Prediction and Empirical Analysis of Residential House Price Based on Grey Theory——Taking Huangdao District as an Example

Chenghui Li
College of Mining and Safety Engineering
Shandong University of Science and Technology
Qingdao, China
2235281182@qq.com

Ruixia Zhang
Hospital of Shandong University of Science and Technology
Shandong University of Science and Technology
Qingdao, China

Xinghua Li
College of Mining and Safety Engineering
Shandong University of Science and Technology
Qingdao, China
13310671720@126.com

***Abstract*—Analysis of the influencing factors and future trends of residential prices in Huangdao District, Qingdao. Theoretical research and empirical analysis based on feature price model and grey prediction model. First, the micro factors affecting the housing price factor are coded and quantified, and the semi-logarithmic model is analyzed by SPSS software. Secondly, according to the gray prediction model, the future housing prices in the Huangdao area are predicted separately. Finally, a reasonable suggestion is made for the results.**

Keywords-hedonic model; quantitative; semi log model; grey prediction

I. INTRODUCTION

At present, the rising rate of housing prices in major cities is higher than per capita disposable income [1-2]. The housing problem has become a major issue related to the national economy and people's livelihood. It is imperative to regulate and control the policies and regulations of high housing prices. By studying the influencing factors of house price, we can forecast the future house price, and on the basis of the forecast data, we can formulate reasonable regulation policies to provide housing security for the common people.

II. HEDONIC MODEL AND SELECTION OF VARIABLES

A. Hedonic Model

Hedonic Model [3-4] is also called utility estimation method. The functional relationship between the characteristics of housing and housing price or the recognition degree of buyers to housing price is the key to the fluctuation of housing price. Residence is composed of many characteristics, which can be decomposed in the study to form a single factor to keep the total amount unchanged. Each feature is analyzed to explore its impact on housing prices, and then the independent factors are further decomposed to find out the impact of each independent factor on housing prices.

Hedonic Model has the advantages of both the Expenditure System Demand Function [5] and Traffic Cost Model [6-7]. The model is mature, practical, accurate in feature variables, appropriate in sample size, easy to obtain data, convenient and flexible in estimation, and more suitable for this study.

B. Model variable selection

Variables are divided into macro and micro factors. Because macro-factors have a universal impact on real estate, this paper only studies the impact of micro-factors on real estate in depth. The independent variable of the article is the characteristic variable, while the dependent variable is its transaction price. The research factors can be roughly divided into building factors, neighborhood factors and location factors.

III. EMPIRICAL ANALYSIS OF REGIONAL RESIDENTIAL FEATURE PRICE MODEL

A. Determination of the study area and data collection

a) Determination of the study area

The object selected in this paper is the Huangdao area, which is affiliated to Qingdao City, Shandong Province. It borders on the Yellow Sea in the east, Zhucheng and Wulian County in the west, Rizhao City in the south and Jiaozhou in the north. The three major residential sections of Tangdaowan Residential Area, Changjiang Road Commercial Circle and Anzi Area are the ‘ridges’ of the ‘Three Cities Linkage’ in the middle and west coast of Qingdao. The regional data selected in this paper are Changjiang Road, Tangdao Bay, Anzi District, Xiangjiang Road, Bonded Area, Xin'an, Xuejiadao, and Petroleum University.

b) Data Sources and Data Integration

The specific workflow for data source and data integration is shown in “Fig. 1”.

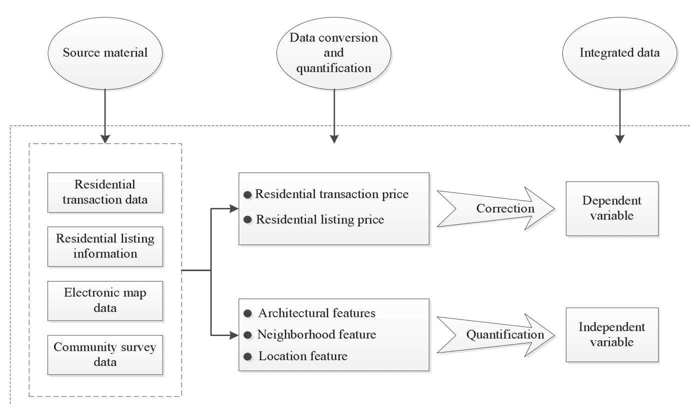

Figure 1. Flowchart

978-1-7281-0860-5/19/$31.00 ©2019 IEEE

B. Quantification of research data

1) Quantification of dependent variables

The dependent variable is the total residential transaction price. By looking at the data, we can see that most of them do not provide the actual transaction price, so we need to convert the transaction price and the listed price. In this paper, we will no longer study the conversion between the two. We will draw directly on Wen Haizhen's doctoral thesis [8]. Through the analysis of 270 samples, we find that there is a clear linear relationship between the two. We use the linear function to transform them and get the final real price. The results are as follows:

