Analysis and forecast of the influence factors of commercial housing price in Wuhan City

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Abstract
In recent years, too fast growth of commercial housing prices has significant impact on national economic development and social stability. And housing price issue has become one of the focus of national attention. This paper analyzes the impact of commercial housing price demand factors and supply, the multiple linear regression model is established to qualitatively and quantitatively analyze the main source of Wuhan house continued rising prices. And according to the gray prediction model, the price of commercial housing in Wuhan in the next five years is predicted.

Keywords: commodity housing price, multiple linear regression, Grey prediction GM (1, 1) model, predication.

Introduction

Since 2003, the price of commercial housing in our country has been rising all over the year. Housing prices not only has become the focus problem of the whole people, but also it is the problem that governments try their best to solve [1]. Wuhan city is one of the biggest cities in Central China. In the past ten years, the price of commercial housing has been steadily rising. Although the government's regulations and controls achieve a certain score, regulations are more qualitative administrative methods, and Quantitative control program is very few. Regulation and control policy is generally only a brief practical period of a particular period. Regulations, to a certain extent, do not achieve the desired effect. In this paper, the mathematical model is established according to the economic data of Wuhan city in recent years, The main influencing factors of commodity housing price fluctuation in Wuhan city are analyzed and summarized, and the next 5 years Wuhan city commercial housing prices are predicted [2]. By analyzing and predicting the conclusion, the paper not only effectively provide a theoretical basis for scientific and rational purchase, but also can effectively evaluate the government's macro-control policy. At the same time, the paper provides the policy recommendations to further control.

Qualitative analysis of the factors affecting the commodity housing price: The change of supply and demand is the direct factor that causes the change of the price of commodity house, so the factors affecting the commodity housing price is the factors that affect the relation between supply and demand.[3]

In other words, for factors affecting demand and factors affecting supply, the mainly factors that affect demand are per capita income, population, bank interest rate, residential area, residential building cost and so on. The mainly factors that affect supply are gross product (GDP), price level (CPI), completion area and so on [4]. By collecting and sorting out the statistical yearbook of Wuhan and China real estate statistics, the following data is got: nearly ten years of Wuhan City commercial housing price changes data and the main related data of price influencing factors. In order to make the data source consistent and accurate, the economic data only is collected from 2005 to 2015, as shown in the following table.

Multiple linear regression model is established based on the above data to explore the relationship between the commercial housing price and the number of factors and the explanatory power of various influencing factors on the price change [5]. The mathematical expression of the regression model is:

$$y = a_0 + a_1 x + a_2 x + \cdots + a_k x (k = 1, 2, \cdots, n)$$

y is dependent variable, $x_1, x_2, \cdots, x_k$ is independent variable, a_0 is constant, $a_1, a_2, \cdots, a_k$ is regression coefficient, b is return the remainder.

Because the regression analysis calculation is more complex, generally the software is used to achieve. The following empirical analysis uses the statistical product and service solutions software (SPSS) [6]. If commodity housing price (yuan) is the dependent variable and it is expressed by ZP, residential sales area (10000 square meters), per capita income (yuan), urban population (million) and bank interest rates are demand independent variables, SA, SR, RK, LL, are respectively expressed. Residential investment (100 million), the residential area (10000 square meters), GDP (billion), the number of consumer prices CPI (above one year is 100) are the supply of variables, ZT, JA, GDP, CPI are respectively expressed. From the demand factors for the observation point, there is the following table.

From table 3, we can see that in the five models, the model 3 is optimal, $R = 0.992$, $R^2 = 0.984$, R^2 that can be adjusted is $R^2 = 0.977$. It means that the fitting degree of regression model is better for the sample observation value. The value of $D-W$ is 2.181 and it is closer to 2. It means that the model variables are independent of each other. There is no linear relationship among the variables [7]. In the model 3, the variable of bank rate is removed, then urban population, housing sales area, residents per capita income can be explained by the variable price of residential 98%.

