Research Article

Development and Supervision of Robo-Advisors under Digital Financial Inclusion in Complex Systems

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Received 18 October 2020; Revised 17 December 2020; Accepted 4 January 2021; Published 28 January 2021

Academic Editor: Zhihan Lv

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With the rapid development of the market economy, there are more and more projects in the financial industry, and their complexity and technical requirements are getting higher and higher. The development of computer technology has promoted the birth of robot consultants, and it is of great significance to use robot consultants to manage and supervise financial industry projects. In order to further analyze the development and supervision of robo-advisors under the digital inclusive financial system, this paper uses complex systems and clustering algorithms as technical support to carry out research. First, the traditional K-means algorithm is used to select the initial clustering center, to improve the noise and outlier processing capabilities, and to build a data mining system based on the improved algorithm. Then, a product design model for robo-advisors is built and the risks of robo-advisors are analyzed from three aspects: technology, market, and law. Analyzing the performance of the improved K-means algorithm, in the operation of the experimental dataset B, the accuracy of the clustering result after 6 iterations reached 97.08%, which shows that the algorithm has good performance. During the trial operation of the data mining system, the four types of customers of financial institutions were accurately clustered, and it was concluded that the main type of customers who brought benefits to financial institutions was high-income customers accounting for 10.75%. Robo-advisory product models are used to build five risk-level investment portfolios and conduct risk backtests. Except for the growth and income portfolio, other portfolios have consistently outperformed the performance benchmark during the analyzed time period. Running the research system of this paper in a financial institution, comparing the capital budget before and after the operation, found that the system can improve the accuracy of the budget and reduce the risk of the robo-advisor for the financial institution.

1. Introduction

1.1. Background Significance. In the operation of financial activities, there are many projects and tasks in parallel, which brings great impact to the traditional financial management concept. As an important application of financial technology in the field of wealth management, the mode of intelligent investment adviser is more complex. In the era of big data, there are many problems in the development and supervision of intelligent investment advisers [1]. Complex systems can be said to be all over every corner of daily life. Complexity science is an emerging research form that reveals the operation laws of complex systems [2]. The development and supervision of robo-advisors in the digital age is also an extremely complex research object. Therefore, it is a unique and meaningful new idea to study the development and supervision of digital inclusive finance and robo-advisors from the perspective of complex systems.

1.2. Related Work. Complex systems have become the focus of research in various fields due to their complexity and extensiveness. Lehuta et al. focused on handling uncertainties by optimizing model complexity for management goals and technical issues to increase confidence in complex system models. They reviewed how the complex system model fits into the existing institutional and legal environment of the current European fishery decision-making framework [3]. Although their research is of reference significance, their research methods lack innovation.
Inclusive finance plays an important role in improving the income gap and improving the living standards of the poor and disadvantaged groups, so it is the object of key research. Yan et al. studied the impact of digital financial inclusion (DFI) on the stabilization of household consumption in China. They used the data from the two “Chinese Family Forum” studies from 2010 to 2016. They divided household income shocks into permanent and temporary parts and assessed whether digital financial inclusion can help families resist income shocks [4]. Their research data are very representative but lack certain accuracy in processing the data. The risk analysis of robo-advisors has always been the focus of attention in the financial field. Jung et al. determined the needs of robo-advisors, derived design principles, and evaluated it through algorithm iterations in a controlled laboratory study [5]. Their research has given us a deeper understanding of robo-advisors, but they have not made constructive suggestions for the improvement of its supervisory system.

1.3. Innovative Points in This Paper. In order to build a more complete robo-advisory supervision system, reduce risks, and improve the digital level of inclusive finance, this paper studies the development and supervision of robo-advisors based on complex systems and clustering algorithms. The innovations of this research are as follows. (1) Improve the traditional K-means algorithm, optimize the selection of its initial clustering center, reduce the influence of noise, and improve the processing ability of isolated points. (2) A data mining system is constructed based on the improved algorithm. The functions of the system include opening files, importing data, data preprocessing, data clustering, and result query. (3) This paper constructs the product design model of intelligent investment consultant and uses the model to construct five risk-level portfolios for risk backtesting. This paper analyzes the risks of intelligent investment advisers from three aspects of technology, market, and law and puts forward suggestions to improve the supervision of intelligent investment advisers.

