Research on the Problems of Housing Prices in Qingdao from a Macro Perspective

Liu Zhiyuan, Sun Zongdi, Liu Zhiyuan, Sun Zongdi

Abstract—Qingdao is a seaside city. Taking into account the characteristics of Qingdao, this article established a multiple linear regression model to analyze the impact of macroeconomic factors on housing prices. We used stepwise regression method to make multiple linear regression analysis, and made statistical analysis of F test values and T test values. According to the analysis results, the model is continuously optimized. Finally, this article obtained the multiple linear regression equation and the influencing factors, and the reliability of the model was verified by F test and T test.

Keywords—Housing prices, multiple linear regression model, macroeconomic factors, Qingdao City.

I. INTRODUCTION AND LITERATURE REVIEW

QINGDAO City is adjacent to the coastline, geographical location and the environment is superior to attract people from all over the country to come here for sightseeing. In recent years, Qingdao's housing prices have increased year by year, and the rate of housing price growth has exceeded the growth rate of people's wages [1]. However, the housing vacancy rate is significantly improved, which has a negative impact on people's housing needs.

Sun Jiguo, Wang Yuanyuan [2], from the perspective of supply and demand, made descriptive analysis on real estate market development of Qingdao City. Cai Lijuan [3], through the analysis of panel data, found the demand for houses has significant influence on housing prices. Yu Yonghu [4], by constructing Tobin Q theory analysis framework, using panel data to study the effect of real estate tax on housing prices, found that there is a significant negative correlation between real estate tax and housing prices. In eastern region, it has the most significant impact; in middle and western regions, the impact is small. Song Chuan [5] took the supply and demand rule as a standard, found that the urban resident population and disposable income level were positively correlated with commercial housing demand. The difficulty of urban resident' housing mortgage loans has significant negative impact on the demand of housing.

Due to the unique nature of the housing, it is determined that the price mechanism is more complex than other products [6]. Considering Qingdao's unique geographical location and

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environment, in addition to include common factors, we also selected other factors, such as the domestic tourism income, foreign tourism revenue, the total import and export volume.

II. MACROECONOMIC FACTORS

Macroeconomic factors affecting housing prices mainly include GDP, total investment in fixed assets, real estate investment, international tourism income, total import and export of foreign trade at the port, the balance of local currency loans of financial institutions, per capita disposable income of urban residents, total number of employees in the unit, home sales [7]. We get the data of these macroeconomic factors from 2000 to 2014 year, as shown in Figs. 1-8.
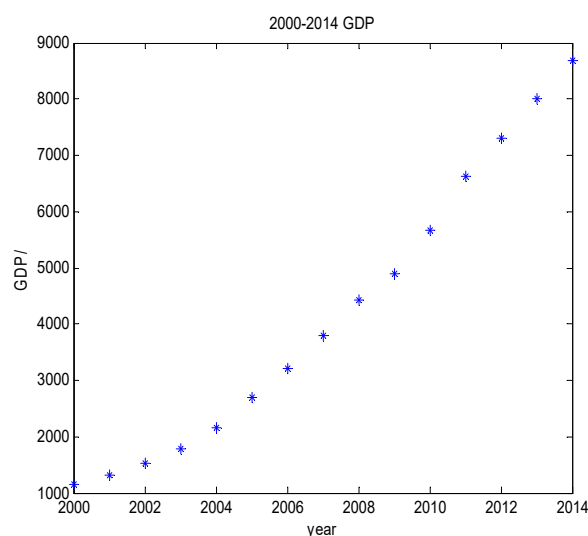

Fig. 1 2000-2014 GDP

III. MODEL ESTABLISHMENT

According to the theory of multiple regression analysis, assume that there is a linear relationship between the twelve factors and housing prices [8]. The multiple linear regression model is as:

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$$P = a_0 + a_1X + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + a_6X_6 +$$
$$a_7X_7 + a_8X_8 + a_9X_9 + a_{10}X_{10} + a_{11}X_{11} + a_{12}X_{12} + \varepsilon \quad (1)$$

