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Real estate price correllation prediction based on maxinum conjugate gradient continuous functional

Chen Weijun*, Liu Yuejun
School of Software, Anyang Normal University, Anyang 455000, Henan, (CHINA)
E- mail : Email:cwj@aynu.edu.cn

ABSTRACT

The accurate prediction of the trend of real estate prices is an important content of the national monetary policy and economic regulation. It needs to construct the fluctuation of interest rate, the real estate investment and real estate prices for real estate price related variables, and the real estate price index dynamic trend is predicted. An improved real estate price correlation prediction algorithm is proposed based on maximum conjugate gradient continuous functional, predictive factors of the real estate prices are analyzed, the association SVM model is constructed with real estate prices, interest rates and real estate investment. PCA system design is obtained for real estate price estimation, the conjugate gradient maximum continuous function is proposed, singular semi positive definite double periodic is taken, and the prediction algorithm is obtained. The contribution degree of the effect of interest rate is taken into consideration, the price related characteristics of state information fusion is processed, and the prediction error can be reduced. The simulation results show that the prediction accuracy is higher, error is controlled within 1.5%, it has superior performance.

KEYWORDS

Prediction model; Functional; Algorithm; Price.

INTRODUCTION

The real estate industry quickly develops like the bamboo shoots after a spring shower in recent years. the real estate industry plays an important role in development of economy in China. Its healthy development and macroeconomic control will directly correlate trend of the economy in China and peace of people living. With quick increase of the real estate price in recent years, the research on prediction and evaluation of the real estate price has formally involved in the popular subjects such as mathematic theory research and prediction control. To accurately predict and mathematically model real estate price and fluctuation can provide theoretical basis for the state to issue related macroeconomic control policies, which is very meaningful for maintaining stability of the real estate market and stabilizing the society. prediction of the real estate price involves factors such as the interest rate fluctuation, real estate investment and national money policies and correlates factors such as the national money policy control and macroeconomic control, so studying the correlative prediction algorithm of the real estate price is very meaningful in theory and practices and the research on related modeling and algorithms are focused[1].

In essence, correlative prediction modeling of trend of the real estate is to process the sample data affecting the price of the real estate. This processing process aims to estimate and forecast this sample sequence. The linear model or equivalent similar linear models are used to process and analyze the sample sequence affecting the price of the real estate in the traditional method and some research achievements have been achieved. in the reference[2], He Wei and Zhang Hengquan propose price and trend analysis model of the real estate based on improved grey neural network, which analyzes and processes the real estate index sample sequence by using the grey prediction model GM(1,1) and BP NN in order to accurately predict the trend of real estate price in next year, but this algorithm only considers the linear components of the price sample sequence and does not consider the grey correlated non-linear components of the real time price index, so it leads to low prediction precision The reference[3]constructs a correlated model of interest rate fluctuation, real estate investment and real estate price, studies the mutual influence effect of the interest rate, real estate investment and real estate price, gets the variance decomposition equation for the impact and fluctuation of the real estate investment and interest rate on the real estate price. This method can accurately predict the trend of the real estate, but the influence of the real estate investment on the real estate should be considered from the view of long balance in this algorithm model. It is difficult to practice. In the reference[4], Feng Tao and Yang Da propose the dynamic random general balance model based on Bayes estimation to realize the real estate price and money policy control model, but this algorithm can not accurately and effectively fit the real estate price trend under influence of the multiple non-linear dynamic model, so this model can not accurately predict the price of the real estate and the algorithm overhead is heavy.

For the above problems, this paper proposes a correlative prediction algorithm of the real estate price based on the maximum conjugate gradient continuous functional. This algorithm first establishes a simple SVM model. Based on the SVM model, PCA method is used to realize weighted smoothing of the original price fluctuation sequence. The mathematic sample sequence processing method based on maximum conjugate gradient continuous functional is used to improve the prediction algorithm. The simulation experiment validates effect of this prediction algorithm of the real estate price.