Table 1
Data of demand factors in Wuhan

Particular year	Commodity housing price (yuan /m^2)	Residential sales area (ten thousand m^2)	Per capita income (yuan)	Urban population (million)	Bank rate %
2005	2986.2	834.18	10849.72	801.36	6.2
2006	3535.26	908.92	12359.98	818.84	6.84
2007	4515.76	1069.89	14357.64	828.21	7.23
2008	4680.52	683.24	16712.44	833.24	7.9
2009	5198.54	1041.39	18385.02	835.55	7.58
2010	5550.00	1095.22	20806.3	836.73	5.4
2011	6675.99	1085.34	23738.1	827.24	6.2
2012	6895.36	1692.72	27061	821.71	6.65
2013	7238.00	1749.74	29821.22	822.05	6.15
2014	7806.00	1978.96	33270	827.31	6.15
2015	8861.00	2134.25	36436	1060.77	6.55

Table 2
Data of supply factors in Wuhan

Particular year	Total investment in fixed assets (100 million yuan)	Residential sales price (yuan / M)	Residential investment (100 million yuan)	Residential area (ten thousand m^2)	GDP (Billion yuan)	CPI
2005	1055.18	2986.2	834.18	834.18	249.10	102. 70
2006	1325. 29	3535.26	908.92	908.92	321.33	101. 40
2007	1732. 79	4515.76	1069.89	1069.89	483.14	104. 10
2008	2252. 05	4680.52	683.24	683.24	319.79	105. 70
2009	3001. 10	5198.54	1041.39	1041.39	541.37	99. 40
2010	3753.17	5550.00	1095.22	1095.22	606.01	103.6
2011	4255.16	6675.99	1085.34	1085.34	654.27	105.2
2012	5031.25	6895.36	1692.72	1692.72	858.17	102.8
2013	6001.96	7238.00	1749.74	1749.74	896.74	102.4
2014	7002.85	7806.00	1978.96	1978.96	1006.95	101.6
2015	8353.12	8861.00	2045.63	2226.88	1100.00	102.5

Table 3
The summary of model

Model	R	R^2	Adjusting R^2	Standard error of estimation	Durbin-Watson
1	.992[a]	.984	.973	294.10826	2.132
2	.986[a]	.972	.960	356.35692	1.579
3	.992[a]	.984	.977	272.88423	2.181
4	.992[a]	.983	.976	276.08566	2.028
5	.940[a]	.884	.834	728.63423	1.973

1. predictive variable: (constant), urban population(RK), bank rate %, residential sales area (SA), per capita income (SR).
2. predictive variable: (constant), bank rate %, residential sales area (SA), per capita income (SR).
3. predictive variable: (constant), urban population(RK), bank rate %, residential sales area (SA), per capita income (SR).
4. predictive variable: (constant), urban population(RK), bank rate %, per capita income (SR).
5. predictive variable: (constant), urban population (RK), bank rate %, residential sales area (SA).
b. dependent variable : commodity housing price(ZP).

Table 4
Model coefficient

Model		Non standardized coefficient		Standard coefficient	t	Sig.	Co linear statistic	
		B	Standard error	Trial version			tolerance	VIF
3	(constant)	-13599.816	5480.781		-2.481	.042		
	per capita income (SR)	.215	.032	.957	6.730	.000	.115	8.689
	residential sales area (SA)	-.226	.522	-.057	-.434	.677	.135	7.422
	urban population (RK)	18.073	6.791	.157	2.661	.032	.668	1.497
3. predictive variable: (constant), urban population(RK), residential sales area (SA), per capita income (SR). a.dependent variable: commodity housing price(ZP).								

What can be seen from table 4 is the coefficient of the dependent variable and the independent variable, the relationship between dependent variable and independent variable is

$$ZP = -13599.816 + 0.215 \times SR - 0.226 \times SA + 18.073 \times RK.$$

In the same way, supply factors are the observation point, the relationship between dependent variable and independent variable is:

$$ZP = -8383.912 + 3.562 \times ZT + 3.876 \times JA + 1.023 \times GDP + 76.910 \times CPI.$$

From the above formula, the following conclusion can be got: the main demand factors are per capita income, population, and housing sales area. Per capita income is the most important factor [8]. The main factors that affect the price of commercial housing are the gross domestic product (GDP), the price level (CPI), the amount of residential investment and the completion area. Price level is the most important factor. At the same time, through the comparison of the two relations, it is easy to get that housing prices continue to rise and the main sources perform in three aspects: (1) supply and demand are not imbalance. The interaction between housing supply and demand forces plays a leading role in the change of house prices. From short-term, the price of a house is more dependent on the quantity demanded than the quantity supplied. [9]