P means housing prices, $X_i(i=1:12)$ means the twelve factors, $a_i(i=1:12)$ means the regression coefficients, ε means random error term.
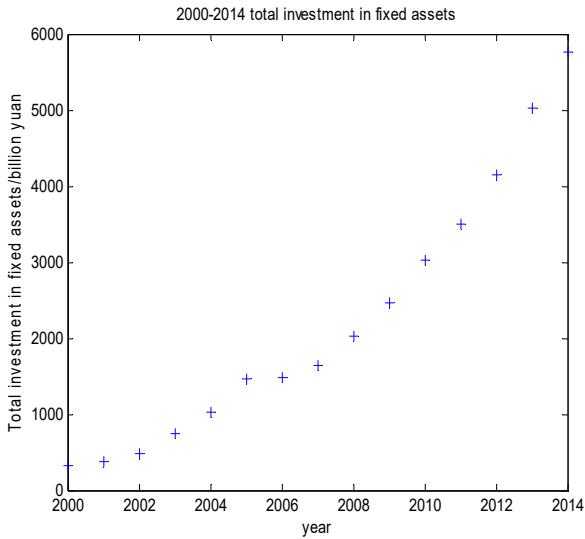

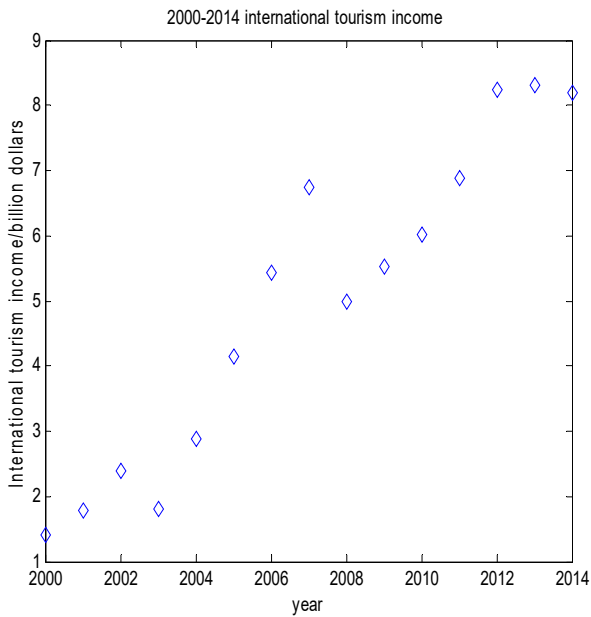Fig. 2 2000-2014 total investment in fixed assets