2. Complex Systems and Technologies Related to Digital Inclusive Finance

2.1. Complex System

2.1.1. Characteristics of Complex Systems. Complex systems exist in every corner of human life. Ecosystem, population system, and global economic system belong to the category of the complex system. They all have the same characteristics as the complex system. Complex systems are systematic first, which is not the superposition of simple systems and organizations. Therefore, it is not possible to study complex systems with traditional system analysis methods [6, 7]. The elements of a complex system are in a nonlinear relationship. Simple partial stacking cannot represent the whole. The local laws are not the same as the overall laws. Therefore, a new system theory is needed to consider the logical relationship between complex systems.

Complex systems are also hierarchical and interactive. The hierarchical nature of the complex system is mainly embodied in the nested relationship of different levels of interconnectedness [8]. Therefore, in the research of complex systems, it is necessary to update the traditional concept of hierarchy and analyze the research objects from the level of complex system theory. Complex systems and the external environment always interact. Different complex systems together form a larger and more complex system. When studying a complex system, we must fully consider the internal environment and external environment, study the information exchange between them, and consider the self-adjustment of the complex system in the complex external environment.

Complex systems have emergence and development. Complex systems are composed of various subsystems and local subsystems which are composed of various combinations and correlations. If the format and functional structure of the subsystem and the local subsystem are different, the complex system will no longer be the sum of the subsystem functions [9]. Complex systems may have a variety of new features, so when studying complex systems, we must consider the original features and the various new features that may appear. The self-renewability of complex systems is mainly reflected in the continuous development of the system, which is also the fundamental reason for biological evolution and the development of human society. Complicated systems become intelligent due to internal hierarchical, systematic and external interactivity, and emergence, so they can adapt to the needs and changes of the environment.

2.1.2. Agent Complex System. The complex adaptive system is based on the characteristics of the complex system and further develops the Agent theory. Agent is an independent individual or subsystem in a complex system, with a life cycle, which can perceive and adapt to the environment, run autonomously in the environment, and even change the environment. The structure of Agent generally includes environment perception, reasoning, control decision-making, knowledge base, and communication [10].

Agent has the characteristics of autonomy, social ability, initiative, learning, and adaptability [11]. Agents can use their own state and knowledge to make decisions independently, without relying on outside help. Agents can achieve a certain degree of communication, negotiate and cooperate to resolve conflicts, and complete complex tasks. Agents can judge their own situation according to the external environment and actively make choices that are beneficial to themselves at the right time. Agents can also continue to learn, adjust their own state and behavior, and adapt to the constantly changing external environment.

A single Agent has autonomous capabilities to a certain extent, but a single Agent cannot complete work in a complex and changeable environment. A multiagent system emerged at the historic moment, in which each Agent can communicate with each other. There are two or more Agents in a multiagent system, each with autonomy but limited...
capabilities [12]. The multiagent system does not have complete global control. A single Agent has its own judgment and status. The calculation of the entire system is asynchronous, concurrent, or parallel. The coordination methods between Agents in the multiagent system are classified as follows.

As shown in Figure 1, the coordination methods of multiagent systems can be divided into two categories: explicit coordination and implicit coordination. The explicit coordination includes complete centralized coordination, complete distributed coordination, and centralized and distributed combined coordination, and implicit coordination includes social rules and filtering strategies.

2.1.3. Evolutionary Dynamics of Complex Systems. There are some common dynamic behaviors in the evolution of complex systems. Under the action of dynamics, complex systems can evolve and develop continuously. It is also feasible to use the dynamic behavior of individuals to illustrate the evolution of the entire complex system. Individual-based dynamic processes are usually defined by strategy update rules. The strategy update rule is based on factors such as environment and information to update and select the benchmark of the game strategy adopted by the individual in the system.