For example, in Wuhan, the sales area is greater than the construction area in a certain degree in recent years, it directly leads to the rise of housing prices in Wuhan. (2) The influence of the per capita disposable income of urban residents. The income level of urban residents is an important indicator to measure the purchasing power of residents. At the same time it is also an important indicator of real estate prices. As can be seen from the above table, the annual disposable income of urban residents has been in a rapid growth, and has been in the price of commodity sales and residential sales price. The income and expenditure of urban residents support the rise of real estate prices. Residents income levels continue to improve, so the effective demand for real estate is increasing and real estate prices also rise. (3) Policy factor. Moderate easing monetary policy and the expansion of credit to provide a strong financial support for developers, so that the level of funding for developers reduce. In addition, the deposit and loan interest rates decline, pressure on the purchase of the first payment reduces, so that investment models and self occupied demand expand at the same time. In the case that supply flexibility is smaller or even reduces, the demand for the expansion will inevitably lead to the rise in housing prices. [10]

The Wuhan commodity housing price forecast based on GM (1, 1) model

Grey system GM(1,1) is an effective predication method for these problems with fewer obtained information, the short data age, little fluctuation and the monotonous trend year by year. But because the solution of GM (1, 1) model is number curve and is general monotone tendency. For a long period of prediction, the results are higher. Therefore the volatility of the data fitting is poor, prediction accuracy is lower [11, 12]. The change trend of housing price in Wuhan in the recent ten years accords with the scope of application of grey model. And the prediction of this paper uses short-term data, so it avoids the shortcomings of the grey model. The following is the model.

If time series X^0 have n observed numbers, $X^0 = \{X^0(1), X^0(2), \cdots, X^0(n)\}$, through accumulation it turns into accumulation sequence: $X^1 = \{X^1(1), X^1(2), \cdots, X^1(n)\}$, and the corresponding differential equations of GM(1,1) model is

$\frac{dX^1}{dt}+aX^1=u$, a is development gray number, u is internal control gray number. α is estimated parameter vector, $\alpha=\begin{bmatrix}a\\u\end{bmatrix}$, the solution is got by least square method: $\alpha=\left(B^TB\right)^{-1}B^TY_n$.

$$B=\begin{bmatrix}-\frac{1}{2}\left[X^1(1)+X^1(2)\right] & 1\\ -\frac{1}{2}\left[X^1(2)+X^1(3)\right] & 1\\ \vdots & \vdots\\ -\frac{1}{2}\left[X^1(n-1)+X^1(n)\right] & 1\end{bmatrix},\quad Y_n=\begin{bmatrix}X^0(2)\\X^0(3)\\\vdots\\X^0(n)\end{bmatrix}.$$

Through differential equation, prediction model with the observation value of the accumulated sequence is:

$$\hat{X}^1(t+1)=\left[X^0(1)-\frac{u}{a}\right]e^{-at}+\frac{u}{a},(t=1,2,\cdots,n).$$

Combining with gray system theory, it is easy to get:

$$\hat{X}^0(t)=\left[X^0(1)-\frac{u}{a}\right]\times\left[e^{-a(t-1)}-e^{-a(t-2)}\right],(t\geq 2).$$

Data selected by the model is 2010-2015 annual average price of commercial housing in Wuhan, in order to easily calculate, the annual average price is reduced by 100 times the data as the original data.[13, 14]

If the original sequence is:

$$X^0(i)=\{55.50,66.76,68.95,72.38,78.06,88.61\}.$$

The accumulated sequence based on the original sequence is:

$$X^1(i)=\{55.50,107.49,174.25,243.20,315.58,393.64\}.$$

$$B=\begin{bmatrix}-79.7377 & 1\\ -140.8677 & 1\\ -208.7227 & 1\\ -279.8395 & 1\\ -354.6095 & 1\end{bmatrix},\ Y_n=\begin{bmatrix}66.76\\68.95\\72.38\\78.06\\88.61\end{bmatrix},$$

$$\alpha=\left(B^TB\right)^{-1}B^TY_n$$

So the paper can get $a=-0.07308,\ u=52.78778.$

The prediction model is got:

$$\frac{dX^1}{dt}-0.07308X^1=52.78778,\ X^0(1)=55.50,$$

$$\frac{u}{a}=\frac{52.78778}{-0.07308}=-722.29935,$$

$$X^0(1)-\frac{u}{a}=55.50-(-722.29935)=777.79935.$$

Through differential equation, prediction model with the observation value of the accumulated sequence is:

$$\hat{X}^1(t+1)=777.79935e^{0.07308t}-722.29935.$$

The predicted value is:

