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Research on Loan Market Share Prediction Based on Grey Model and Exponential Smoothing Method

Tenghua Zhao [1,3] | Xiaoying Pan [2,*] | Lifeng Wu [1,2]

[1] *College of Management Engineering and Business, Hebei University of Engineering, Handan 056038, China*

[2] *School of Water Conservancy and Hydroelectric Power, Hebei University of Engineering, Handan 056038, China*

[3] *Bank of Handan, Handan 056000, China*

*Corresponding author: 1015782995@qq.com

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Abstract: The market share of loans is one of the important indicators in the operation of banking business, representing the market penetration and business operation of commercial banks in a certain region. It largely reflects the competitive position, influence, and profitability of the enterprise. Therefore, predicting the market share of loans is of great significance. This article takes H Bank's loan market share as the research object. Firstly, analyze the loan market data of H Bank over the past decade. Secondly, the relevant knowledge of grey prediction model and exponential smoothing method was introduced. Finally, the grey prediction model and exponential smoothing method are applied to predict the market share of H Bank's loan market. The results show that the market share of H Bank's loan market has been declining year by year, and effective strategies are proposed to increase market share.

Keywords: Commercial banks; market share of loans; grey forecast; exponential smoothing method

1. Introduction

Commercial banks are financial institutions that operate currency and credit businesses, are the mainstay of modern financial industry, and are the hub of national economic operation (Yao, 2008). After experiencing reform and opening up, the market economy has flourished, industrial upgrading, and technological innovation. In this era, the banking industry has been able to develop rapidly. At the same time, with the introduction of various policies, the participating entities in the banking industry have achieved unprecedented development in both quantity and quality. In this industry context, the internal competition in the banking industry is constantly increasing, and commercial banks are more eager for profits. Meanwhile, the market share of loans is the fundamental basis for the development of banks and the foundation for the existence of profits (Wu, 2015). Under controllable risk conditions, the better the loan market share indicator, the greater the profit margin, the stronger the ability to sustain operations, the less operational pressure, and the more promising the future development (Yang, 2024).

The grey prediction model (Wu *et al.*, 2017; Chu, 2017; Liang & Sha, 2014; Wang, 2006) and exponential smoothing method (Cao, 2009) have been applied and studied by scholars both

domestically and internationally in many fields. The market share of loans is an important operational indicator for banks, but there are relatively few research results on the application of grey prediction models and exponential smoothing methods in this area. The grey prediction model is suitable for situations with poor data quality and small sample sizes. It constructs grey differential equations and uses the correlation between known and unknown data for prediction, which can obtain more accurate prediction results in situations with limited data. The exponential smoothing method predicts future trends by weighted averaging historical data, using a smoothing factor to control the importance of past data. It can flexibly adapt to data with different fluctuations and obtain relatively stable prediction results. In predicting the market share of loans, the index smoothing method can assist the grey prediction model, verify and correct the prediction results, and improve the prediction accuracy. The current progress of grey model is shown in *Table 1*.

H Bank is a real bank located in Handan City, Hebei Province, China. H Bank has always been the largest commercial bank in the region. In the past decade, the number of banking operators in the region has gradually increased and stabilized, and the regional business environment is highly competitive. Therefore, this study aims to analyze the market share of H Bank's loans, predict the future loan market share indicators of H Bank, and propose effective strategies to improve market share, providing useful references for the development of commercial bank loan business.

2. Analysis of Local Loan Market Share

Since 2014, the loan balance of H Bank and the region has shown a continuous growth trend, and the market share of H Bank's loans has shown a parabolic shape from low to high and then to low, reaching its peak in the loan market share in 2018. After investigation, it was found that after 2020, due to the conversion of some book loans into debt, equity, write offs, and balance sheets, the loan balance has decreased. In recent years, the loan balance in the region has been increasing year by year, and the relative growth rate of H Bank's loan balance has slowed down. The loan market share has shown an unfavorable development trend. The loan data of H Bank and the region in the past 10 years are shown in *Table 2*.