GENERAL MODELING AND PROBLEM DESCRIPTION

Influence factors and model design of correlative prediction of real estate price

First a statistical model should be constructed. a SVM model with real estate price, interest rate and real estate investment should be established in design of the prediction algorithm of the real estate price. The principal component analysis method of the SVM model is used to realize design of the PCA estimation system of the real estate price[5]. The SVM model for real estate price estimation and prediction is based on the statistical data. This paper selects the monthly data of the real estate price from March, 2006 to Oct, 2013 as the original data sample sequence. The mathematic expression of the sample sequence is described as follows:

$$U = \{U_1, U_2, \cdots, U_N\} \tag{1}$$

U_i is a random variant with dimension d. Different random variant U_i are independent of each other. The short-term interest rate data for 1-3 years are selected in the parametric model of the price influence[6]. The probability density function of the interest rate sequence is expressed as follows:

$$K_v(z) \propto \sqrt{\frac{\pi}{2}} \frac{e^{-z}}{\sqrt{z}} \left[1 + O\left(\frac{1}{z}\right)\right] \qquad (|z| \to \infty) \tag{2}$$

$$F_Y(y;\alpha,\lambda) = \int_0^y \frac{4}{\sqrt{\lambda}\Gamma(\alpha)} \left(\frac{t}{\sqrt{\lambda}}\right)^{\alpha} K_{\alpha-1}\left(\frac{2t}{\sqrt{\lambda}}\right) dt \tag{3}$$

Variant data are converted by using the natural logarithm prior to modeling. The price fluctuation data X complies with the stability distribution feature and is expressed as $X \sim S_{\alpha}(\sigma, \beta, \mu)$. The maximum likelihood estimate of β can be obtained via the unit root test and co-integration test of different series. When V is a continuous variant, the feature function should meet the following conditions:

$$\Phi(\omega) = E[e^{j\omega X}] = \begin{cases} \exp\{j\mu\omega - |\sigma\omega|^{\alpha}[1 - j\beta\,\mathrm{sgn}(\omega)\tan(\frac{\pi\alpha}{2})]\}, \alpha \neq 1 \\ \exp\{j\mu\omega - |\sigma\omega|^{\alpha}[1 + j\beta\,\mathrm{sgn}(\omega)\frac{2}{\pi}\ln|\omega|]\}, \alpha = 1 \end{cases} \quad (4)$$

The above equation is used to establish a price fluctuation model of real estate with endogenous variables such as real estate price, interest rate and real estate investment. The mathematic expression of the model is described as follows:

$$S(x) = \sum_{i=1}^{N} v_i(x)\nabla^2 v_i(x) \quad (5)$$

In the above equation, $n = 1, 2, \cdots, N$, $v_i(x)$ is k-dimension endogenous variable. The interest rate m gets one-dimension vector $\boldsymbol{X}_n$ in the price correlated parameter estimate of the real estate. It indicates the maximum consumption index under the constraint. The related inflation rate is $\boldsymbol{X}_{\eta(n)}$, so the phase equilibrium equation can be established to affect the correlative prediction influence factors of the real estate:

$$V_1(x(t)) = x^T(t)Px(t) + \int_{t-d_1(t)}^{t} x^T(s)Q_1x(s)ds + \int_{t-d(t)}^{t-d_1(t)} x^T(s)Q_2x(s)ds \quad (6)$$

In the above equation, the expected value of the iterative logarithm likelihood function $\mathrm{sgn}(\omega)$ can be obtained via the maximum conjugate gradient continuous function under the singular positive semi-definite double-cycle complex analysis, so it can realize the correlative prediction of the real estate price. The area of the price influence parameter value is shown as the figure 1.

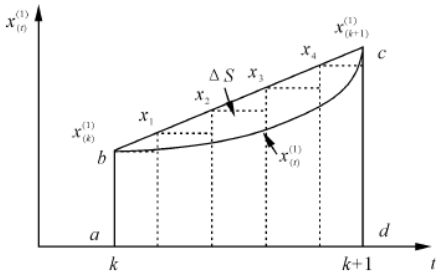


Figure 1: Schematic diagram of the parameters which influence the real estate price area

In the figure 1, the area x_t^1 enclosed by x coordinate indicates the fluctuation amplitude of the price data. The area abcd enclosed by $x_t^1(k)$ and $x_t^1(k+1)$ indicates the change trend and sharp degree of the sample price data, so it can realize design of the correlative prediction influence factors and model of the real estate and lay foundation for prediction algorithm design.