The evolutionary power strategy update rules of complex systems can be divided into two categories: imitation-learning strategy update rules. In this process, only the original strategy is imitated without innovation; the strategy update rules of the optimal response process include the optimal response process generated by the new strategy. In the process of evolution, individuals can use different types of strategies to update rules or use the same strategy to update rules [13]. There are two types of update methods: synchronous update and asynchronous update. Synchronous update refers to the synchronous update of the entire overall population in each individual time step. Asynchronous updates are updated in batches in a specific order.

In a complex system, individuals use a series of different dynamic behaviors in the development process according to different strategic update rules so that the evolution of the complex system shows the common characteristics of a series of complex systems. The dynamic behavior and dynamic factors of specific complex system evolution are also involved. Most of them start from the perspective of game theory and analyze the evolution of complex systems represented by individual competition, cooperation, and learning interactions in complex systems.

2.2. Digital Inclusive Finance

2.2.1. Content Framework of the Inclusive Financial System. The connotation of inclusive finance reflects fairness, comprehensiveness, and profitability, so inclusive finance has the characteristics of inclusive and sustainable development [14]. The complete framework of the inclusive financial system considers that large-scale groups excluded by traditional financial institutions want to obtain financial services and benefit from them. Financial services must be integrated into the customer, micro, meso, and macro levels of the financial system. The framework of the inclusive financial system is as follows.

As shown in Figure 2, the customer level refers to the key service targets of inclusive finance, including vulnerable groups excluded by formal finance. The micro level refers to providers of financial services, including formal and informal financial institutions, as well as other types of financial institutions in the middle. The meso level refers to financial infrastructure and related services, including basic financial facilities, a series of auxiliary services that expand the scope of services, reduce costs, and promote transparency [15]. The macro level refers to the appropriate development environment, including the macroeconomic environment, institutional environment, and supervision and management environment.

As shown in Figure 3, commercial, policy, and cooperative financial institutions together form the ternary supply structure of the inclusive financial system at the mature stage [16]. They complement each other. Policy financial institutions provide policy guidance, and commercial financial institutions provide capital flows. Cooperative financial institutions provide necessary subsidies.

2.2.2. Development Stage of Digital Inclusive Finance. Digital inclusive finance extends and expands the meaning of financial services by using digital technologies such as the Internet and big data, expands the coverage of its services, and reduces the threshold and cost of financial services [17]. Moreover, digital financial inclusion can promote information sharing and reduce the degree of information asymmetry. The development stages of digital financial inclusion are as follows.

As shown in Figure 4, the development of digital financial inclusion has gone through four stages. The initial form of microfinance was very simple, and then new business models such as the individual farmer household loan system and the installment payment system appeared. Although it overcomes the moral crisis brought about by information asymmetry to a certain extent, the scope is limited. And, its funding sources are mainly foreign aid funds provided by the government, international aid, and nonprofit organizations. Once the foreign aid funds are reduced, it will not be possible to continue lending, and sustainable development will face challenges [18]. The development of microfinance is more sustainable and diverse. Sustainability is reflected in the expansion of its business into deposits, wealth management, and other fields, without relying on the financial support of the government, other organizations, and individuals and financial sustainability. Diversity is reflected in the diversification of institutions, businesses, and service targets. Inclusive finance not only provides financial products and services to the poor and
vulnerable groups but also promises to meet the diverse financial needs of all classes and groups in the society and encourages the wide participation of various financial institutions in the society. Digital finance is a new financial model that not only reduces transaction costs and information asymmetry but also expands the possibility of a series of transactions.

