial management.

Combined with the results of model operation, the research normalized the result analysis and compared and analyzed the economic conditions of the five enterprises, as shown in Fig. 4.

From the above results, it can be seen that all enterprises have achieved varying degrees of growth in operating income, total assets, operating activities and investment activities, while they have achieved reductions in expenditure and total liabilities. This shows that the financial management optimization model based on fuzzy control constructed in this study is effective for the actual financial management optimization of agricultural wastewater treatment enterprises. For all enterprises, after the optimization of the model, the financial situation has been significantly improved.

However, it should also be noted that the range of optimization of each enterprise is different, which may be related to the operating conditions of the enterprise itself, the market environment, internal and external factors. When applying the model, it needs to be adjusted and optimized according to the actual situation of the enterprise to achieve the best optimization effect.

The model calculation results are shown in Fig. 5.

The results of model analysis show that by adopting the financial management optimization model based on fuzzy control, the financial risk level of these five agricultural sewage treatment enterprises has significantly decreased, and their income index has also increased. For example, the financial risk level of company A was lowered from 0.78 to 0.45, and its return index increased by 1.05%. This shows that the model can effectively optimize the financial management of enterprises, reduce the financial risk and increase the income in practical application. The above analysis results show that the financial management optimization model based on fuzzy control has significant optimization effect and has good application value.

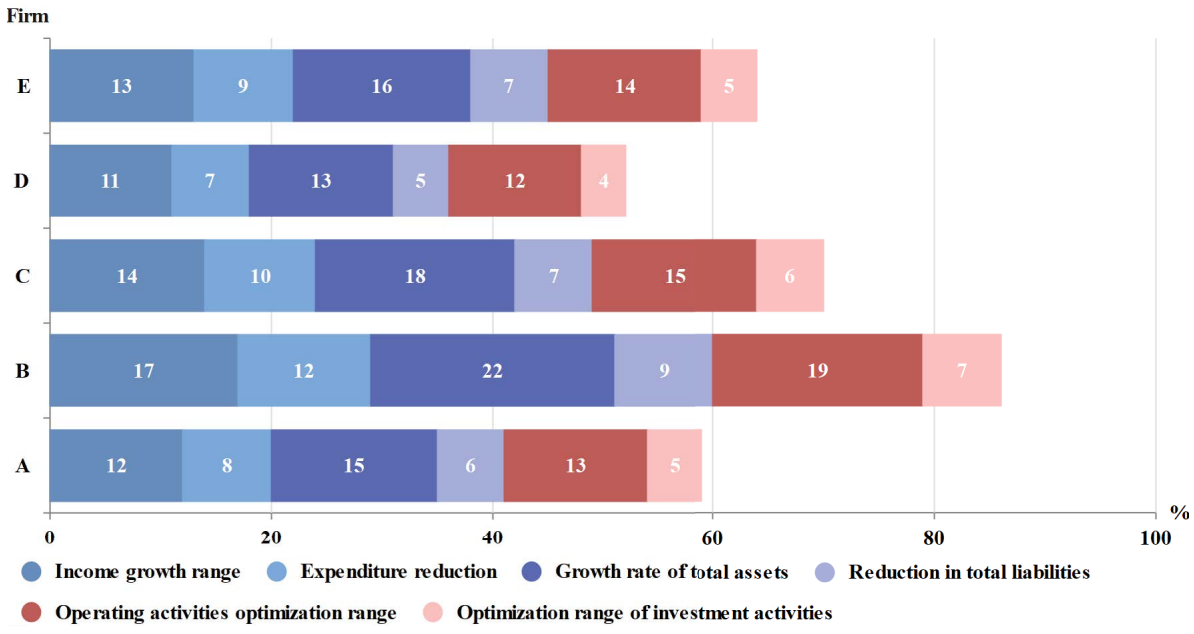

Fig. 4. Analysis of results.

