Construction And Prediction of China ' S Financial Pressure Index Based On A-E-G Coupling Perspective

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Abstract: The Financial Stress Index (FSI), as a powerful tool to measure systemic financial risk in China, can provide a basis for regulators to formulate relevant macro-prudential policies. In this paper, nine representative financial stress indicators are selected from the banking system, bond market, stock market, foreign exchange market and real estate market, and the weights of each indicator are calculated using the Attribute Hierarchical Method (AHM) and Entropy Weighting Method (EWM), respectively, and coupled with the calculation to construct the Chinese Financial Stress Index (CFSI). Further, GM (1, 1) is applied to predict the future development trend of CFSI. This paper constructs and forecasts the CFSI based on A-E-G method (AHM- EWM- GM (1, 1)). The results show that the CFSI index synthesized by the AHM and EWM assignment method can effectively identify major financial events and is real-time and robust. The GM (1, 1) predicts that China's financial stress will decline moderately in the future five years. This implies that the consistent implementation of financial regulatory policies can achieve the desired results.

1. Introduction

As China's economic development enters a new normal and reforms in the financial sector deepen, preventing systemic financial risks has become a top priority for China's financial work. Systemic financial risks can be transmitted across financial systems such as bond markets, stock markets and foreign exchange markets, generating financial stresses that can exert a damaging effect on the real economy and thus hinder macroeconomic development. The use of reasonable tools to measure and identify the level of systemic financial risks in China and to grasp the trend of financial risks in China is an important prerequisite for the prevention and resolution of financial risks, and also provides an empirical basis and methodological support for the implementation of prudential supervision policies.

The Financial Stress Index (FSI) is a comprehensive indicator that measures the pressure exerted on economic agents by changes in uncertainty and expected losses in financial markets and institutions, which is capable of measuring the level of systemic financial risk in China, and has been widely studied and adopted by academics. Illing and Ilu [1] first selected nine indicators from the Canadian financial markets of banks, stocks and foreign exchange, and used equal variance weights, Hakkiot and Keeton [2] adopted the Principal Component Approach (PCA) to construct the Kansas Financial Stress Index. Chinese scholars also used various weighting methods to construct China's financial stress index. Xu Dilong and Chen Shuanglian [3] constructed a financial stress index based on the CRITIC (Criteria Importance Though Intercrieria Correlation) method, selecting sub-indicators from banks, real estate, stock market and external financial markets. Deng Chuang and Zhao Ke [4] used the dynamic CRITIC method to synthesize the total index of financial stress in China from three aspects: foreign exchange market, banking system and asset bubbles. Ding Hui et al [5] constructed the Chinese financial market stress index based on the dynamic credit weighting method.

Although scholars have extensively explored the methods of constructing financial stress index, most existing studies have adopted only one assignment method to calculate the weight of each indicator in the financial stress index, and thus have certain limitations. For example, the isovariance weighting method and the PCA method have fixed weights for each variable within the sample period, making it difficult to objectively reflect the changing level of risk in the real financial environment. There is little literature on the use of a combination of subjective and objective weighting methods for the measurement of financial stress indices. In terms of the choice of financial sub-indicators, most studies focus on the basic indicators of the banking system, stock market, bond market and foreign exchange market, with less consideration of the impact of real estate market risk on the financial system, making the financial stress index lacking in comprehensiveness and accuracy in reflecting China's financial systemic risk.

Therefore, the marginal contribution of this paper may be: (1) Based on the existing studies, this paper combines the attribute hierarchy model (AHM) and the entropy weighting method (EWM) to measure the weights of the basic indicators of each financial market at both subjective and objective levels, making the final synthesis of China's financial stress index more objective and accurate. (2) The current price fluctuations in the real estate market have an important impact on China's finance, so the inclusion of financial indicators of the real estate market is intended to construct a comprehensive index that better reflects the financial market stress. (3) The GM (1, 1) method in grey system theory is used to forecast the dynamic trend of China's financial stress index in the future, providing an important reference for regulators and policymakers. This study provides instrumental methods and empirical evidence for measuring financial market stress and systemic financial risk in China. Also, it provides relevant policy insights by assessing current and future financial stress in China. (4) Take the COVID-19 as an influential event to analyze its impact on CFSI.