2.2.3. Threshold Mechanism for the Development of Inclusive Finance. The development of inclusive finance needs to face its threshold mechanism. In order to ensure profitability, financial institutions will set thresholds for mortgages and other services. Only when customers pay for financial services can they enjoy the services. In the mature stage of financial development, low-income groups who were originally excluded from the financial service system can gradually accumulate wealth to enjoy financial services, which will narrow the investment income gap between different groups [19]. It is possible to establish a theoretical analysis framework for the impact of financial development on the income gap from the perspective of the production cycle of the two families.

Assuming that there are rich and poor families, the production cycle of the two families is the same, and the financial service lending thresholds are the same; we can deduce the wealth accumulation process of the two families in the context of the borrowing threshold constraints. A poor family can only save value first to maintain simple reproduction. The initial wealth of the family is as follows:
\[ C = K - D + (\alpha + e)Y_0. \]  
(1)

Among them, \( K \) refers to the family’s external endowment in the \( t \) period, \( \alpha \) refers to the proportion of the family’s current wealth left to the next generation in each period of wealth distribution, and the remaining part of the current wealth for consumption is \( D. Y_0 \) is the initial wealth from the family inheritance of the previous generation. After the preservation and saving with an interest rate of \( e \), the wealth of the family in period \( t \) is as follows:

\[ C_t = K + W_{t-1} + eC_{t-1} - D. \]  
(2)

Among them, \( W_{t-1} \) refers to the inheritance of the previous generation family, so the inheritance left to the next generation by the family is as follows:

\[ W_t = \alpha(K + W_{t-1} + eC_{t-1} - D). \]  
(3)

From formulae (1)–(3), the convergence value of the wealth of the poor family can be derived:

\[ C_{\infty} = \frac{Ba}{(1 - \alpha)}. \]  
(4)

It can be seen from formula (4) that because it is difficult for poor families to cross the borrowing threshold, they are easy to fall into the “poverty trap” without the intervention of external forces. For wealthy families, their initial wealth is relatively abundant, and they can cross the borrowing threshold and obtain credit support. Therefore, the wealth of the family in period \( t \) is as follows:

\[ C_t = K + W_{t-1} + S - M \times (1 + i) - H - D. \]  
(5)

Among them, \( M \) is the amount of credit support, \( S \) is the income of each period after the credit support is invested in the project, and \( H \) is the cost of borrowers entering the financial market. In addition, the return on investment projects must be greater than the cost of the loan.

\[ B = K + S - M \times (1 + i) - H - D. \]  
(6)

According to formula (6), we can calculate the legacy of wealthy families to the next generation:

\[ W_t = \alpha C_t = \alpha(W_{t-1} + B). \]  
(7)

The convergence value of the wealth of the rich family can be deduced according to formulae (5)–(7):

\[ C_{\infty} = \frac{Ba}{(1 - \alpha)}. \]  
(8)

From formula (8), it can be seen that increasing the proportion of legacy left to the next generation and reducing the cost of entering the financial market can increase the wealth of wealthy families.

2.3. Related Technologies of Financial Data Mining

2.3.1. Data Mining Technology and Data Storage Technology. Data are the basis of data mining, and various algorithms are the means of data mining. The ultimate goal of data mining is to obtain the knowledge contained in the data to assist analysis and decision-making [20]. The mining of financial data is to promote the development of financial economy. The content of data mining includes things and dimensions, distribution and relationships, description and prediction, and phenomena and knowledge [21]. The main techniques of data mining include forecasting, clustering, association rules, and time series analysis.

MySQL is a relational database management system. The relational database uses the structured query language SQL as the most commonly used standard language to store data in various tables and access [22]. It can be used as individual application in the network environment of client and server. It can also be incorporated into other software as a library to provide multi-language support. MySQL database has good versatility and can improve storage efficiency.