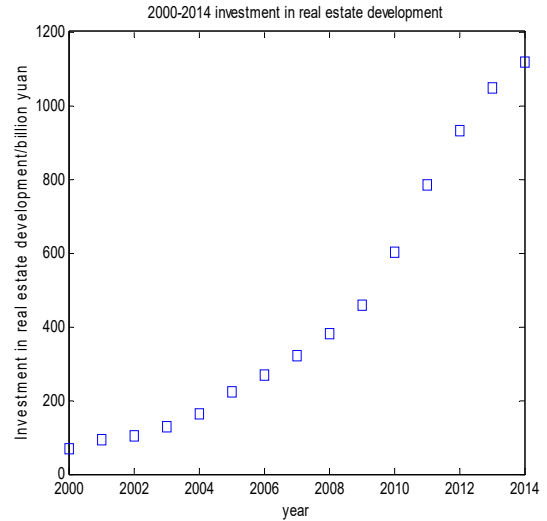Fig. 3 International tourism income

Fig. 4 2000-2014 real estate investment

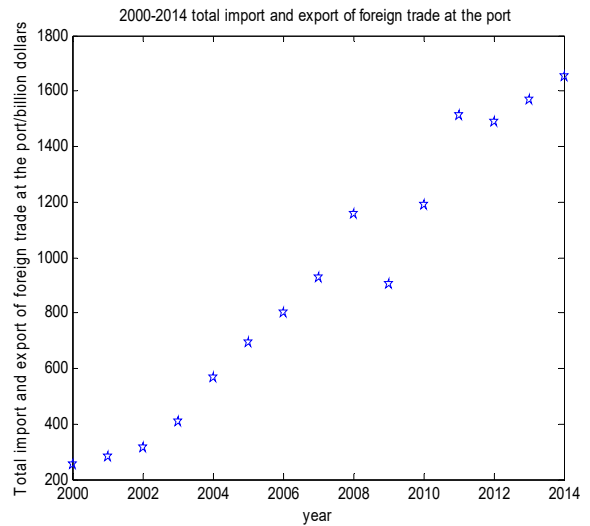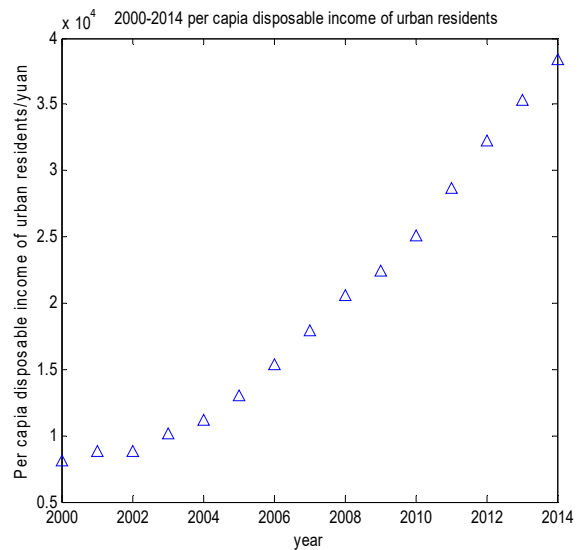Fig. 5 Total import and export of foreign trade

Fig. 6 Per capias disposable income

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Fig. 7 The balance of local currency loans of financial institutions

The macroeconomic data of Qingdao City from 2000 to 2014 year were analyzed by MATLAB, using stepwise regression

analysis method to determine the impact of variables on housing prices, the preliminary results are shown as Fig. 9.