3. Model Introduction

3.1 Exponential smoothing method

Exponential smoothing, also known as exponential smoothing, is an important time series forecasting method. The exponential smoothing method essentially takes the weighted average of historical data as the prediction result for future time points. The weighting coefficient decays in a

Table 1. The current progress on grey models

Theme	Literature
A novel fractional lag-based mixed-frequency discrete grey model (FMDGM(1,N)).	Gou *et al.* (2025)
To improve prediction accuracy for nonlinear and small-scale data, this study introduces residual learning into grey models, proposing a hybrid model.	Hao *et al.* (2025)
The study proposed a grey model with heterogeneity accumulation operators to predict the future energy consumption in Chinese provinces under the shared socioeconomic pathways.	Zhao and Wu (2025)
This research proposed an innovative hybrid Hausdorff fractional grey model (HfGM) for electricity consumption prediction, weakening buffer operator (WBO) was incorporated to minimize interference of external shocks to original data, the optimal core parameters of HfGM were searched by a newly developed multi-objective enhanced version of slime mould algorithm in two stages, achieving Pareto optimal solutions theoretically.	Qian *et al.* (2025)
This study introduces a novel polynomial-driven discrete grey power model (PFDPGM(1,1)) that includes time perturbation parameters, enabling a flexible representation of complex variation patterns in the data.	Yang *et al.* (2025)
The grey prediction model has been well applied in many fields. This study aims to apply the grey model to the prediction of loan market share.	This study

Table 2. Loan data of H Bank and the local region from 2014 to 2023

Year	H Bank	**Local**	**Proportion**
2014	240.7	2397.6	10.0%
2015	336.6	2803.8	12.0%
2016	406.2	3129.2	13.0%
2017	457.6	3385	13.5%
2018	535.1	3661.4	14.6%
2019	594.3	4167.9	14.3%
2020	601.7	4922.9	12.2%
2021	714.3	5757	12.4%
2022	854.2	6751.9	12.7%
2023	908.3	7768.4	11.7%

Unit: 100 million yuan Data source: Internal data

geometric series, and the closer the time period, the greater the weight, and the sum of weights is equal to 1. Due to the fact that the weighting coefficients follow the exponential law and have the function of exponential smoothing, they are called exponential smoothing (Cao, 2009).

The exponential smoothing model is

$$Q_t{}^{(1)} = \alpha Y_t + (1-\alpha) Q_{t-1}{}^{(1)}.$$

where, α is the smoothing coefficient, with a value range of [0,1]. $Q_t{}^{(1)}$ is the exponential smoothing value at time t, and Y_t represents the actual observation value of the t-th period.

The quadratic exponential smoothing model is

$$Q_t{}^{(2)} = \alpha Q_t{}^{(1)} + (1-\alpha) Q_{t-1}{}^{(2)}.$$

where, $Q_t{}^{(2)}$ is a smoothed value of time t. α is the smoothing coefficient, with a value range of [0,1]. $Q_{t-1}{}^{(2)}$ is the quadratic smoothed value of time $t-1$.

The prediction formula is

$$Y_{t+S} = a_i + b_i S.$$

where, t is the starting point for prediction, and S is the prediction step size.

$$a_i = 2Q_t{}^{(1)} - Q_t{}^{(2)}, b_i = \frac{\alpha}{1-\alpha}\left(Q_t{}^{(1)} - Q_t{}^{(2)}\right)$$

Its basic idea is to preprocess the raw data first, eliminate accidental changes in the time series, and increase the importance of recent data in prediction in the collected data. The processed data is called a 'smoothed value'. Then, based on the smoothed values, a prediction model is constructed through calculation to predict the future target values (Zhang, 2023).

The advantages of exponential smoothing method are: a) it does not require collecting a lot of historical data, considers the importance of each period's data, and uses all historical data. It is an improvement and development of the moving average method and has a wide range of applications. b) It has the advantages of simple calculation, small sample requirements, strong adaptability, and stable results. c) Not only can it be used for short-term forecasting, but it also has better performance for medium and long-term measurement (Cao, 2009).

When using exponential smoothing method for prediction, the value of weight α is also crucial. Generally speaking, if the data fluctuates greatly, the α value should be set larger to increase the influence of recent data on the prediction results. If the data fluctuates steadily, the α value should be taken smaller. Based on the specific time series situation, roughly determine the rated value range, then take several α values for trial calculation, compare the prediction standard error under different α values, and select the α with the smallest prediction standard error (Zhang, 2023).