Transaction price = -1.196 + 0.930 * listed price

2) Quantification of independent variables

a) Quantification of quantitative variables

The quantification of quantitative variables directly uses the actual values of the residential characteristic variables. The variables that fall into this category are: building area, age, property management fee, greening rate, floor area ratio, and CBD distance.

b) Quantification of qualitative variables

(1) Two-dimensional dummy variable

Quantization is performed using dummy variables, such variables are in the area, traffic conditions, parking spaces.

(2) Graded assignment

The graded value method is used to divide the decoration level of the residential community, the internal environment of the community, and the property management service into three grades, preferably 3 points, followed by 2 points, and the worst is 1 point. The higher the score, the higher the grade of the community, the higher the residential price will be, and there is a positive correlation.

(3) Comprehensive indicator measurement

Using a comprehensive indicator can divide many variables into one variable, reducing the number of variables and preventing a serious collinearity. Such variables include: cultural and sports facilities, living facilities, and educational packages.

In summary, the coding, quantification of 15 residential characteristic variables and the expected impact of their respective variables on the home are shown in “TABLE I”.

TABLE I CODING AND QUANTIFICATION OF RESIDENTIAL FEATURE VARIABLES

Classification	Characteristic Variable	Quantification Variables	Expect Impact	Classification	Characteristic Variable	Quantification Variables	Expect Impact
Architectural Feature	Covered Area (MJ)	Total floor area of a house (Square Meter)	+	Neighbor -hood Feature	Community Environment (HJ)	Good(3points) Average(2points) Poor(1point)	+
	Housing Age (FL)	Years from the date of completion to 2018	-		Property Management (WY)	Good(3points) Average(2points) Poor(1point)	+
	Decoration Degree (ZX)	Hardcover (3points) Lite(2points) Rough(1point)	+		Sports Facilities (WT)	Whether there are cultural and sports facilities within 500 meters of the neighborhood, one point for each item, a total of 5 points	+
	Parking Spaces (CW)	Have a garage or parking space assigned to 1, otherwise 0	+		Education Matching (WT)	Whether there is an educational package within 500 meters of the neighborhood, one point for each item, a total of 5 points	+
	Volume Ratio (RJ)	Volume rate of residential quarters	-		Life Matching (SH)	Whether there is a living package within 500 meters of the neighborhood, one point for each item, a total of 5 points	+
	Afforestation Rate (LH)	Greening rate of residential quarters	+	Location Feature	Traffic Conditions (GJ)	Number of lines near bus stations	+
	Property Management Fee (WYF)	Property management free of residential quarter (RMB/m2/month)	No		CBD Distance (CBD)	Distance from residential area to commercial center (km)	-
					Location Area (PQ)	The main area of the district is assigned a value of 1, otherwise it is 0.	+

C. Analysis of semi-logarithmic model

In the semi-logarithmic model, the dependent variable adopts the logarithmic form of the residential transaction price, and the 15 independent variables are directly substituted into the model. The form is:

$$Lnp = c + \sum a_i z_i + \varepsilon \qquad (i = 1, 2 \cdots n) \tag{1}$$

a) Descriptive statistics of the sample.

Descriptive statistics of transformed independent and dependent variables are shown in “TABLE II”.