Fig. 8 Domestic tourism income
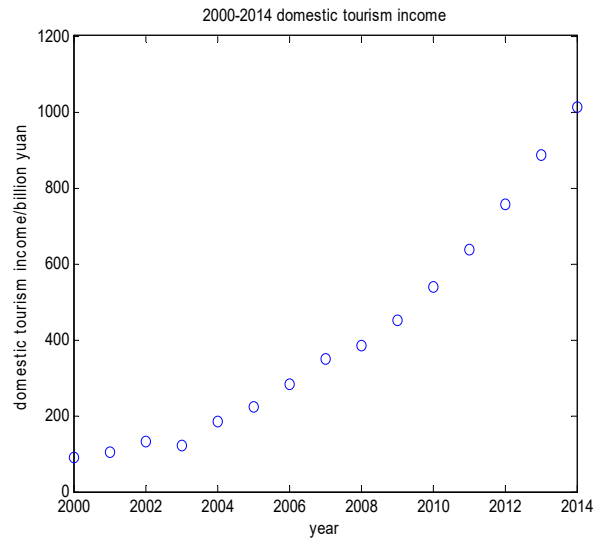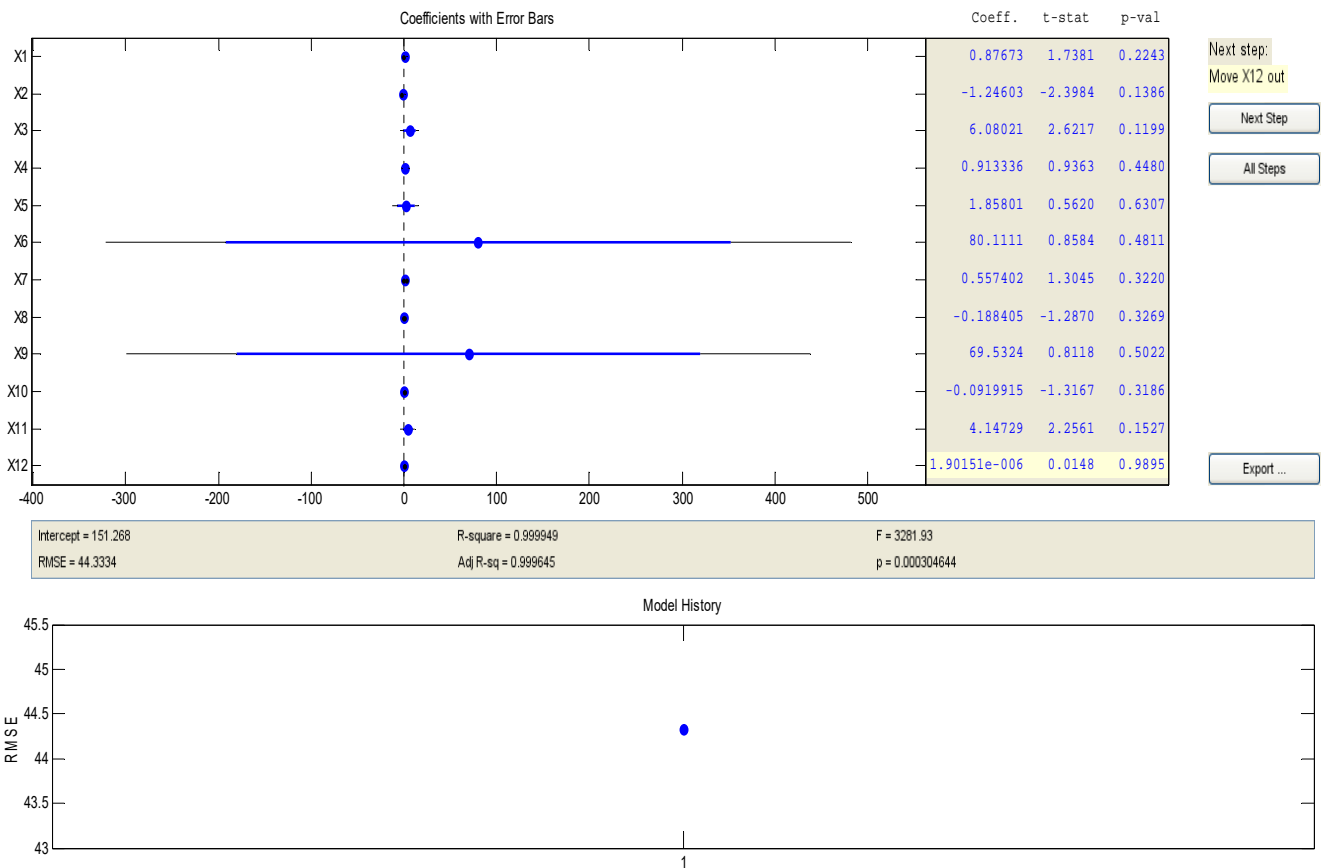

Fig. 9 The preliminary results

$$RMSE = 44.3334, \ R^2 = 0.999949, \ \overline{R}^2 = 0.999645,$$
$$F = 3281.93$$

The t test results of the twelve independent variables are shown in Table I.

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TABLE I
THE T TEST RESULTS OF THE TWELVE INDEPENDENT VARIABLES

t	t_1	t_2	t_3	t_4	t_5	t_6
t test value	1.738	-2.398	2.62	0.93	0.56	0.86
t	t_7	t_8	t_9	t_{10}	t_{11}	t_{12}
t test value	1.30	-1.287	0.812	-1.317	2.256	0.015