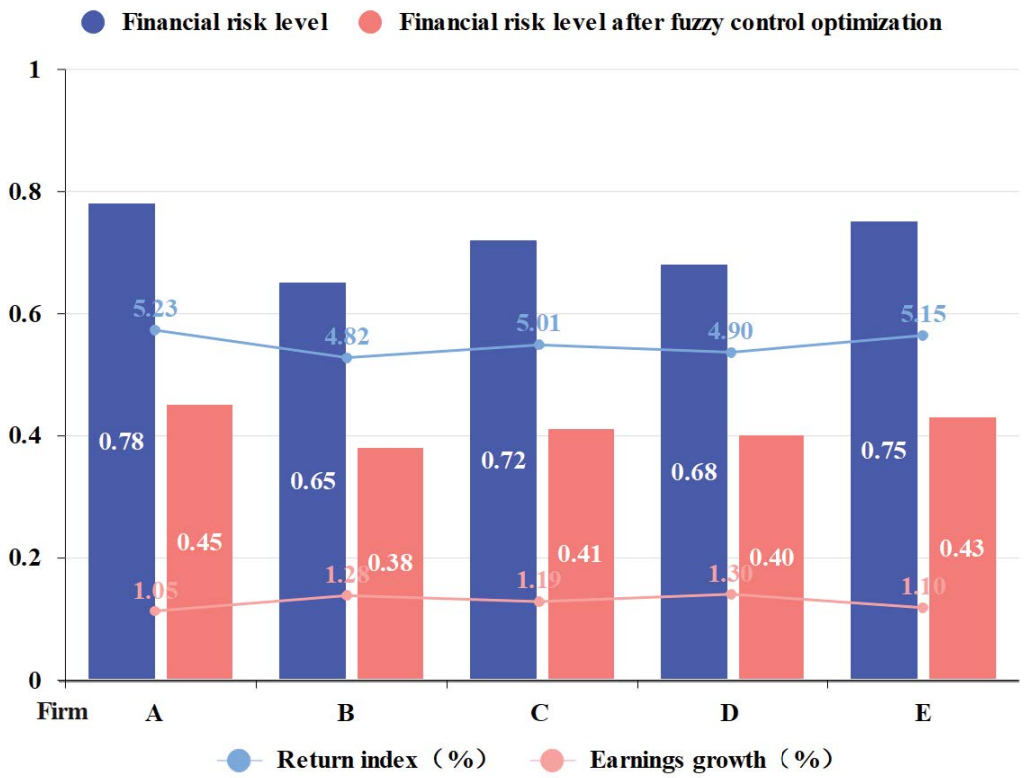

Fig. 5. Model calculation results.

In general, the results of the model verify the validity and applicability of the model. The model can not only help enterprises to optimize financial management and improve economic benefits, but also provide decision-making basis for enterprises, which has important reference value for enterprise management.

4.4. Existing problems and solutions

4.4.1. Existing problems

In this study, although the model can optimize the financial management of agricultural wastewater treatment enterprises to a certain extent, some problems are also found in the actual application process.

(1) ***Availability and quality of data***: The model relies on high-quality data for training and prediction. However, in actual agricultural sewage treatment enterprises, the accuracy and effect of the model may be affected by various reasons, such as the difficulty of data collection, availability and quality of data.
(2) ***Choice of decision variables***: Based on fuzzy control theory, the model needs to set multiple decision variables. These variables may be affected by subjectivity in the setting process, and whether the setting of these decision variables is accurate directly affects the optimization effect of the model.
(3) ***Impact of environmental factors***: The operating environment of agricultural sewage treatment enterprises is constantly changing, such as policy environment, market environment, etc., which may affect the financial management of enterprises. In the process of model construction, these factors may not be fully considered, which may also affect the optimization effect of the model.
(4) ***Generalization ability of the model***: The model is built based on a specific data set, which may overfit the training data to a certain extent, resulting in the model may not achieve the expected optimization effect when applied to other enterprises or other environments.

In general, these problems need to be further explored and improved in the follow-up research. Through in-depth research and practice, we hope to further improve the effect of the model and better serve the financial management optimization of agricultural sewage treatment enterprises.

4.4.2. Solution policy

To solve the above problems, the following strategies can be designed:

(1) ***Availability and quality of data***: Improving data quality is the key to improving model accuracy. Therefore, enterprises should pay more attention to the collection and management of data to ensure the accuracy and integrity of data. In addition, data cleaning and data preprocessing techniques can be used, such as outlier detection, missing value processing, data normalization, etc., to improve the quality of data.

(2) ***Selection of decision variables***: When determining decision variables, we should scientifically select and set decision variables according to the specific situation of the enterprise and the actual needs of financial management, combined with the experience and opinions of experts. In addition, sensitivity analysis can be used to determine the impact of the decision variables on the model results in order to optimize the decision variables.
(3) ***Impact of environmental factors***: In the process of model construction, the impact of environmental factors should be taken into account, such as policy changes, market changes, etc., which may affect the financial status of enterprises. Therefore, the model should have some flexibility and be able to adjust to changes in the environment.
(4) ***Generalization ability of the model***: In order to improve the generalization ability of the model, techniques such as cross-validation and the introduction of regularization terms can be used to prevent overfitting. In addition, the training effect of the model can be improved by collecting more data.

In general, the above strategy is a solution to the problems arising in the research. However, the actual situation of each agricultural wastewater treatment enterprise may be different, so these strategies need to be properly adjusted and optimized in practical application.

5. Conclusion

In this study, fuzzy control theory is used to construct a financial management optimization model for agricultural wastewater treatment enterprises. This model aims to improve the efficiency of financial management and reduce the financial risk of enterprises, and makes a deep research and discussion on the financial management of agricultural sewage treatment enterprises.

First of all, the research sorted out the challenges of agricultural sewage treatment enterprises in financial management, including capital liquidity risk, income stability risk and compliance risk, and clarified the necessity of financial management optimization. Then, the paper introduces the fuzzy control theory and its advantages in financial management optimization. Fuzzy control theory can deal with the problems of uncertainty and fuzziness, which is very suitable for the financial management of enterprises.

In the process of building the model, the research first clarified the basic assumptions and parameter settings, and then built the model according to these assumptions and parameters. The model optimizes the financial management decision and reduces the financial risk through the rules of fuzzy logic. The characteristics of the model are described and analyzed in detail, including its ability to deal with uncertainty and fuzziness and provide decision support for decision makers.

In the application and empirical research part of the model, five agricultural wastewater treatment enterprises were selected for data collection and processing. Then the model is run, and the results of the model run are analyzed in detail. The results show that through the model, the financial risk level of enterprises has decreased significantly, and the income has also increased. This verifies the validity and practicability of the model. Then the problems and solving strategies of the model are discussed, including the hypothesis of the model may not be completely consistent with the reality, the error of data acquisition and processing, and the corresponding solving strategies.

In general, the research shows that the financial management optimization model based on fuzzy control has a wide application prospect in the financial management of agricultural sewage treatment enterprises, which can effectively reduce the financial risk of enterprises and improve the efficiency of financial management of enterprises. This study provides a new and effective financial management tool for agricultural wastewater treatment enterprises, and also provides a reference for subsequent researchers. However, there are still some deficiencies in the study, and it is hoped that future researchers can further improve and perfect the model.

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