TABLE II DESCRIPTIVE STATISTICS OF SEMI-LOGARITHMIC MODELS

	Mean	Standard Deviation	N
ln (CJZJ)	14.066324706	0.38975568262	103
MJ	95.83	16.578	103
FL	7.76	4.566	103
WYF	1.673	0.9419	103
LH	33.81	6.537	103
RJ	2.312	0.9631	103
CBD	4.36262	2.700112	103
GJ	4.63	2.279	103
CW	0.91	0.284	103
ZX	2.27	0.717	103
HJ	2.27	0.629	103
WY	2.24	0.533	103
SH	3.03	0.954	103
JY	1.51	0.624	103
WT	1.64	0.712	103
PQ	0.37	0.485	103

b) Estimation and verification of semi-logarithmic model

(1) Significance test and analysis of variance According to "TABLE III", the complex correlation coefficient R=0.903 and the decision coefficient R_2=0.815 indicate that the model has a good degree of fitting and good interpretation ability.

TABLE III GOODNESS OF FIT FOR SEMI-LOGARITHMIC MODELS

Model	R	R^2	Adjustment R^2	Standard Estimated Error	Durbin-Watson
1	0.903[a]	0.815	0.783	0.18160732 864990	2.211

From "TABLE IV",VIF $_{min}$=1.193, VIF $_{max}$ =2.036, average VIF value is 1.9575, far less than 10, so we can reject the hypothesis of collinearity between variables, we can think that the collinearity between independent variables is not very serious.

TABLE IV COLINEARITY STATISTICS FOR SEMI-LOGARITHMIC MODELS

Model		Collinear Statistics	
1	*(Constant)*	*Tolerance*	*VIF*
	MJ	0.746	1.341
	FL	0.518	1.932
	WYF	0.491	2.036
	LH	0.663	1.507
	RJ	0.662	1.511
	CBD	0.585	1.710
	GJ	0.706	1.417
	CW	0.838	1.193
	ZX	0.555	1.800
	HJ	0.552	1.811
	WY	0.654	1.529
	SH	0.760	1.316
	JY	0.788	1.270
	WT	0.694	1.441
	PQ	0.597	1.676

(2) Homogeneity test of variance

As can be seen from "Fig. 2", most of the observations randomly fall between the positive and negative horizontal lines, satisfying the assumption of homogeneity of variance.

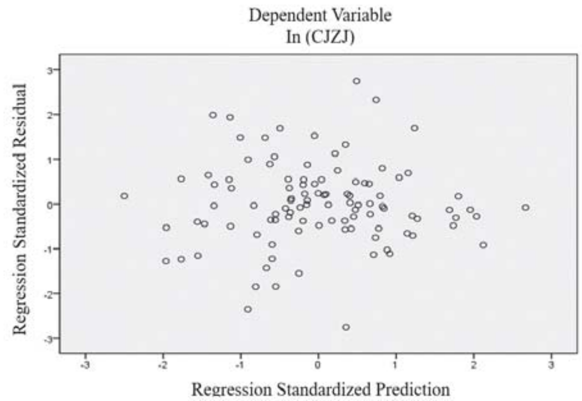

Figure 2. Semi-logarithmic model scatter plot

(3) Independence test (D-W value test)

It is known from "TABLE IV" that the D-W =2.211 and its value is very close to 2, so the error term in the model can be considered to be substantially independent. At the same time, combined with "Fig. 2", it can be judged that there is basically no heteroscedasticity problem.

(4) Normality test of residuals

It can be seen from the histogram of the residual "Fig. 3" and the residual cumulative probability map "Fig. 4" that the curve of the semi-logarithmic model is close to a straight line, indicating that the residual is in accordance with the normal distribution.

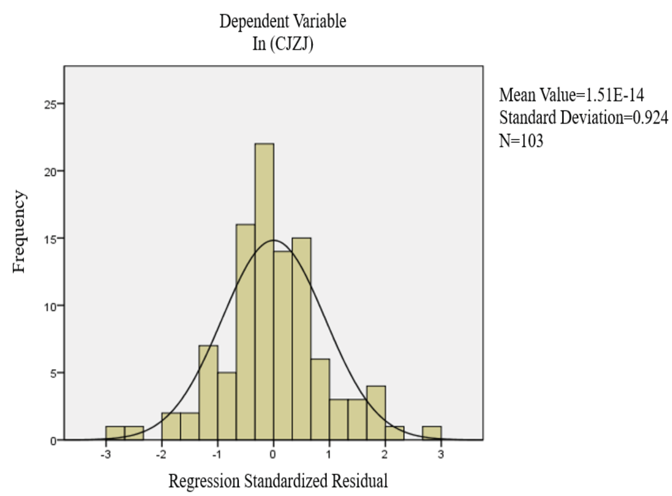

Figure 3. Semi-logarithmic model histogram

In summary, the semi-logarithmic model basically satisfies the normality hypothesis, the equal variance hypothesis, has good fitness and high explanatory power, so it can be used for research.