Memcached is a high-performance distributed memory object caching system, which can reduce the load of the database, reduce the frequency of database access, and increase the high load of dynamic and data-driven websites [23]. Memcached has a simple protocol and built-in memory storage method. The data management access between the data layer and the service layer can cope with the emergence of high concurrent access and high concurrent query scenarios.
2.3.2. Bayes Classifier. The Bayes principle describes the probability of event $Y$ when event $X$ occurs. The Bayes formula is as follows:

$$P(X|Y) = \frac{P(Y|X)P(X)}{P(Y)}.$$  \hspace{1cm} (9)

In order to adapt formula (9) to the entire sample space, it is necessary to derive the total probability formula on the basis of conditional probability. Assuming that the sample space is $S$ and the remaining part of the sample space except event $X$ is $X'$, the total probability formula is the conditional probability formula summarized in this sample space.

$$P(Y) = P(Y \cap X) + P(Y \cap X'),$$  \hspace{1cm} (10)

$$P(X \cap Y) = P(Y|X)P(X),$$  \hspace{1cm} (11)

$$P(Y) = P(Y|X)P(X) + P(Y|X')P(X').$$  \hspace{1cm} (12)

We can derive formula (12) from formulae (10) and (11). This is the total probability formula. $P(X)$ is the prior probability, $P(Y|X)$ is the posterior probability, and $P(Y)/P(Y)$ is the likelihood function.

2.3.3. K-Means Clustering Algorithm. The K-means clustering algorithm is very common in the field of data mining. In this algorithm, K clustering centers are used to describe the clustering results. When the clustering objective function is known, the clustering analysis can be carried out by iterative updating to get the clustering results [24]. The schematic diagram of the K-means clustering algorithm process is shown in Figure 5:

The K-means clustering algorithm expresses the similarity measure between different clustered objects and data through distance. The performance evaluation method of the clustering result of this algorithm is usually the square of the mean square error [25]. After the iterative calculation, the objective function value of the algorithm will decrease, and the operation of the algorithm is a continuous iterative process.

The K-means clustering algorithm can process image and text features and has high stability and scalability. The clustering effect is good, and the result is more intuitive and easy to understand. When using an approximate algorithm to process datasets, as long as the target datasets are independent of each other, there is no need to restrict the scope of the dataset. However, the K-means clustering algorithm has limitations in practical applications, and the K value will directly affect the clustering effect. It is easy to be disturbed by local noise in the iterative process, which makes the result bias.

3. Experiments on Algorithm Optimization and Robo-Advisor Development and Supervision

3.1. Improvement of K-Means Clustering Algorithm and Construction of the Data Mining System

3.1.1. Improve the Selection of Initial Cluster Centers. The key technologies to improve the K-means clustering algorithm include clustering information resource sharing technology based on the interoperability meta-model framework and cluster automatic detection technology based on multiengine fusion. The square error and the benchmark function can be used to achieve cluster analysis of datasets with large differences in shape. The most convenient method is to randomly select multiple different initial values to execute the algorithm to reduce the dependence of the K-means clustering algorithm. According to the processing method of the representative points, the ideal clustering result is obtained by selecting the global best solution in the clustering result. When choosing the initial clustering center of the clustering algorithm, it is necessary to improve the selection of the initial clustering center.

In order to improve the stability of K-means clustering algorithm results, it is necessary to select data samples according to the characteristics of data distribution. In the process of determining the initial cluster center, it can reflect the characteristics of the initial data, and the data will not be distorted after sampling.

3.1.2. Improve Noise and Outlier Processing Capabilities. Perform clustering according to the steps of the traditional K-means clustering algorithm, delete outliers, and obtain a new dataset. Select the data object corresponding to the smallest density value from the set $S$ as the initial cluster center. When the distance between each point and the data and the remaining points is greater than the sum of the distances between the data object and all points, this point is treated as an isolated point.

In order to reduce the interference influence of the clustering effect of the K-means clustering algorithm, it is necessary to calculate the sum of the distance between each point and the data and the remaining points and the distance between the data object and all points.

$$Q_e = \sum_{i=1}^{e} \sqrt{\sum_{d=1}^{d} (x_{id} - x_{yd})^2},$$  \hspace{1cm} (13)

$$H = \sum_{i=1}^{e} \frac{Q_i}{e}.$$  \hspace{1cm} (14)

Among them, $e$ and $d$ are the sample data and data dimensions, respectively; $i$ is all points in the set; and $j$ is a constant.
3.1.3. Data Mining System Construction. There are five functions of the data mining system, which are file opening, data importing, data preprocessing, data clustering, and result query. The overall program flow of the system is as follows.