This paper first selects the basic indicators from the banking system, stock, bond, foreign exchange and real estate markets to construct the Chinese financial stress index system, and then calculates the weights of each indicator based on the AHM and EWM methods for the collected monthly frequency data respectively, and uses the multiplier synthesis normalization method to calculate the coupling weights to finally synthesize the Chinese financial stress index. Finally, the GM (1, 1) algorithm is applied to forecast the future dynamic development of the constructed stress index, and relevant conclusions and policy recommendations are drawn accordingly.

2. Construction of the China Financial Stress (CFSI) Indicator System

2.1 Principles of Indicator Selection

In this paper, the selection of basic indicators is based on two main principles. One is that the selected indicators can basically cover China's financial market, so they can reflect the overall stress level of China's financial system; Hollo et al. [6] point out that the financial system mainly consists of three parts: financial market, financial intermediation and financial infrastructure. The financial market includes the bond market, the stock market and the foreign exchange market, the financial intermediation includes the banking and insurance sectors, and the financial infrastructure involves the payment system, the clearing system and the regulatory system. After considering the representativeness of the indicators and data availability, this paper selects nine basic indicators from the banking system, bond market, stock market, foreign exchange market and real estate market to construct the CFSI. the second principle of the indicators is to reflect the characteristics of financial stress. Financial stress is usually characterized by uncertainty in asset prices and investor behavior, information asymmetry, as well as rising demand for low-risk assets and increasing demand for highly liquid assets by market participants. Based on this, the indicators selected in this paper all reflect the unstable state of financial markets and the weakening of market expectations. Drawing on the literature of Ding Lan et al [7], Kliesen, K. L. and D. C. Smit [8], the indicators selected in this paper are justified by their positive and negative nature as follows.

2.2 Banking system indicators

The SHIBOR and treasury yield spread is calculated as the difference between the 3-month SHIBOR and the 3-month Treasury yield [9], with an increase in the spread reflecting banks' demand for a higher risk premium to protect against external risk shocks in the banking sector. The spread on interbank lending rates reflects the short-term liquidity premium in the interbank market. The larger the indicator, the greater the liquidity risk in the interbank lending market, the higher the cost of interbank funding and borrowing, and the greater the financial stress on the banking sector.

2.3 Bond market indicators

The bond market uses term spreads and corporate bond rates as indicators. 5-year government bonds are an important species in the bond market with relatively active trading volumes. The larger the term spread between its yield to maturity and the yield to maturity of treasury bonds, the higher the forward premium demanded by the market, the higher the market expects the forward interest rate risk to rise and the stress on the bond system to increase; the corporate bond-Treasury bond yield reflects the market credit risk premium and usually shows a positive relationship with financial stress.

2.4 Stock market indicators

Stock market volatility is selected as an indicator. Stock price volatility is measured by calculating the time-varying variance series of the GARCH (1,1) model for the index.

2.5 Foreign exchange market indicators

The foreign exchange market uses real effective exchange rate volatility and the rate of change in foreign exchange reserves as indicators [10]. The volatility of the exchange rate index reflects the state of risk in the exchange rate market; the greater the volatility, the greater the financial stress on the market. Negative changes in foreign exchange reserves will increase the pressure of RMB devaluation to a certain extent, thus increasing financial pressure.

2.6 Real estate market indicators

The State Property Prosperity Index reflects the prosperity of the real estate industry. A larger index indicates that the real estate industry is improving and the pressure on the real estate market is weakening; the volatility of the State Property Prosperity Index measures the volatility of the real estate industry, and an increase in volatility indicates that the risk in the real estate industry is strengthening and the pressure on the real estate market is increasing. See Table 1 for details.