After the above analysis, the semi-logarithmic function R^2=0.815 is the highest, indicating that the semi-logarithmic model can explain the difference of the dependent variable by 81.5%, and the explanatory ability is very strong. The significance of the variance of the semi-log model equations is 25.520, which is also the highest. The significance probability level Sig=0.000 indicates that the linear relationship between the characteristic independent variable and the dependent variable is highly significant, and the overall linear relationship of the model can be established.

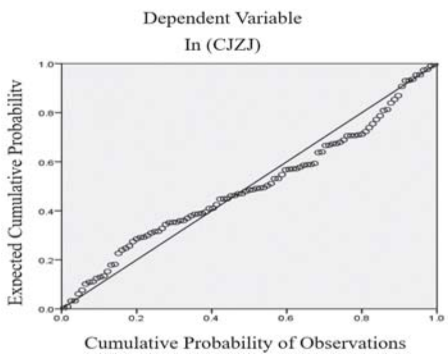

Figure 4. Semi-logarithmic model cumulative probability plot

IV. GREY FORECAST RESIDENTIAL AVERAGE PRICE

A. Grey GM (1,1) prediction

The model raw data series is shown in “TABLE V”.

TABLE V AVERAGE HOUSING PRICE OF HUANGDAO DISTRICT IN 2011-2018 “UNIVALENCE (YUAN)”

Year	2010	2011	2012	2013	2014	2015	2016	2017
Average Price	8500	8365	8552	8961	9422	8977	8638	11337

(1) Collect raw data.

Use the data from 2011 to 2018 in Qingdao Huangdao District to obtain the model raw data series:

$$
\begin{aligned}
X^{(0)} &= (X^{(0)}(1), X^{(0)}(2)\cdots X^{(0)}(8)) \\
&= (8500, 8365, 8552, 8961, 9422, 8977, 9638, 11337)
\end{aligned} \tag{2}
$$

(2) Accumulating to generate a gray sequence.

The sequence generated by the accumulation is usually expressed as AGO [9-10] in the gray theory, and the cumulative generation is public:

$$
x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i) \qquad (k = 1, 2\cdots n) \tag{3}
$$

According to formula (3), the original data is subjected to AGO accumulation generation, and the cumulative generation series is obtained:

$$
\begin{aligned}
X^{(1)} &= (X^{(1)}(1), X^{(1)}(2)\cdots X^{(1)}(8)) \\
&= (8500, 16865, 25417, 34378, 43800, 52777, 62415, 73752)
\end{aligned} \tag{4}
$$

(3) Generate a series of immediate values.

Generate the immediate mean value based on the accumulated sequence $x^{(1)}$ as:

$$
z^{(1)}(k) = \frac{1}{2}(x^{(1)}(k) + x^{(1)}(k-1)) \qquad (k = 2, 3\cdots n) \tag{5}
$$

Obtain the immediate mean series according to formula (5).

$$
\begin{aligned}
Z^{(1)} &= (Z^{(1)}(2), Z^{(1)}(3)\cdots Z^{(1)}(8)) \\
&= (12682.5, 21141, 29897.5, 39089, 48288.5, 57596, 68083.5)
\end{aligned} \tag{6}
$$

(4) Find the time-corresponding sequence of the GM (1,1) model.

The differential equation is:

$$
\frac{dx^{(1)}}{dt} + ax^{(1)} = b \tag{7}
$$

Its basic form is:

$$
x^{(0)}(k) + az^{(1)} = b \tag{8}
$$

Substituting the original data series and the immediate mean series into equation (8)

8365+12682.5a=b

……

11337+68083.5a=b

$$
Y = B\hat{a} \tag{9}
$$

$$
Y = \begin{bmatrix} 8365 \\ 8552 \\ 8961 \\ 9422 \\ 8977 \\ 9638 \\ 11337 \end{bmatrix} \quad B = \begin{bmatrix} -12682.5 & 1 \\ -21141.0 & 1 \\ -29897.5 & 1 \\ 39089.0 & 1 \\ 48288.5 & 1 \\ -57596.0 & 1 \\ -68083.0 & 1 \end{bmatrix}
$$

$$
\text{Got } \hat{a} = \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} -0.0437 \\ 7595.1 \end{bmatrix}
$$