As shown in Figure 6, the user can specify the stored data file according to the flow instructions and then preprocess the data. After the data are stored in the database, users can choose whether to generate data or not and can query the data.

3.2. Robo-Advisor Product Design Model. Assuming that the asset portfolio $R$ selected by the investor contains $M$ different asset targets, the capital weight for investing in the $n$-th asset is $X_n$, and the expected return calculation method of portfolio $R$ is shown in the following formula:

$$Q_R = \sum_{n=1}^{M} X_n Q_n.$$  \hspace{1cm} (15)

The variance calculation of portfolio $R$ returns is shown in the following formula:

$$\sigma_R^2 = \sum_{n=1}^{M} X_n^2 \sigma_n^2 + \sum_{n=1}^{M} \sum_{j=1}^{M} X_n X_j \sigma_{nj}.$$  \hspace{1cm} (16)

For each asset target, $\sigma_n^2$ is a diversible risk, but $\sigma_{nj}$ is a nondispersible overall market risk. Then, when the target expected rate of return of the investment portfolio is determined, the investment portfolio with the least risk has the largest rate of return. The expression is shown in the following formula:

$$\min \; \alpha^T \sum \alpha \quad \text{s.t.} \quad \begin{align*}
\alpha E(Q_R) &= \eta \\
0 &\leq \sigma_{en} \leq 1 \\
1^T \alpha &= 1
\end{align*}$$  \hspace{1cm} (17)

Among them, $\eta$ is the expected rate of return of the investment portfolio target and $\alpha$ is the combination weight of the asset and the covariance matrix between the asset targets.

3.3. Risk Analysis of Robo-Advisor. The risk analysis of robo-advisors can be conducted from three aspects: technology, market, and law. Technical risks can be divided into internal and external. The external is cyber risk, and the internal is algorithmic defects and operational risks. The investment effect of market risk on robo-advisors needs to be tested by the market. The homogeneity of robo-advisory algorithms may have an intensifying effect on market resonance, thereby exacerbating the procyclicality of investment behavior. The complexity of robo-advisor business is directly proportional to the correlation between institutions. Legal risks include the contradiction between operational intelligence and fiduciary obligations and the contradiction between the professionalism of algorithms and regulatory methods.

4. Discussion on Robo-Advisor Development and Regulatory Issues

4.1. Algorithm Performance and System Operation Effect

4.1.1. Algorithm Performance. In order to verify the effectiveness of the improved K-means clustering algorithm, three datasets (A, B, and C) in the UCI database are randomly used as experimental datasets. The traditional K-means clustering algorithm, Clara algorithm, and the improved algorithm of this research are used for comparative analysis. The details of the experimental dataset are as follows.

As shown in Table 1, the total number of samples in the three datasets varies, and the number of attributes is also different. There are three cluster centers in dataset B and dataset C and four in dataset A. The traditional K-means clustering algorithm, Clara algorithm, and the improved algorithm of this research are run 10 times to compare the accuracy of clustering. The results are as follows.

As shown in Figure 7, in the three datasets, the accuracy of the clustering results of the traditional K-means clustering algorithm is lower than the Clara algorithm and the improved algorithm in this paper. The accuracy of the improved algorithm in this paper is higher than the traditional K-means clustering algorithm and Clara algorithm. Among them, in dataset B, the improved algorithm has the highest accuracy, up to 97.08%. In dataset C, the traditional K-means clustering algorithm has the lowest accuracy, as low as 62.17%. This shows that the improved algorithm in this
paper has a better performance in the accuracy of the clustering results.