3.2 Grey prediction model

The grey prediction model establishes a grey differential prediction model based on a small amount of incomplete information, and then makes long-term descriptions of the development laws of things (Tu, 2023). Next, we will analyze the construction and solution process of traditional grey prediction GM(1,1) models (Deng, 2002).

STEP 1: Assuming the original data sequence is

$$X^{(0)} = \left\{x^{(0)}(1), x^{(0)}(2), \cdots, x^{(0)}(n)\right\}$$

The first-order cumulative sequence is

$$X^{(1)} = \left\{x^{(1)}(1), x^{(1)}(2), \cdots, x^{(1)}(n)\right\}$$

where

$$x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i)\ (k = 1,2, \cdots, n) \tag{1}$$

STEP 2: $\left\{Z^{(1)}(2), Z^{(1)}(3), \cdots, Z^{(1)}(n)\right\}$ is the adjacent mean sequence of $X^{(1)}$, representing the background values of the entire model, where

$$Z^{(1)}(k) = \frac{x^{(1)}(k) + x^{(1)}(k-1)}{2}(k = 2,3, \cdots, n) \tag{2}$$

Therefore, the classic univariate grey prediction model is

$$x^{(0)}(k) + az^{(1)}(k) = b \tag{3}$$

Among them, a is the development coefficient of the system, and b is the grey action quantity. Parameters a and b are obtained through the least squares method

$$\begin{bmatrix}\hat{a}\\ \hat{b}\end{bmatrix} = (B^T B)^{-1} B^T Y \tag{4}$$

where

$$B = \begin{bmatrix} -Z^{(1)}(2) & 1 \\ -Z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -Z^{(1)}(n) & 1 \end{bmatrix}, Y = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{bmatrix}$$

STEP 3: Time response equation of GM(1,1) model

$$\hat{x}^{(1)}(k+1) = \left(x^{(0)}(1) - \frac{\hat{b}}{\hat{a}}\right)e^{-\hat{a}k} + \frac{\hat{b}}{\hat{a}}(k = 1,2, \cdots, n-1) \tag{5}$$

By substituting the calculated parameters $\hat{a}$ and $\hat{b}$ into the time response equation, the fitting value sequence of the first-order cumulative sequence $X^{(1)}$ of the original sequence can be obtained

$$\hat{X}^{(1)} = \left\{\hat{x}^{(1)}(1), \hat{x}^{(1)}(2), \cdots \hat{x}^{(1)}(n), \hat{x}^{(1)}(n+1), \hat{x}^{(1)}(n+2), \cdots\right\}$$

STEP 4: By reducing and restoring accumulated data, it can be obtained

$$\hat{x}^{(0)}(k+1) = \hat{x}^{(1)}(k+1) - \hat{x}^{(1)}(k)(k = 1,2, \cdots, n-1) \tag{6}$$

Therefore, the fitting value $\hat{x}^{(0)}(1), \hat{x}^{(0)}(2), \cdots \hat{x}^{(0)}(n)$ of sequence $X^{(0)}$ and the predicted $\hat{x}^{(0)}(n+1), \hat{x}^{(0)}(n+2) \cdots$ can be obtained by formula restoration.

STEP 5: By calculating the Mean Absolute Percentage Error (MAPE), the fitting and prediction performance of the model can be analyzed, and the formula is as follows

$$\text{MAPE} = 100\% \times \frac{1}{n} \sum_{n=1}^{k} \left| \frac{\hat{x}^{(0)}(k) - x^{(0)}(k)}{x^{(0)}(k)} \right|.$$

4. H Bank Loan Market Share Forecast

4.1 Exponential smoothing method

4.1.1 Forecast of H Bank's Loan Market Size. The initial value is the actual average value from 2014 to 2016. After comparison, when α is 0.9, the predicted value is closest to the actual value and the predicted result is optimal. *Table 3* shows the process values for predicting the size of H Bank's loan market. According to the quadratic exponential smoothing prediction model $Y_{t+S} = a_i + b_i S$, $a_i = 909.12$, $b_i = 69.29$ is obtained. Finally, Y=909.12+69.29S was obtained, which can effectively predict the size of the loan market from 2024 to 2030. The predicted loan market size of H Bank in the next 7 years under the index smoothing method is shown in *Table 4*.