TABLE II
STATISTICAL DATA TABLE FOR DELETION OF VARIABLE COMBINATIONS

The delete variable	$RMSE$	F	R^2	$\overline{R}^2$
X_{12}	36.2001	5369.85	0.999949	0.999763
X_9	42.345	3924.35	0.999931	0.999676
X_4	43.4118	3733.84	0.999927	0.999659
X_5	38.9518	4637.92	0.999941	0.999726
X_6	42.345	3924.35	0.999931	0.999676
$X_{12}\ X_9$	38.6972	5168.96	0.999923	0.999729
$X_{12}\ X_4$	102.622	734.649	0.999456	0.998095
$X_{12}\ X_5$	39.8085	4884.37	0.999918	0.999713
$X_{12}\ X_6$	49.4063	3170.85	0.999874	0.999559
$X_{12}\ X_9\ X_4$	93.3109	987.288	0.999438	0.998425
$X_{12}\ X_9\ X_5$	40.3237	5289.15	0.999895	0.999706
$X_{12}\ X_9\ X_6$	57.1168	2635.93	0.999789	0.99941
$X_{12}\ X_4\ X_5$	98.078	893.651	0.999379	0.99826
$X_{12}\ X_4\ X_6$	99.8595	861.975	0.999356	0.9988197
$X_{12}\ X_5\ X_6$	66.2705	1957.89	0.999716	0.999206
$X_{12}\ X_9\ X_4\ X_5$	91.1151	1164.78	0.999357	0.998499
$X_{12}\ X_9\ X_4\ X_6$	96.437	1039.69	0.999279	0.998318
$X_{12}\ X_9\ X_5\ X_6$	74.053	1763.74	0.999575	0.99008
$X_{12}\ X_4\ X_5\ X_6$	91.8308	1146.69	0.999346	0.998475
$X_{12}\ X_9\ X_4$ $X_5\ X_6$	89.3133	1385.32	0.999279	0.998557
$X_9\ X_4$	38.2627	5287.03	0.999924	0.999735
$X_9\ X_5$	36.2969	5875.26	0.999932	0.999762
$X_9\ X_6$	55.4187	2520.07	0.999841	0.999445
$X_9\ X_4\ X_5$	36.5273	6445.84	0.999914	0.999759
$X_9\ X_4\ X_6$	80.1021	1339.94	0.999586	0.99884
$X_9\ X_4\ X_5\ X_6$	79.0467	1547.84	0.999516	0.99887
$X_4\ X_5$	40.167	4797.55	0.999917	0.999708
$X_4\ X_6$	80.7141	1187.82	0.999663	0.998822
$X_4\ X_5\ X_6$	75.979	1489.37	0.999627	0.998956
$X_5\ X_6$	73.2869	1440.86	0.999722	0.999029

We can find t test values of variables X_{12}, X_9, X_4, X_5, X_6 are very small; therefore, the explanation function is not obvious. After deleting different combinations of variables X_{12}, X_9, X_4, X_5, X_6, redo multiple linear regression analysis, make statistical analysis of F test values, the results are shown in Table II.

Analysis of data in Table II, after deleting variables X_9, X_4, X_5, we can get:

$$RMSE = 36.5273,\ F = 6445.84,\ R^2 = 0.999914,$$
$$\overline{R}^2 = 0.999759$$

At this point, the model effect is the best.

In Fig. 10, variables X_9, X_4, X_5 shown in red color, means these three variables have been removed, and get the results:

$$RMSE = 36.5273,\ F = 6445.84,\ R^2 = 0.999914,$$
$$\overline{R}^2 = 0.999759$$

The t test results of the independent variables shown in Table III.

TABLE III
THE t TEST RESULTS OF THE INDEPENDENT VARIABLES

t	t_1	t_2	t_3	t_6
test values	2.3148	-9.6655	8.3181	4.8061
t_8	t_{10}	t_{11}	t_{12}	t_7
-1.2158	-1.4999	5.1748	5.6862	1.4303

From the overall analysis of the model, the F test has passed, the complex decision coefficient $R^2 = 0.999914$, the adjusted complex decision coefficient $\overline{R}^2 = 0.999759$, and the t distribution values can properly reflect the relationship among the factors and housing prices. Therefore, we can get the final model:

$$P = 650.433 + 0.904X_1 - 0.929X_2 + 4.206X_3 + 145.391X_6 + \atop 0.462X_7 - 0.116X_8 - 0.072X_{10} + 3.377X_{11} + 0.00012X_{12} \tag{2}$$