Then, compare the number of iterations of the three algorithms in the clustering process to analyze the stability of the algorithms. The results of the number of iterations are compared as follows.

As shown in Figure 8, the improved clustering algorithm in this paper and the traditional K-means clustering algorithm have 4 and 7 iteration times in A dataset, 6 and 11 iterations in B dataset, and 11 and 18 iterations in C dataset, respectively. This shows that the improved algorithm in this paper has strong stability in the selection of initial clustering centers.

4.1.2. System Operation Effect. Run a data mining system based on the improved K-means clustering algorithm of this paper to analyze 1804 customers of digital financial institutions. Use the system to divide customers into four categories: high-income customers, low-income customers, customers to be developed, and consumer customers. The criteria for dividing customers are as follows.

As shown in Table 2, there is not much difference in age between the four types of customers, mainly middle-aged people. The salient feature of high-income customers is that their annual income exceeds 100,000 and their deposits exceed one million. The salient feature of low-income customers is that the annual income is less than 40,000 and the deposit is less than 500,000. The notable feature of the customers to be developed is that they have deposits of more than 500,000, but they have not been used for financial management or loans. The salient feature of consumer customers is that their annual income and deposits are relatively high, the amount used for financial management is higher than the annual income, and the loan amount exceeds 200,000.

After the customer classification standard is established, the type distribution of 1804 customers is analyzed, and the results are as follows.

As shown in Figure 9, among the 1804 customers of digital inclusive financial institutions, the number of customers to be developed is the largest, accounting for 46.12% of the total, and the number of high-income customers is the least, accounting for 10.75% of the total. The main types of customers who bring benefits to financial institutions are high-income customers with the smallest proportion. They often purchase wealth management products and are good at making reasonable use of the inclusive financial system to generate income for themselves.

4.2. Evaluation and Risk Backtesting of Robo-Advisor Product Models. Use backtesting analysis to compare the performance of robo-advisor product portfolios with performance benchmarks and evaluate the quality of product design based on the calculation of various indicators. The five risk-level investment portfolios are the capital preservation group, income group, growth and income group, growth group, and capital appreciation group. Compare the performance of the five portfolios from February 1 to 10 and the corresponding performance benchmarks. The results are as follows.
As shown in Figure 10, select the RMB seven-day notice deposit interest rate, the five-year bank fixed deposit interest rate, half of the sum of the CSI All-in-One Index and the All-in-China Securities Bond, 70% of the All-in-China Securities Index, and 30% of the All-in-China Securities Bond. The Hehe and China Securities Growth Index are used as the
performance benchmarks for the five risk levels. As can be seen from the figure, the performance of the growth and income portfolio was slightly lower than the performance benchmark on February 9 and February 10 and was better than the performance benchmark in the rest of the time. Other combinations have consistently outperformed performance benchmarks during the analyzed time period.

A backtest analysis of the five major risk-level investment portfolios and the backtest results are as follows.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|}
\hline
 & Capital preservation & Income & Growth and income & Growth & Capital appreciation \\
\hline
Interval return & 0.3564\% & 0.5377\% & -0.0969\% & 2.9108\% & 5.3314\% \\
Range fluctuation & 0.1348\% & 0.3581\% & 3.1252\% & 4.5537\% & 6.7002\% \\
Maximum drawdown & -0.3455\% & -0.7553\% & -3.1124\% & -5.10295 & -7.5337\% \\
Sharpe ratio & 1.58 & 1.21 & -0.08 & 0.59 & 0.79 \\
\hline
\end{tabular}
\caption{Backtest results of the five major risk grade portfolios.}
\label{tab:backtest}
\end{table}

As shown in Table 3, the combination of growth and income is in a state of diminishing returns in the interval, and other combinations are in an increasing state in both the range of returns and fluctuations. This shows that the construction of the five risk-level investment portfolios is reasonable.