4.1.2 Forecast of Loan Market Size in the Region. Using the average value from 2014 to 2016 as the initial value. After comparison, when α is 0.9, the predicted value is closest to the actual value and the predicted result is optimal. *Table 5* shows the predicted process values of the loan market size in the region. According to the quadratic exponential smoothing prediction model $Y_{t+S} = a_i + b_i S$, $a_i = 7767.85$, $b_i = 1007.45$ is obtained. Finally, Y =7767.85+1007.45S was obtained, which can effectively predict the size of the loan market from 2024 to 2030. The predicted loan market size of H Bank in the next 7 years under the index smoothing method is shown in *Table 6*. By using the quadratic exponential smoothing method for prediction, the loan market share of H Bank for the next 7 years is obtained, as shown in *Table 7*.

Table 3. H Bank loan market size prediction process value

Year	H Bank's actual value	Q_1 (Simple exponential smoothing)	Q_2 (Double exponential smoothing)
α		0.9	0.9
2013	Initial value	327.83	325.21
2014	240.7	249.43	257.00
2015	336.6	327.85	320.77
2016	406.2	398.37	390.61
2017	457.6	451.65	445.55
2018	535.1	526.76	518.64
2019	594.3	587.59	580.69
2020	601.7	600.24	598.29
2021	714.3	702.88	692.42
2022	854.2	839.10	824.43
2023	908.3	901.42	893.72

Table 4. Forecast of H Bank's loan market for the next 7 years using exponential smoothing method

Year	2024	2025	2026	2027	2028	2029	2030
Forecast	978.41	1047.7	1116.99	1186.28	1255.57	1324.86	1394.15

Unit: 100 million yuan

Table 5. Process value of predicting the size of the loan market in the region

Year	H Bank's actual value	Q_1 (Simple exponential smoothing)	Q_2 (Double exponential smoothing)
α		0.9	0.9
2013	Initial value	2776.87	2765.16
2014	2397.6	2435.53	2468.49
2015	2803.8	2766.93	2737.09
2016	3129.2	3093.01	3057.42
2017	3385.0	3355.82	3325.98
2018	3661.4	3630.83	3600.35
2019	4167.9	4114.24	4062.85
2020	4922.9	4842.06	4764.14
2021	5757.0	5665.55	5575.41
2022	6751.9	6643.31	6536.52
2023	7768.4	7655.91	7543.97

Table 6. Forecast of loan market in the area for the next 7 years using exponential smoothing method

Year	2024	2025	2026	2027	2028	2029	2030
Predictive value	8775.3	9782.75	10790.2	11797.65	12805.1	13812.55	14820

Table 7. H Bank's loan market share forecast

Year	2024	2025	2026	2027	2028	2029	2030
Loan market share %	11.15	10.71	10.35	10.06	9.81	9.59	9.41

4.2 Grey prediction model

4.2.1 Grey prediction of H Bank's loan market size. The grey prediction model takes small sample data as the research object. This section uses the GM (1,1) prediction model to use the loan market data of H Bank from 2016 to 2023 as the historical data for constructing the model, and obtains the predicted data. The detailed process is as follows.

(1) Initialize the modeling raw sequence

$$X^{(0)} = \{406.2,457.6,535.1,594.3,601.7,714.3,854.2,908.3\}$$

(2) Generation of 1-AGO from the original sequence

$$X^{(1)} = \{406.2,863.8,1398.9,1993.2,2594.9,3309.2,4163.4,5071.7\}$$

(3) Generation of Neighbor Mean for 1-AGO Generated Sequence

$$Z^{(1)}(k) = \{635.0,1131.4,1696.1,2294.1,2952.10,3736.3,4617.6\}$$

(4) Calculate the grey model development coefficient a and grey action quantity b

$$a = -0.115, b = 386.168$$

(5) The fitted predicted values and MAPE values are shown in *Table 8*.