Table 1. CFSI's indicator system construction

	Indicator Name	Indicator Code	Indicator Implication	Calculation	Positive or Negative
Banking System	SHIBOR and treasury yield spread	X11	External risk shocks	3 Month SHIBOR-3 Month treasury yield	Positive
	SHIBOR spread	X12	Liquidity risk in the interbank lending market	1 Year SHIBOR- 7 days SHIBOR	Positive
Bond Market	Term spread	X21	Liquidity risk	5 Year Treasury yield -1 Year Treasury yield	Positive
	Corporate bond yield and treasury yield spread	X22	Credit risk	1 Year AAA Corporate bond yield-1 Year Treasury yield	Positive
Stock Market	Stock price volatility	X31	Stock market volatility	Standard deviation of closing price of the SSE	Positive
Foreign Exchange Market	Real effective exchange rate volatility	X41	Exchange market volatility	Time-varying variance series of the GARCH (1,1) model for the real effective exchange rate index	Positive
	Rate of change in foreign exchange reserves	X42	Exchange market vulnerability	Monthly rate of change in foreign exchange reserves	Negative
Real Estate Market	Real Estate Climate Index volatility	X51	Real estate market volatility	Time-varying variance series of the GARCH (1,1) model for the real estate climate index	Positive
	Real Estate Climate Index	X52	Real estate market prosperity degree	Real estate climate index	Negative

3. Establishment of AHM-EWM model

3.1 Subjective weight calculation based on AHM

Attribute Hierarchy Model (AHM) is a simple subjective weighting method for solving relative attributes and finally obtaining index weights, which was proposed by Cheng Qiansheng in 1997 on the basis of Analytics Hierarchy Process (AHP) proposed by Professor T. L. Saaty, an American operational researcher. In addition to the characteristics of AHP, it also has the advantages of simple and fast, saving the steps of calculating feature vectors and checking consistency. The steps are as follows:

STEP 1: Establish hierarchical structure model: It can be divided into three categories, namely, the highest / target layer, the middle layer / criterion layer and the bottom layer / measure layer / scheme layer. The elements of the upper layer as a criterion dominate the relevant elements of the next layer. Set A as the target layer, B as the criterion layer, C as the index layer. Suppose there are n elements $X_1, X_2, X_3, ..., X_n$. For the criterion layer B, compare two different factors $X_i, X_j (i \neq j)$ and denote the relative importance of X_i, X_j to the criterion layer B as X_{ij}, X_{ji} respectively. As required by the attribute measure, the following conditions need to be satisfied:

$$X_{ij} \geq 0, X_{ji} \geq 0, X_{ij} + X_{ji} = 1 \ (i \neq j) \tag{1}$$

$$X_{ij} = 0, 0 \leq i \leq n \ (i = j) \tag{1}$$

STEP 2: Constructing attribute judgment matrix: attribute judgment matrix $(X_{ij})_{m \times m}$ $(1 \leq m \leq n)$ is a matrix composed of relative attributes. The relative attribute measures of X_i and X_j can be converted from the relative proportional measure a_{ij} of the comparative judgment matrix constructed by the 9-scale method in the Analytics Hierarchy Process (AHP).

The 9-scale method of AHP establishes pairwise comparison matrix, also called judgment matrix, which takes two factors X_i and X_j each time. a_{ij} represents the ratio of the influence of X_i and X_j on A. All results are represented by $A = (a_{ij})_{n \times n}$, and the number 1-9 and its reciprocals are usually cited as scales. The conversion formula can be referred to the following formula, where k is a positive integer greater than 2 and U is greater than or equal to 1, generally $U = 1$ or $U = 2$.

$$X_{ij} = \begin{cases} \dfrac{U_k}{U_k + 1} & a_{ij} = k \\ 0.5 & a_{ij} = 1 \quad i \neq j \\ \dfrac{1}{U_k + 1} & a_{ij} = \dfrac{1}{k} \end{cases} \tag{2}$$

STEP3: Calculation of relative weight and composite weight: relative attribute weight W_{cxi} can be calculated by the following formula, and finally the composite weight W_{AHM} of each index relative to the system target can be obtained.

$$W_{(cxi)} = \frac{2}{n(n-1)} \sum_{j=1}^{n} x_{ij} \quad (i = 1, 2, ..., n) \tag{3}$$

$$W_{AHM} = \left[W_{cx1}, W_{cx2}, \cdots, W_{cxn}\right]^{\mathrm{T}} \tag{4}$$