4.3. Effects and Suggestions of Robo-Advisor Supervision

4.3.1. Effect of Robo-Advisor Supervision. Analyze the fund budget of an inclusive financial institution before and after using the data mining system of this research. The 6 items of income, tax rebates, sales costs, wages, travel expenses, and financial costs (the item numbers are H1, H2, H3, H4, H5, and H6) are budgeted and compared with the actual amount, and the results are as follows.

As shown in Table 4, before the system was used, there was a big difference between the financial institution’s capital budget and actual amount. Among them, the difference in cost of sales is the largest, with a difference of 230,000, followed by wages and income, with a difference of 140,000 and 120,000, respectively. After the system is put into use, compare the fund budget and actual amount of these six projects again, and the results are as follows.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|}
\hline
Item number & Budget item & Budget amount & Actual amount & Difference \\
\hline
\textbf{H1} & Income & 6320000 & 6200000 & 120000 \\
\textbf{H2} & Tax refund & 100000 & 120000 & -20000 \\
\textbf{H3} & Cost of sales & 4130000 & 3900000 & 230000 \\
\textbf{H4} & Wage & 1220000 & 1080000 & 140000 \\
\textbf{H5} & Travel expenses & 100000 & 90000 & 10000 \\
\textbf{H6} & Financial costs & 40000 & 30000 & 10000 \\
\hline
\end{tabular}
\caption{Comparison of capital budget before system use.}
\label{tab:capital-budget}
\end{table}

As shown in Table 4, before the system was used, there was a big difference between the financial institution’s capital budget and actual amount. Among them, the difference in cost of sales is the largest, with a difference of 230,000, followed by wages and income, with a difference of 140,000 and 120,000, respectively. After the system is put into use, compare the fund budget and actual amount of these six projects again, and the results are as follows.
As shown in Figure 11, after the system was put into use, the difference between the financial institution’s capital budget and the actual amount has narrowed a lot. The budgets for tax rebates, travel expenses, and financial costs were consistent with the actual amounts. The sales cost, which had the biggest difference before, was controlled at 40,000 yuan after the system was used. This shows that the use of the system has greatly helped financial institutions’ capital budgets and can improve the accuracy of budgets.

4.3.2. Suggestions on the Supervision of Robo-Advisors. Based on the above analysis results, the improvement of the robo-advisory regulatory system must innovate regulatory methods, promote financial pilots, use regulatory technology, and effectively prevent risks brought by opportunities and must rely on the existing financial supervision system and laws and regulations for supervision. The synergy of self-regulatory organizations between industries must be brought into play. Financial institutions must establish and improve dispute resolution and loss compensation mechanisms and information disclosure systems.

5. Conclusions

Complexity science is an emerging form of research that reveals the operating rules of complex systems. Complex systems can be found in every corner of life. The development of digital inclusive finance has gone through the four stages of microfinance, microfinance, inclusive finance, and digital finance. A data mining system based on complex systems and clustering algorithms can effectively cluster, help financial institutions analyze customer information, improve the accuracy of capital budgets, and reduce risks for financial institutions.

It is high-income customers who bring benefits to inclusive financial institutions because they often buy financial products and are good at making rational use of the inclusive financial system to generate income for themselves. In this paper, the construction of the five risk-level portfolio is very reasonable. After the risk backtest, we find that except the growth and income portfolio, the performance of other portfolios is better than the performance benchmark, and the interval return and interval volatility are increasing.

We must innovate regulatory methods, promote financial pilots, use regulatory technology, and effectively prevent risks brought by opportunities and must rely on the existing financial supervision system and laws and regulations for supervision. The synergy of self-regulatory organizations between industries must be brought into play. Financial institutions should establish and improve dispute resolution and loss compensation mechanisms and information disclosure systems. Only in this way can the problems that arise in the supervision of robo-advisors be improved, and the robo-advisor system can be improved.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author declares no conflicts of interest.

Acknowledgments

This work was supported by the Beijing Social Science Foundation Co-Construction Project “Research on Financial Support System for Coordinated Development of Strategic Emerging Industries in Beijing-Tianjin-Hebei Region.”

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