4.2.2 Grey prediction of loan market size in the region. This section uses the GM (1,1) prediction model to use the loan market data of the region from 2016 to 2023 as the historical data for constructing the model, and obtains the predicted data. The detailed process is as follows.

(1) Initialize the modeling raw sequence

$$X^{(0)} = \{3129.2,3385,3661.4,4167.9,4922.9,5757,6751.9,7768.4\}$$

Table 8. Forecast of H Bank's loan market size

Year	Actual value of H Bank loan market	Predictive values
2016	406.2	406.20
2017	457.6	458.76
2018	535.1	514.68
2019	594.3	577.41
2020	601.7	647.78
2021	714.3	726.74
2022	854.2	815.31
2023	908.3	914.69
MAPE		3.081%
2024		1026.17
2025		1151.24
2026		1291.56
2027		1448.98
2028		1625.59
2029		1823.72
2030		2046.00

Unit: 100 million yuan

(2) Generation of 1-AGO from the original sequence

$$X^{(1)} = \{3129.2,6514.2,10175.6,14343.5,19266.4,25023.4,31775.3,39543.7\}$$

(3) Generation of Neighbor Mean for 1-AGO Generated Sequence

$$Z^{(1)}(k) = \{4821.7,8344.9,12259.6,16805.0,22144.9,28399.4,35659.5\}$$

(4) Calculate the grey model development coefficient a and grey action quantity b

$$a = -0.148, b = 2494.974$$

(5) The fitted predicted values and MAPE values are shown in *Table 9*.

4.2.3 Prediction of H Bank's Loan Market Share in the Region. By using the grey model for prediction, the market share of H Bank's loan market for the next 7 years is obtained, as shown in *Table 10*.

Table 9. Forecast of H Bank's Loan Market Size

Year	Actual value of total regional loan market volume	Predictive value
2016	3129.2	3129.2
2017	3385.0	3185.919
2018	3661.4	3692.426
2019	4167.9	4279.461
2020	4922.9	4959.823
2021	5757.0	5748.353
2022	6751.9	6662.245
2023	7768.4	7721.431
MAPE		1.748%
2024		8949.01
2025		10371.75
2026		12020.69
2027		13931.78
2028		16146.70
2029		18713.75
2030		21688.93

Unit: 100 million yuan

Table 10. Prediction of the Market Share of H Bank Loans

Year	2024	2025	2026	2027	2028	2029	2030
Loan market share, %	11.85	11.47	11.10	10.74	10.40	10.07	9.75

4.3 Prediction results

Through the grey prediction model and the quadratic exponential smoothing method, it can be seen that H Bank's loan market share will show a significant downward trend in the next 7 years. If effective measures such as business reform and product innovation are not actively implemented to reverse the current trend, the development prospects of H Bank are not optimistic.

5. Suggestions for increasing the market share of loans

5.1 Increase marketing and promotion

Diversified marketing strategies, in addition to traditional advertising methods, can also utilize social media, short video platforms, content marketing, and other means to attract potential customers by creating interesting and practical financial knowledge content. Brand story dissemination, describing the bank's development history, service philosophy, and successful customer cases, enhancing the brand's appeal and trust. Customer experience activities such as offline customer salons and financial product experience days are held to provide customers with a more intuitive understanding of the bank's products and services.

5.2 Innovative loan products

Gain a deep understanding of customer needs through market research, customer interviews, and other methods to understand their actual needs and pain points, and provide strong basis for product design. Introduce diversified loan products based on the needs of different customer groups, such as low interest loans, flexible repayment plans, etc. Develop specialized financial service solutions for specific industries or enterprises to meet their unique funding needs. Innovative guarantee methods, such as joint guarantee, guarantee company guarantee, accounts receivable pledge, etc., can solve the problem of guarantee for small and micro enterprises. Based on factors such as customers' credit status, repayment records, and industry characteristics, customers are segmented into different groups to provide differentiated loan products for different groups.