$\hat{X}^1(1)_{=55.50}$; $\hat{X}^1(2)_{=118.66}$; $\hat{X}^1(3)_{=186.60}$; $\hat{X}^1(4)_{=259.70}$

$\hat{X}^1(5)_{=338.34}$; $\hat{X}^1(6)_{=393.53}$; $\hat{X}^1(7)_{=478.13}$

The decreasing sequence of prediction value is $\hat{X}^0(i)$

$$\hat{X}^0(1)=\hat{X}^1(1)=55.50,$$

$$\hat{X}^0(2)=\hat{X}^1(2)-\hat{X}^1(1)=118.66-55.50=6316,$$

$$\hat{X}^0(3)=\hat{X}^1(3)-\hat{X}^1(2)=186.60-118.66=67.94,$$

$$\hat{X}^0(4)=\hat{X}^1(4)-\hat{X}^1(3)=259.70-186.60=73.10,$$

$$\hat{X}^0(5)=\hat{X}^1(5)-\hat{X}^1(4)=338.34-259.70=78.64,$$

$$\hat{X}^0(6)=\hat{X}^1(6)-\hat{X}^1(5)=426.94-338.34=88.60$$

Generally gray prediction model test includes a residual test, correlation degree test and correlation degree test. Through these model tests, the model $\hat{X}^1(t+1)=777.79935e^{0.07308t}-722.29935$, test results are good. It can be used to predict. The prediction formula is $\hat{X}^0(i+1)=\hat{X}^1(i+1)-\hat{X}^1(i).$

In this paper, $i=6$, so the values of $\hat{X}^0(7)$、$\hat{X}^0(8)$、$\hat{X}^0(9)$、$\hat{X}^0(10)$、$\hat{X}^0(11)$ are

$$\hat{X}^0(7)=\hat{X}^1(7)-\hat{X}^1(6)=91.0111,$$

$$\hat{X}^0(8)=\hat{X}^1(8)-\hat{X}^1(7)=97.9113,$$

$$\hat{X}^0(9)=\hat{X}^1(9)-\hat{X}^1(8)=105.3346,$$

$$\hat{X}^0(10)=\hat{X}^1(10)-\hat{X}^1(9)=113.3207,$$

$$\hat{X}^0(11)=\hat{X}^1(11)-\hat{X}^1(10)=121.4872.$$

From the predication model, forecast prices in Wuhan city in 2016, 2017, 2018, 2019, 2020 are 9101.11 (yuan / square meter), 9791.13 (yuan / square meter), 10533.46 (yuan / square meter), 11332.07 (yuan / square meter), 12148.72 (yuan / square meter).

Conclusion

Commodity housing price is an important part of the competitiveness of a city or region. Housing price has an important influence on the industrial structure, industrial policy and industrial development of a country's national economy. At the same time it also directly relates to the people's happy life. A comprehensive understanding of the relationship between housing prices and various factors within the price system is the key to grasp the running of the entire housing market. In this paper, from two perspectives of demand and supply, the influence factors of housing price in Wuhan city are analyzed qualitatively and quantitatively. And the root of the continued commodity housing prices is contradiction between supply and demand. Wuhan commercial housing price is analyzed quantitatively base on the multiple regression method, it is concluded that the per capita income of Wuhan city is the biggest influence on the price of housing. In the quantitative analysis of the housing price in Wuhan, the data is more standard and complete, and the forecast result is more accurate. It can provide a scientific and effective decision-making basis for the public housing and the government's macro-control. But the paper does not take into account the impact of land prices on housing prices. In the quantitative analysis of Wuhan housing price, the paper also does not use the multiple linear regression model to predict the price, and there isn't GM (1, 1) model of price forecasting. This is also a place to improve in the future.

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