Find the variables a=-0.0437, b=7595.1, and then find the time response function:

$$x^{(1)}(t)=(x^{(1)}(1)-\frac{b}{a})*e^{-a*t}+\frac{b}{a} \quad (10)$$

The time response sequence of the basic form of the GM (1,1) model is further determined as:

$$\hat{x}^{(1)}(k+1)=182300.92*e^{0.0437*k}-173800.92 \quad (k=1,2\cdots8) \quad (11)$$

Restore value:

$$\begin{aligned}&\hat{x}^{(0)}(k+1)=\hat{x}^{(1)}(k+1)-\hat{x}^{(1)}(k)\\&=(1-e^{-0.0437})*182300.9153*e^{0.0437*k} \quad (k=1,2\cdots7)\end{aligned} \quad (12)$$

Bring “K” into the above formula in turn and plot the price trend as shown in “Fig. 5”.

According to the time series of GM (1,1) model, the model prediction series is obtained:

$$\hat{x}^{(0)}=(8500,8143,8507,8887,9284,9699,10132,10584) \quad (13)$$

B. Model accuracy test

In the grey system theory, the residual size test and the correlation test are usually used. These two methods are used to test the accuracy of the gray model.

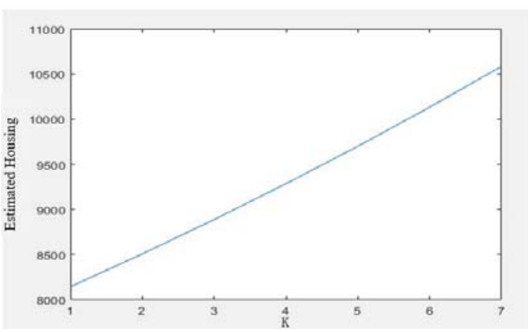

Figure 5. The price map corresponding to the K

(1) Residual test.

Define the residuals based on the above-mentioned original data series and the corresponding model simulation predicted data series:

$$\varepsilon(k)=x^{(0)}k-\hat{x}^{(0)}k \quad (k=1,2\cdots8) \quad (14)$$

Residual series:

$$\varepsilon^{(0)}=(0,222,45,74,138,-722,-494,753) \quad (15)$$

The relative error series is: $\Delta k=\left|\frac{\varepsilon(k)}{x^{(0)}(k)}\right|$ (16)

Got $\overline{\Delta}=\frac{1}{8}*\sum_{k=1}^{8}\Delta k=0.0316025, q=0.968398$

Calculated by: $\Delta=0.0316025<0.1, \Delta_8=0.06642<0.1$

According to the “TABLE VI” model test reference table comparison, the prediction model accuracy belongs to the third level.

TABLE VI MODEL INSPECTION REFERENCE TABLE

Index Threshold / Accuracy Level	Relative Error	Correlation
First level (good)	0.01	0.90
Level 2 (qualified)	0.05	0.80
Level 3 (reluctant)	0.10	0.70
Level 4 (unqualified)	0.20	0.60

(2) Relevance test step

The original sequence $X^{(0)}$ is known, and the model simulation series $\hat{x}^{(0)}$, ε is the absolute correlation degree of $X^{(0)}$ and $\hat{x}^{(0)}$.

$$|s|=\left|\sum_{k=2}^{7}\left\{\left[x^{(0)}(k)-x^{(0)}(1)\right]+\frac{1}{2}\left[x^{(0)}(8)-x^{(0)}(1)\right]\right\}\right| \quad (17)$$
$$=8382$$

$$|\hat{s}|=\left|\sum_{k=2}^{7}\left\{\left[\hat{x}^{(0)}(k)-\hat{x}^{(0)}(1)\right]+\frac{1}{2}\left[\hat{x}^{(0)}(8)-\hat{x}^{(0)}(1)\right]\right\}\right| \quad (18)$$
$$=9904$$

$$|\hat{s}-s|=1522, \varepsilon=\frac{1+|s|+|\hat{s}|}{1+|s|+|\hat{s}|+|\hat{s}-s|}=0.933$$

According to “Table VI”, the correlation degree is 0.933, indicating that the accuracy test is good at the first level, and the result of the residual test is three-level reluctance, which indicates that the accuracy needs to be improved. When the initial gray GM (1,1) model accuracy test is not qualified or the accuracy is not enough, the residual GM (1,1) model can be used to correct, so as to enhance the accuracy of the prediction and make it reach the first level.