3.2 Objective Weight Calculation Based on EWM

Entropy originated from thermodynamics and was introduced into information theory by C. E. Shannon. When the system may be in several different states and the probability of each state is p_i, the entropy of the system can be defined as:

$$e = -\frac{1}{\ln m} \sum_{i=1}^{m} p_i \ln p_i \tag{5}$$

Entropy Weight Method (EWM) is an objective weighting method that can obtain more objective index weights according to the variation degree of each index, which is generally used to evaluate the advantages and disadvantages of multiple schemes. In general, the smaller the entropy value is, the more information the index value is, the greater the role of evaluation is, the greater the weight is, and vice versa. The steps are as follows:

STEP1:Construct indicator matrix: Suppose there are m evaluation objects and n evaluation indicators, and the value of the i^{th} evaluation object regarding the j^{th} evaluation indicator is b_{ij}. Matrix $B=(b_{ij})_{m\times n}$ can be constructed.

STEP2: Standardise the index data to obtain r_{ij}, with B being the maximum value in b_{ij} and b being the minimum value in b_{ij}. In turn, the weight p_{ij} of the i^{th} evaluation object with respect to the j^{th} evaluation indicator can be calculated.

$$r_{ij}=\frac{b_{ij}-b}{B-b} \tag{6}$$

$$p_{ij}=\frac{r_{ij}}{\sum_{i=1}^{n} r_{ij}} \tag{7}$$

STEP3: Calculate the entropy value of the j^{th} indicator as

$$C_j=-\frac{1}{\ln n}\sum_{i=1}^{n} p_{ij}\ln p_{\mathrm{ij}} \tag{8}$$

STEP4: Calculate the coefficient of variation of the j^{th} indicator as

$$D_j=1-C_j \tag{9}$$

STEP5: Calculate the weight of each indicator as

$$\mathrm{w_j}=\frac{D_j}{\sum_{j=1}^{n} D_j} \tag{101}$$

STEP6: Calculate the comprehensive evaluation value of the i^{th} evaluation object as

$$W_{EWM}=\sum_{j=1}^{n} w_j p_{ij} \tag{12}$$

3.3 AHM-EWM weight coupling

After the subjective weight W_{AHM} and objective weight W_{EWM} are obtained, the multiplier synthesis normalization method can be used to find the coupling weights W because it can effectively reflect the relative weight relationship of each index and its weight proportion in the whole.[11]

$$W=\frac{W_{AHM}W_{EWM}}{\sum_{i=1}^{n} W_{AHM}W_{EWM}} \tag{11}$$

4. Establishment of GM (1,1) model

The commonly used time series prediction mainly includes grey prediction, linear fitting and nonlinear fitting. Among them, the grey prediction was established by Professor Deng Julong in the 1980s. It can not only fit small sample indexes with insignificant change trend, but also have good fitting effect on other indexes with obvious change trend such as linear growth and exponential growth. It can save a lot of process that when the number of indexes is large, the curve fitting of indexes needs to select the approximation function corresponding to each index one by one. GM is a part of grey prediction, and GM (1,1) indicates that the prediction model is first order and the variable is one. [12] The steps are as follows:

STEP 1: Generate cumulative generating sequence: let $X^{(0)}=\{x_1^{(0)}, x_2^{(0)}, \cdots, x_n^{(0)}\}$ be the original sequence, generate the first order cumulative generating sequence (1-AGO) sequence as

$$\begin{aligned} X^{(1)} &= \{x_1^{(1)}, x_2^{(1)}, \cdots, x_n^{(1)}\} \\ &= \{x^{(0)}(1), x^{(0)}(1)+x^{(0)}(2), \cdots x^{(0)}(1)+\cdots+x^{(0)}(n)\} \end{aligned} \tag{12}$$