Original data pre-processing of price prediction model of real estate

Based on the above prediction model, the traditional linear processing and quasi-linear processing method for analyzing sample sequence leads to low prediction precision. This model should be improved to pre-process the sample sequence. To study the real estate price, first the price sample should be regarded as a time sequence and be processed by using the signal processing method, so the original data of the real estate price should be pre-processed by using the signal processing method.

For K input sample data set $\{x_i, y_i\}$, $i = 1,2,\cdots,k$ of the input support vector, k indicates the number of the data samples. The history data of the test is mapped to the higher vector space S to compute the maximum conjugate gradient continuous functional of the real estate price. If this value is more than 0, the tested real estate price sequence is non-linear. After the maximum conjugate gradient continuous functional index value is obtained, the non-linear sample time sequence prediction method is used to predict the price index sequence of the real estate. based on the above co-integrated test results, the initial data values are used in the grey prediction model to get the center point X_m in the price index phase space and nearest adjacent point X_k. The distance between two points is expressed as the Euclidean distance, shown as follows:

$$d_m(0) = \|X_m - X_k\| \tag{7}$$

In the above equation, X_m and X_k can further evolve to X_{m+1} and X_{k+1}, so it can provide the data for accurate prediction of the price. The maximum conjugate gradient continuous functional method is used to get the predicted data value at n + m + k(k $>$0). It indicates the index of the growth and change classification of two vectors. The equation is shown as follows:

$$\|X_{m+1} - X_{k+1}\| = \|X_m - X_k\| e^{\lambda_1} \tag{8}$$

In the above equation, the final component $x(t_{n+1})$ of X_{m+1} is unknown and only this component is unknown., The computing equation is expressed as follows:

$$X_{m+1}(m) = X_{k+1}(m) \pm \sqrt{(d_m(0)e^{\lambda_1}+)^2 - \sum_{i=1}^{m-1}[X_{m+1}(i) - X_{k+1}(i)]^2} \tag{9}$$

In the above equation, $d_m(0)$ indicates the analysis interest rate of the pulse response function, $X_{m+1}(i)$ indicates the contribution degree of the real estate investment on the real estate price, $X_{k+1}(i)$ indicates the number of the samples, so a simple SVM model is established. Based on the SVM model, the weighted smoothing and accurate prediction of the original price fluctuation sequence can realized by combining the maximum conjugate gradient continuous functional.

IMPLEMENTATION OF IMPROVED PRICE PREDICTION ALGORITHM

First the real estate price under different initial conditions is evaluated online. The price fluctuation curve shows the exponential separation with time in the motion and evolution. Considering contribution of the real estate price to the real estate investment and interest change, the auxiliary matrix method is used for maximum conjugate gradient continuous functional and one-order differential stabilization processing of the variant sequence. The obtained price fluctuation sequence is described as follows:

$$\int_{t-\sigma}^{t} \begin{bmatrix} y(s) \\ f(y(s)) \end{bmatrix}^T \begin{bmatrix} R_1 & E \\ E^T & R_2 \end{bmatrix} \begin{bmatrix} y(s) \\ f(y(s)) \end{bmatrix} ds \tag{10}$$

When the price factor and inflation are considered, price budge constraint cost caused by one-off overall payment is used. The year-on-year growth rate of the house sale price index is introduced, so the new state item is shown as follows:

$$\int_{t-\sigma}^{t} \left[y^T(s) R_1 y(s) + f^T(y(s)) R_2 f(y(s)) \right] ds \tag{11}$$