5.3 Improving customer service quality

It is suggested that the banks make efforts to enhance employees' professional competence, provide regular professional training to employees, and improve their professional competence and service level. They should also strive to improve customer service system, establish customer follow-up system, timely understand customer feedback, solve customer problems, and improve customer satisfaction. They should also strive to establish a rapid response mechanism, specifically for customer inquiries and complaints, to ensure timely resolution of issues. Meanwhile, efforts should be made to introduce advanced financial technologies, utilize big data, artificial intelligence and other financial technology tools to optimize the loan approval process, while improving approval efficiency and accuracy.

5.4 Optimizing loan structure

For high-risk areas such as real estate and local government financing platforms, it is necessary to strictly control loan disbursement, avoid excessive concentration of risks, and integrate business with local economic development. According to national industrial policies and local economic development needs, we will focus on supporting areas such as energy conservation and environmental protection, technological innovation, and small and micro enterprises. Pay attention

to the small and micro enterprise market and increase credit support for small and micro enterprises. Keeping up with the deployment of technological innovation development, optimizing the customer structure of scientific and technological innovation, and supporting the development of high-tech enterprises. Intensify the expansion of retail consumer credit, business credit and other businesses, and increase the proportion of retail loans in total loans.

5.5 Improve the loan pricing mechanism

Considering cost factors comprehensively, pricing should take into account factors such as capital costs, operating costs, and risk costs to ensure the rationality of pricing. Reflecting market orientation, adjusting loan interest rates in a timely manner based on market interest rates and competitive conditions to maintain market competitiveness. Flexible pricing strategy, based on the characteristics of different customers and loan products, adopts flexible pricing strategies to improve the targeting and effectiveness of pricing. Emphasize the principle of differentiation and establish different interest rates based on factors such as the customer's credit rating and loan purpose.

5.6 Strengthen cooperation with third-party organizations

Establish cooperative relationships with other financial institutions such as banks, insurance companies, and guarantee companies to jointly explore the market. Through cooperation, resource information sharing and complementary advantages can be achieved to improve business processing efficiency and risk prevention and control capabilities. Jointly plan and carry out joint marketing activities to expand market share and brand influence. Utilize the advantages in network, business logic, and basic customer base, and choose third-party companies that match your own strategy and business priorities for cooperation.

5.7 Utilizing financial technology to enhance productivity

Develop credit approval processes and credit evaluation models that adapt to the characteristics of various enterprises, utilize information technologies such as big data, blockchain, artificial intelligence, and big data to enhance credit risk assessment capabilities, and strengthen the deep penetration of emerging technologies in the financial field. Provide a more efficient and orderly business collaboration mechanism, quickly respond to customer and market demands, focus on the shortcomings and weaknesses of financial services, continuously improve full lifecycle, diversified, and relay style financial services, and promote better adaptation to the innovation needs of enterprises in the new era. Utilize emerging financial technology to optimize business processes and operational models, strengthen risk prevention and cost management.

6. Conclusion

There are numerous evaluation indicators for commercial banks, which can be used to evaluate the size, quality, and risk of various assets from different dimensions. The loan market share indicator represents the market penetration and business operations of commercial banks in a certain region, and to a large extent reflects the competitive position, influence, and profitability of enterprises. It is one of the important indicators in banking business operations. The prediction of loan market share plays a crucial role in the development of financial markets and banking industry for financial institutions to formulate strategies, optimize resource allocation, and manage risks.

The current study first analyzed the performance of H Bank's loan market share in the past decade. By applying the grey prediction model and exponential smoothing method, H Bank's loan market share in the region was predicted for the next seven years, which were mutually confirmed. The predicted trend of market share decline was obtained, and relevant suggestions for improving the loan market share were proposed.

The current study validates and compares the effectiveness of the two forecasting methods by constructing them and applying them on H Bank’s loan market share. However, existing research

still has some shortcomings. Although grey prediction models and exponential smoothing methods have their own advantages, they also have limitations. For example, grey prediction models perform well with limited data, but may have some errors in long-term forecasting. The exponential smoothing rule focuses more on predicting short-term trends and may not be accurate enough in grasping long-term trends. Therefore, in practical applications, it is necessary to coordinate the various influencing factors of commercial bank market share according to specific situations, analyze and judge from multiple aspects and dimensions, and lay a solid foundation for the rapid and healthy development of banks.

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