STEP2: Generate mean generating sequence: Let $Z^{(1)}=\{Z_2^{(1)}, Z_3^{(1)}, \cdots, Z_n^{(1)}\}$ be a continuous adjacent mean generating sequence, then

$$Z^{(1)}(k)=0.5x^{(1)}(k)+0.5x^{(1)}(k-1) \tag{13}$$

STEP3: Establishing differential equation: Establishing grey differential equation $x^{(0)}(k)+az^{(1)}(k)=b, k=2,3,\cdots,n$, the corresponding whitening differential equation is

$$\frac{dx^{(1)}(t)}{dt}+ax^{(1)}(t)=b \tag{14}$$

let $u=[a,b]^{\mathrm{T}}, Y=[x^{(0)}(2), x^{(0)}(3), \cdots, x^{(0)}(n)]^{\mathrm{T}}, B=\begin{pmatrix} -Z^{(1)}(2) & 1 \\ -Z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -Z^{(1)}(n) & 1 \end{pmatrix}$, the estimated value of $J(u)=(Y-Bu)^{\mathrm{T}}(Y-Bu)$ that minimizes u can be obtained by the least square method as $\hat{u}=[\hat{a},\hat{b}]^{\mathrm{T}}=(B^{\mathrm{T}}B)^{-1}B^{\mathrm{T}}Y$, and the whitening differential equation can be solved.

$$\hat{x}^{(1)}(k+1)=(x^{(0)}(1)-\frac{\hat{b}}{\hat{a}})e^{-\hat{a}k}+\frac{\hat{b}}{\hat{a}} \tag{15}$$

STEP4: Test and process the data: let $X^{(0)}=\{x_1^{(0)}, x_2^{(0)}, \cdots, x_n^{(0)}\}$ be the original sequence to calculate the rank ratio of the sequence.

$$\lambda(k)=\frac{x^{(0)}(k-1)}{x^{(0)}(k)} \tag{16}$$

If all rank ratios fall into $\Theta=(e^{-\frac{2}{n+1}}, e^{\frac{2}{n+1}})$, then $x^{(0)}$ can be used as GM (1, 1) data for grey prediction. If the condition is not met then it needs to be transformed to fall into $\Theta=(e^{-\frac{2}{n+1}}, e^{\frac{2}{n+1}})$. The main method is to take the appropriate constant c for translation transformation, namely

$$y^{(0)}(k)=x^{(0)}(k)+c \tag{17}$$

And the order ratio of $y^{(0)}=(y^{(0)}(1), y^{(0)}(2), \cdots, y^{(0)}(n))$ is

$$\lambda_y(k)=\frac{y^{(0)}(k-1)}{y^{(0)}(k)} \in \Theta \tag{18}$$

STEP 5: Model establishment: GM (1, 1) model can be established according to the above whitening differential equation, and the predicted value can be obtained.

$$\hat{x}^{(1)}(k+1)=(x^{(0)}(1)-\frac{\hat{b}}{\hat{a}})e^{-\hat{a}k}+\frac{\hat{b}}{\hat{a}} \tag{19}$$

$$\hat{x}^{(0)}(k+1)=\hat{x}^{(1)}(k+1)-\hat{x}^{(1)}(k) \tag{20}$$

5. Empirical analysis

5.1 Data collection

The data in this paper comes from Wind database, and the sample range is from January 2007 to November 2021. The frequency of data is daily or monthly, and the daily data is converted into monthly average. Real estate climate index lacks the data of the first month from 2009 to 2016, which is supplemented by the smoothing method of SPSS software. For data with seasonal characteristics, the X-12 seasonal adjustment method in EViews software was used to eliminate seasonal factors. When calculating the volatility of the real effective exchange rate and the real estate climate index, a stable sequence is obtained after the difference of the real effective exchange rate and the real estate climate index. After the test, GM (1, 1) is used to obtain the variance sequence. Specific data are shown in Table 2.

Table 2. Index data required for financial stress index

Index code	2007.3	2007.4	2007.5	…	2021.11
X_{11}	0.885	0.864	0.912	…	0.191
X_{12}	1.375	0.267	0.801	…	0.597
X_{21}	0.604	0.730	0.975	…	0.473
X_{22}	1.066	1.061	1.024	…	0.491
X_{31}	122.547	177.099	105.381	…	32.599
X_{41}	-2.334	-0.652	0.895	…	0.396
X_{42}	0.039	0.037	0.037	…	0.001
X_{51}	0.774	-1.194	-0.588	…	0.324
X_{52}	101.22	102.65	103.32	…	100.51