The principal component analysis structure state and integral cross product item of the price sequence under the maximum conjugate gradient continuous functional is expressed as follows:

$$\int_{t-\sigma}^{t} \left[y^T(s) R_1 y(s) + f^T(y(s)) R_2 f(y(s)) \right] ds \tag{12}$$

$$\int_{t-\sigma}^{t} y^T(s)Ef(y(s))ds \tag{13}$$

The real estate development investment and real estate price affect each other via the supply and demand conduction mechanism, so the statistical data model is computed by using the continuous functional conduction to get the target function of the correlated price prediction as follows:

$$F_Y(x;\alpha,\lambda) = 1 - \frac{1}{2^{\alpha-1}\Gamma(\alpha)} \int_{2y/\sqrt{\lambda}}^{\infty} \frac{4}{\sqrt{\lambda}\Gamma(\alpha)} w^{\alpha} K_{\alpha-1}(w)dw \tag{14}$$

In the above equation, $K_{\alpha-1}(w)$ indicates the Gauss density function, $\frac{1}{2^{\alpha-1}\Gamma(\alpha)}$ is the weighted sum of the multiple Gauss density and $\sqrt{\lambda}\Gamma(\alpha)$ is the coefficient matrix of the price sequence. w^{α} is the weight vector of the long interest rate balance window combined model, u is the average vector of the relation between the house index and house loan. Σ is the covariance matrix and its maximum is computed via the target function of the price correlation prediction. The logarithm function $\ln|\omega|$ is maximized to smooth the price sample sequence and improve prediction precision.

SIMULATION EXPERIMENT OF CORRELATIVE PREDICTION OF REAL ESTATE PRICE

To test the performance of our algorithm and correlative prediction model of the real estate price, a simulation experiment is required. The data is from the Nanjing new house index trading data from Mar, 2006 to Oct, 2013 issued by China Index Research Institute are used in the simulation experiment. The Matlab tool is used to analyze and compare the real estate price index, interest rate and real estate investment. The above parameters are expressed as $R = \frac{n_0}{N}$, $c_i = f(1,B)$. $B' = B / l_0 - 1$. The initial value of the real estate price fluctuation iteration equation is set as 2.2. The growth step is -0.02. After the iterative computing of the computer, we can get B'_5=035432, B'_6=0.5984, B'_8=0.6654 and B'_{10}=0.7569. With the critical values as the cut-off conditions, the statistical trace is 56.55666. If it is more than 5% critical value 29.7663, the original assumption can be rejected to get the co-integrated results of the price prediction of the real estate price. The co-integrated vector is estimated as the TABLE 1.

TABLE 1 : Real estate prices counteraction vector estimation table /104Yuan

K	a1		a2		a3		a4	
	Zk	Pil	Zk	Pil	Zk	Pil	Zk	Pil
1	0.1298	1.000	0.7931	0.811	0.4320	0.998	0.6981	0.811
2	0.1280	0.999	0.7976	0.831	0.4309	0.996	0.6966	0.831
3	0.1303	1.000	0.7922	0.819	0.4326	0.995	0.6960	0.820
4	0.1283	1.000	0.7964	0.830	0.4322	0.996	0.6959	0.829
5	0.1289	1.000	0.7945	0.826	0.4330	0.996	0.6968	0.826
6	0.1299	1.000	0.7936	0.800	0.4333	0.995	0.6996	0.799
7	0.1292	1.000	0.7945	0.815	0.4318	0.997	0.6956	0.815
8	0.1279	1.000	0.7965	0.833	0.4322	0.997	0.6934	0.833
9	0.1302	1.000	0.7922	0.819	0.4318	0.998	0.6970	0.819
10	0.1281	1.000	0.7963	0.818	0.4319	0.995	0.6952	0.818
Mean value	0.1291	0.9999	0.7947	0.8202	0.4322	0.9963	0.6964	0.8201
Standard deviation (10–3)	0.95	0.32	1.93	10.21	0.68	1.16	1.67	10.32

The influence factor of the tendering and bidding cost is 0.11, the influence factor of the central financial investment is 0.65, the influence factor of the construction land expropriation is 0.33, the influence factor of the tax is 0.27 and the influence factor of the credit fund chain is 0.37 in the real estate construction and price influence factor. Based on the above parameter design and algorithm processing analysis, the sample wave form of the original price data is shown as the figure 2.