IV. MODEL RESULTS

According to the multiple linear regression model, the factors which have significant impact on housing prices are: GDP, total investment in fixed assets, investment in real estate development, international tourism income, total import and export of foreign trade, the balance of local currency loans of financial institutions, the per capital disposable income of urban residents, total number of employees in the unit, home sales.
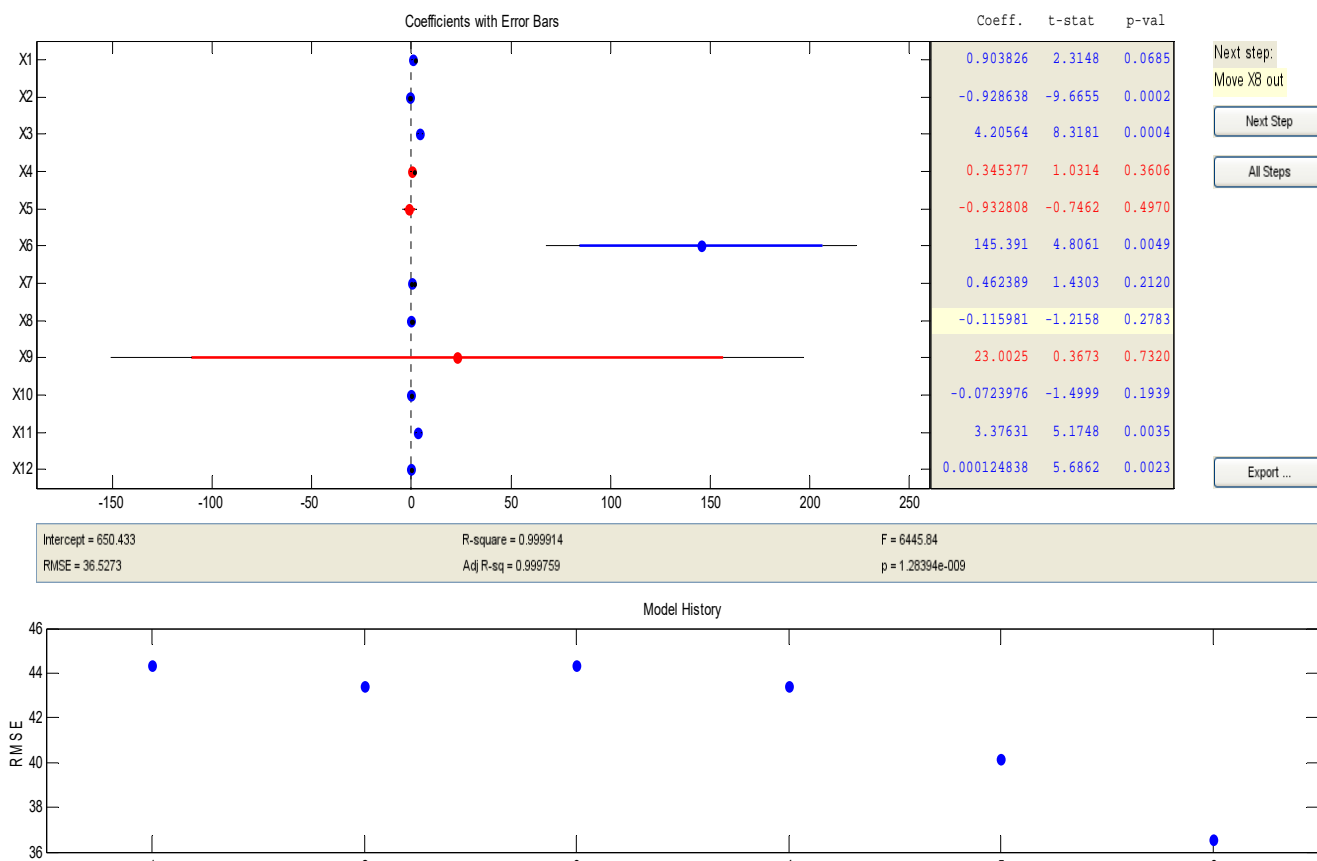
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Fig. 10 Final stepwise regression analysis result

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