5.2 Weight calculation and coupling

As far as financial pressure is concerned, the increase of volatility in the stock market means the increase of uncertainty in the market, which will cause investors' emotional fluctuations, affect the financing function of the stock market, and lead to the increase of financial system pressure and risk. All previous financial crises are marked by the collapse of the stock market and the sharp drop of various indexes. Therefore, the stock market parameters are more important than other parameters. The main business of commercial banks comes from mortgage loans, and the decline of the real estate market will accumulate risks for the financial system, so the importance of the real estate climate index is assumed to be strong; Bond interest rate, international market and other factors also have certain influence on financial pressure. Referring to the results in other literatures and actual risk events, the 9 selected indicators are compared pairwise, and the importance is evaluated according to the scale method of 1~9, so that the 9×9 AHP discriminant matrix can be constructed, and then the matrix is converted into the attribute discriminant matrix by the conversion formula (3). Because the attribute discriminant matrix itself is consistent, it is unnecessary to calculate the eigenvalues and eigenvectors of the matrix. There is also no need for consistency check. We calculate the attribute weight of each evaluation index according to formula (4) (see Table 3) and get the comprehensive weighting result W_{AHM} of AHM. (See table 4).

Table 3. AHM Attribute Discriminant Matrix

Index code	X_{11}	X_{12}	X_{21}	X_{22}	X_{31}	X_{41}	X_{42}	X_{51}	X_{52}
X_{11}	0	4/5	1/7	6/7	1/11	1/7	6/7	1/5	1/11
X_{12}	1/5	0	1/7	4/5	1/15	1/11	6/7	1/7	1/11
X_{21}	6/7	6/7	0	10/11	1/9	1/5	10/11	4/5	1/7
X_{22}	1/7	1/5	1/11	0	1/15	1/13	4/5	1/7	1/15
X_{31}	10/11	14/15	8/9	14/15	0	6/7	18/19	10/11	4/5
X_{41}	6/7	10/11	4/5	12/13	1/7	0	14/15	6/7	1/7
X_{42}	1/7	1/7	1/11	1/5	1/19	1/15	0	1/11	1/17
X_{51}	4/5	6/7	1/5	6/7	1/11	1/7	10/11	0	1/7
X_{52}	10/11	10/11	6/7	14/15	1/5	6/7	16/17	6/7	0

The weight of each index W_{EWM} is obtained by the EWM weighting method in equations (7) ~ (12) above. The coupling weight of AHM-EWM is obtained through the coupling of formula (13), and the results are shown in Table 4.

Table 4. Weighting results and coupling weights of different methods

Methods	*AHM*	*EWM*			$W_{AHM-EWM}$
	W_{AHM}	entropy value C	variation coefficient D	W_{EWM}	
X_{11}	0.088	0.967	0.033	0.142	0.097
X_{12}	0.066	0.996	0.004	0.017	0.009
X_{21}	0.133	0.969	0.031	0.137	0.142
X_{22}	0.044	0.963	0.037	0.162	0.056
X_{31}	0.199	0.930	0.070	0.304	0.471
X_{41}	0.155	0.990	0.010	0.045	0.054
X_{42}	0.023	0.983	0.017	0.076	0.014
X_{51}	0.111	0.997	0.003	0.012	0.010
X_{52}	0.179	0.976	0.024	0.105	0.146

As can be seen from Table 4, compared with other criteria levels, the weight value of the evaluation index of the stock market is the highest, because it is given the importance that superior to others in the AHP scoring system, and the difference of the observed values of the indexes also makes its objective weight value larger. The real estate climate index in the real estate market and the term spread in the bond market also occupy a higher weight. On the basis of selecting objective entropy weight method and subjective analytic hierarchy process, a comprehensive weight coupling evaluation model is established, and a more accurate comprehensive weight is obtained.

5.3 Index calculation and analysis

By standardizing the above index data and weighting them according to the coupling weight, we can get the trends of China's financial pressure index and five market composition indexes, as shown in Figure 1.