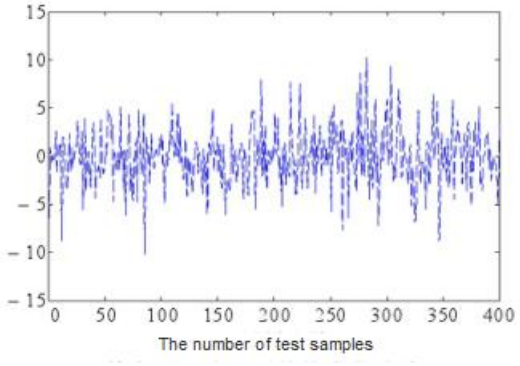
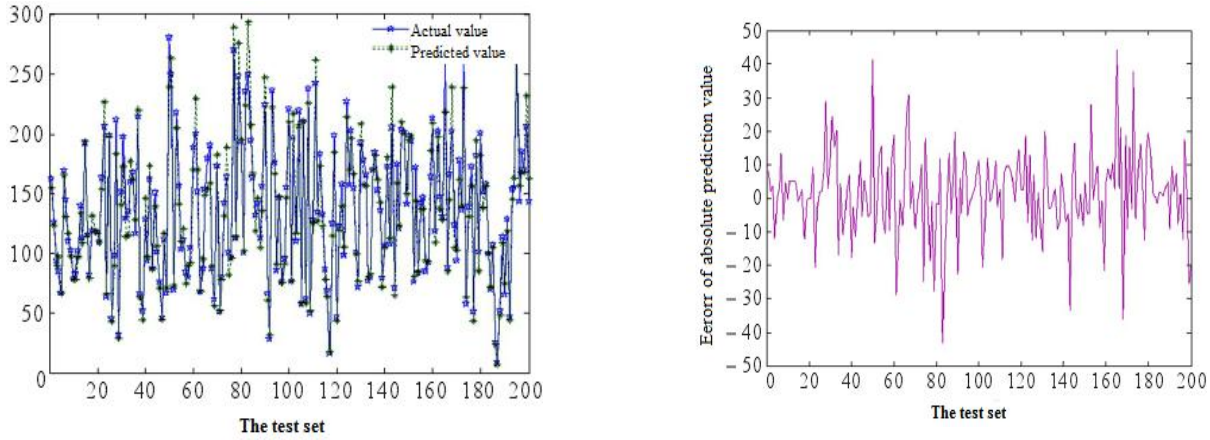


Figure 2: Sample waveform data of the original price of real estate

Based on this research object, First the data sequences are processed and smoothed by using the maximum conjugate gradient continuous functional, next the price correlated analysis is performed by using our algorithm and traditional method to get the prediction results shown as the figure 3. The figure 3 gives the prediction results and prediction error of the real estate price in our algorithm model. Based on the results in the figure 3, our algorithm has higher prediction precision and the prediction error is controlled to be within 1.5%. If the traditional method is used to predict the price of the real estate, the prediction error is bigger. Its guidance on the macroeconomic control of the real estate price is restricted. Our algorithm can effectively control the prediction error, can realize the correlated analysis on different influence factors, and realize the corrected prediction, so our method has excellent prediction performance.



(a)Predicted value **(b)Prediction error analysis**

Figure 3: Simulation results of real estate price association prediction

CONCLUSIONS

The prediction of the real estate price involves interest rate fluctuation, real estate investment and national money policies and correlates the national money policy control and macroeconomic control, so it has critical theoretical and practice meaning to study the correlative prediction algorithm of the real estate price. This paper proposes a correlative prediction algorithm of the real estate price based on the maximum conjugate gradient continuous functional. This algorithm first establishes a simple SVM model Based on the SVM model, PCA method is used to weight and smooth the original price fluctuation sequence. The maximum conjugate gradient continuous functional is used to mathematically process the sample sequences and improve the prediction algorithm. The experimental results indicate that our prediction model and algorithm has higher prediction precision and the prediction error is controlled to be within 1.5%. The algorithm can realize the correlated analysis of different influence factors, has excellent performance, and can better guide the macroeconomic control of the real estate.

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