C. Residual GM (1,1) model prediction

(1) Establish a residual sequence.

This paper takes the last four digits of the residual series $\varepsilon^{(0)}$

$$\varepsilon_1^{(0)} = (138, -722, -494, 753)$$

Since gray predictions generally only predict non-negative sequences, it is necessary to convert negative sequences into non-negative sequences.

Let w=730, then: $\varepsilon_2^{(0)}=\{\varepsilon_1^{(0)}+w\}=(868,8,236,1483)$

(2) Accumulating the residual sequence.

The GM(1,1) model with residual $\varepsilon_2^{(0)}$ is constructed. Following the establishment procedure of the GM(1,1) model in the previous section, the cumulative sequence of residual sequences is obtained as follows:

$$\varepsilon_2^{(1)}=(868,876,1112,2595)$$

(3) Generate an immediate sequence of mean values.

$$z_2^{(1)}=(871,994,1853.5)$$

(4) Determine the time-dependent sequence of the residual sequence GM (1,1) model.

By the above Y2, B2, got $\hat{a}_2 = \begin{bmatrix} a_2 \\ b_2 \end{bmatrix} = \begin{bmatrix} -1.4827 \\ -1262 \end{bmatrix}$

Bring ε2(0)(1)=868,a2,b2 into the formula, you can get:

$$\varepsilon_2^{(0)}(K+1) = 16.858 * e^{1.4827*k} + 851 \tag{19}$$

Then calculate the predicted value of the residual

$$\varepsilon_2^{(0)}=(868,925.2,177.9,2291.1)$$

$$\varepsilon_1^{(0)}=(138,195.1,447.9,1561.1)$$

(5) Find the residual correction model.

$$\begin{cases} \hat{x}_1^{(1)}(k+1) = 182300.92 * e^{0.0437*k} - 173800.92 \\ \qquad + \delta(k-4) * (16.85 * e^{1.482*(k-4)} + 121) \\ \hat{x}_1^{(0)}(k+1) = (1 - e^{-0.0437*k}) * 182300.91153 * e^{0.0437*k} \end{cases} \tag{20}$$

among them, $\delta(k-4) = \begin{cases} 1 & k \geq 4 \\ 0 & k < 4 \end{cases}$ (21)

$$\hat{x}_1^{(1)} = (8500, 16644.1, 25151, 34038, 43459.75, 53215.2, 63600.2, 75297.1)$$

$$\hat{x}_1^{(0)} = (8500, 8143, 8507, 8887, 9421.9, 9756.35, 10384.7, 11697.2)$$

(6) Accuracy test of residual correction model

Residual test:

Defining residuals

$$\varepsilon(k) = x^{(0)}(k) - \hat{x}_1(k) \qquad (k = 1, 2 \cdots 8) \tag{22}$$

Then the residual sequence is

$$\varepsilon^{(0)} = (0, 222, 45, 74, 0.1, -779.35, -746.7, -360)$$

$$\Delta k = (0.0, 0.026, 0.0052, 0.0082, 0.0086, 0.077, 0.031)$$

$$\overline{\Delta} = \frac{1}{8} * \sum_{k=1}^{8} \Delta k = 0.029$$

$\overline{\Delta} < 0.05, \Delta_8 = 0.031 < 0.05$, the corrected model accuracy reached Level 2 pass. Knowing the original sequence $X^{(0)}$, and the model simulation series $\hat{x}_1^{(0)}$, the absolute correlation is

$$K = \frac{1 + |S| + |\hat{S}|}{1 + |S| + |\hat{S}| + |\hat{S} - S|} = 0.917$$

It can be seen from "Table VI" that the correlation degree k=0.917 indicates that the accuracy is still good at the first level, and the result of the residual test is the second level, which indicates that the gray GM(1,1) model established by the original data sequence is corrected by the residual error. Qualified and can be used to predict future residential prices.