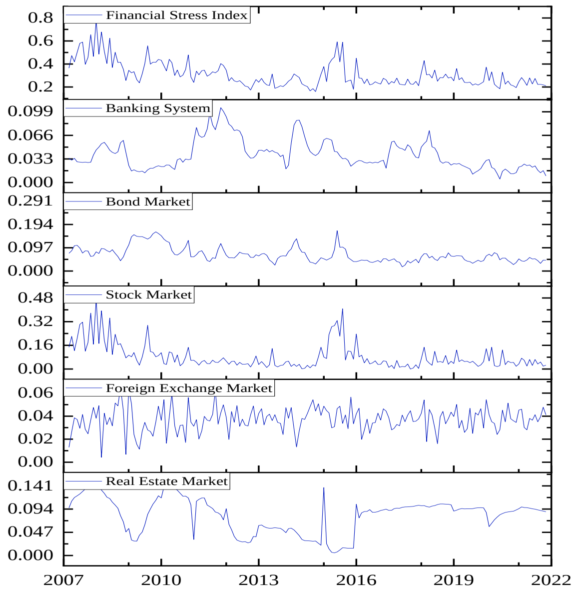

Figure 1. Financial stress index from March 2007 to November 2021 and its market trend

As can be seen from Figure 1, China's financial pressure index shows a fluctuating trend and tends to be flat in recent years. Before 2008, China was integrated into the process of global economic integration, and enjoyed a large export dividend. Domestic markets developed well, and the financial pressure was not high. At the beginning of 2008, the financial stress index began to rise, and declined at the beginning of the second year. During this period, the outbreak of the subprime mortgage crisis in the United States caused the global financial crisis, and China was affected by the economic recession. In order to curb the economic recession, in 2009, China adopted a loose monetary policy and introduced a "4 trillion rescue plans", which effectively boosted the economy and gradually reduced the financial pressure index. The second peak of the financial stress index is in 2015. In November 2014, the "double reduction" channel of the deposit reserve ratio and the benchmark interest rate of deposits and loans released sufficient liquidity, and a large amount of capital rushed to the stock market. In just over a year, the stock market experienced bull market and crash, and the Shanghai Composite Index rose from the 2000-point equilibrium range to the highest point of 5178 points, and fell back to 2629 points in just six months, so the financial pressure index is rising. In March 2018, the United States unilaterally launched a trade war against China, which induced China's financial instability factors, and the financial pressure index showed an upward trend. In the later period, due to China's active communication with the United States and the corresponding consensus, there was no significant fluctuation in the financial pressure index. At the beginning of 2020, COVID-19 broke out in China, and the overall financial stress index fluctuated to a certain extent. However, with the implementation of relevant control policies and the progress of medical research, the economic order gradually improved, and China's financial situation recovered steadily in 2021.

As far as a single market is concerned, the trend of the pressure index of the stock market is basically consistent with the overall financial pressure index, the fluctuation of the bond market lags behind that of the stock market, and the index change of the banking system is related to the monetary policy adopted by the central bank. When liquidity is released, it is easy to generate asset bubbles and then increase financial risks. The foreign exchange market is generally stable with frequent short-term fluctuations. The real estate market is closely related to the economic prosperity. The global financial crisis in 2008 caused a significant impact on China's real estate market. Pessimism and shrinking demand caused China's real estate market to quickly fall into a downturn. After that, the global quantitative easing stimulus and reverse operation made the real estate market switch back and forth between tightening and relaxing policies and the pressure index change periodically. Take COVID-19 as an example, in the beginning of 2020, there were many short-term fluctuations in stock market pressure index, but in the later period, the easing policy implemented by the central bank and the change of mortgage policy made the banking system and the real estate market pressure index show a downward trend, which was the reason for the rapid stability of the overall financial index after a short rise. From the above analysis, it can be seen that the rise of financial stress index is coupled with the period of some major financial events at home and abroad, which means that it can be used to measure China's systemic financial risks and predict future financial risks.

5.4 GM (1,1) Prediction and Analysis

The constructed total index is substituted into GM (1, 1) model for prediction, and the simulated value and actual value are shown in Figure 2, and the prediction interval is from December 2021 to November 2026.