D. *Forecast of average residential price in Huangdao area*

Adopted revised housing price data for Huangdao District from 2011 to 2018.Get a new predictive model through the build process:

$$\hat{x}_1^{(0)}(k+1) = (1 - e^{-0.0583}) * 132458.1 * e^{0.0583*k} \tag{23}$$

It is known that $\hat{x}_1^{(0)}(1)$ is the predicted value of the average residential price in the Yellow Island area in 2011, and so on, $\hat{x}_1^{(0)}(8)$ is the Yellow Island of 2018 The predicted value of the average residential price of the district will bring k=9,10⋯16 into the new forecasting equation, and obtain the average housing price forecast for the next 8 years in the Huangdao area, as shown in the "TABLE VII".

Since the influence of macro factors is mostly permeability, this article will not consider such influencing factors. Under the influence of factors such as policy changes and household income prices, the housing prices in the Huangdao area will increase year by year, with a growth rate of 7%.

TABLE VII AVERAGE RESIDENTIAL PRICE IN THE FUTURE

Year	2019	2020	2021	2022	2023	2024	2025	2026
$\hat{x}_1^{(0)}(k)$	$\hat{x}_1^{(0)}(9)$	$\hat{x}_1^{(0)}(10)$	$\hat{x}_1^{(0)}(11)$	$\hat{x}_1^{(0)}(12)$	$\hat{x}_1^{(0)}(13)$	$\hat{x}_1^{(0)}(14)$	$\hat{x}_1^{(0)}(15)$	$\hat{x}_1^{(0)}(16)$
Price	12960	13678	14439	15246	16101	17008	18969	19987

V. SUGGEST

The factors affecting the residential price in the Huangdao area are multi-faceted. Among the many influencing factors, the building area, CBD distance, age of the house, the internal environment of the community, and the degree of decoration have a great impact on the residential price. Therefore, based on the main factors affecting residential prices, the following comments can be made.

The government should raise the issue of developers' construction of capital quotas. It can establish a review agency for special inspections within the bank and use taxation to curb real estate speculation. While paying attention to product quality and quality improvement, real estate developers establish a transparent information mechanism to curb real estate speculation caused by poor information. Buyers need to purchase houses rationally. They should purchase houses according to individual needs based on factors such as the building area of the house, the distance of the CBD, and the internal environment of the community.

REFERENCES

[1] Sun Weizeng, Zheng Siqi, “How Residents’ Expectations of Housing Prices Affect Housing Price Changes,” Statistical Research, No. 33, vol. 5, 2016.

[2] Zhang Yinghong. “On Promoting the Strategy of Rural Rejuvenation with Capital Characteristics,” Journal of Beijing Agricultural Vocational College, No. 33, vol. 4, 2019, pp. 5-14.

[3] Wang Rui, Analysis of Influencing Factors of Rent of Long–Rent Apartments in Hangzhou Based on Hedonic Model, Zhejiang University, 2019.

[4] Cheng Huan, “Study on School District Housing Premium,” Market Weekly, 2019, pp. 55-58.

[5] Wang Zhaoguo, Study on Consumption Demand and Consumption Behavior of Rural Residents in Heilongjiang Province, Northeast Agricultural University, 2017.

[6] Lu Yuxi, Zhan Changgen, and Dai Yun, “Research on the Influencing Factors of Residential Rent Based on Characteristic Price Model–Taking the Main City of Wuhan as an Example,” China Real Estate, 2019, pp. 58–63.

[7] Qu Qikai, Chen Fujian, and Feng Feiyu, “A Systematic and Time–Varying Traffic Accident Risk Cost Model,” Journal of Southwest University, No. 41, vol. 6, 2019, pp. 127-134.

[8] Wen Haizhen, Li Xuning, and Zhang Ling, “The Impact of Urban Landscape on Housing Prices–Taking Hangzhou City as an Example, Geographical Research,” 2012, pp. 1807–1814.

[9] [8] Li Junfeng, Qiu Shi, and Wei Zhonghua, “Research on the Benefit Model of Integrated Pipe Corridor Construction Considering Transportation Cost,” China Engineering Consulting, May 2018.

[10] Yang Tan, Jiang Yalong, and Sun Zhihao, “1–AGO–GM(1,1) Model and It’s Application in the Prediction of Fire Deaths,” Journal of Changzhou University, No. 31, vol. 4, 2019, pp. 26-30.