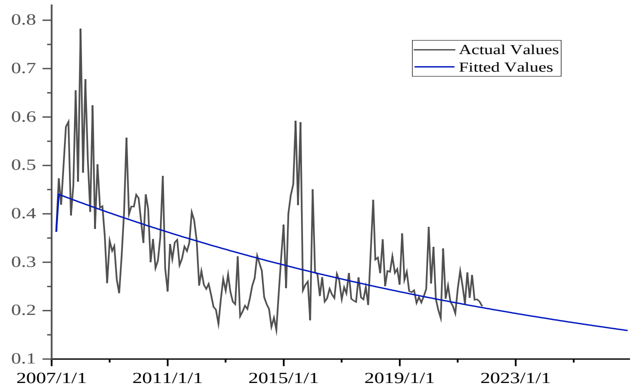

Figure 2. Trend of China's financial pressure index from March 2007 to November 2026 (the simulated values from December 2021 to November 2026)

Comparing the fitting results of the combination model with GM (1, 1), it is found that the average error of the prediction of China's financial pressure index based on AHM-EWM-GM (1, 1) coupling is 12.31%. Although the prediction with GM (1, 1) will bring some errors, the model has strong adaptability to data and good fitting effect. According to the forecast results, China's financial pressure index has a certain downward trend from 2022 to 2026, and then the range slowly tends to be stable. This shows that the stability of the financial system has been further strengthened and that COVID-19's impact on the financial pressure index will not last. The reason may be that after the crisis, China took timely and effective measures to restore the economic growth rate. In addition, China's financial system has been continuously improved in recent years, and the advantages of large economy and sufficient growth resilience also provide a guarantee for stabilizing financial risks.

6. Conclusion

In order to construct China's financial stress index, this paper selects the representative indexes of banking system, bond market, stock market, foreign exchange market and real estate market, and calculates the weights of each index by using AHM model, EWM method and AHM-EWM coupling method respectively, which reflects the financial market risks more accurately by combining subjective and objective methods. Further, according to the trend chart of China's financial stress index, the coupling situation of different markets under related financial events is analyzed, which proves the feasibility of this index. Finally, the grey model GM (1, 1) is used to predict the future development trend of China's financial stress index. The conclusions are as follows:

(1) This paper combines the subjective weight of AHM with the objective weight of EWM, makes up for the defect of single weighting, and constructs the AHM-EWM coupling weighting mechanism. The results show that China's financial pressure index shows a fluctuating trend and tends to be flat in recent years, and the coupling degree between financial risks in overall and various markets and related events is high. Events such as the international financial crisis in 2008, the European debt crisis in 2011 and the unilateral US trade war against China in 2018 have had a great impact on China's financial industry. At this time, China's financial risks have increased. However, due to the timely and effective macro-control of the government and the supervision of the regulatory authorities in place, the overall trend of China's financial pressure is in a low-risk state, and it is in a high-risk state very rarely.

(2) Predicting the changing trend of financial stress index is of great significance to various financial industries and macro-decision planning. The GM (1, 1) model is used to predict China's financial pressure index from March 2007 to June 2026.11. It is found that the fitting average error of the financial pressure index is 12.31%, which can be effectively applied to China's future financial systemic risks. Although there are some errors, the model has strong adaptability to data and the overall trend forecast is credible. The forecast results show that China's financial stress index has a certain degree of downward trend from 2022 to 2026 and gradually tends to be stable, which indicates that the stability of the financial system will be further strengthened in the future.

Based on the previous analysis, this paper gives policy recommendations that can be made in several areas: Firstly, on the grounds of the current situation, although China's financial stress is generally at a relatively stable and low level, in the subsequent macro-prudential management, policy departments should continue to pay close attention to the dynamic changes of the financial stress index and keep early warning in place to provide better protection for the stable operation of the macro-economy and finance. Secondly, considering that the combined weight of the equity market and the real estate market exceeds 62% and that the equity market is the main contributor to financial stress during periods of high financial stress, the government's macroeconomic regulation should focus on relieving the stress in the equity market and the real estate system and strengthening the prevention of "grey rhino" risks in the two major sectors, so as to reduce the transmission of systemic financial risks to the real economy and promote sustainable and healthy economic development. Thirdly, attention should also be paid to preventing "black swan" risk shocks from the banking system and foreign exchange market. The rational use of monetary policy tools is imperative to stabilize the financial system and reduce financial risks in times of high financial stress.

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The order of the author's name is in alphabetical order, and the workload of each author is equivale

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