Research on the Influencing Factors and Fluctuation of Housing price in Jinan City based on GARCH model

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Abstract. For a long time, the real estate industry has been identified as the pillar industry of economic growth, driving the development of the national economy. However, the continuous rise of housing prices has caused many economic and social problems. However, a stable and healthy development of the real estate market is more conducive to people's livelihood, so it is particularly necessary to study the factors and fluctuations affecting the real estate price. Prices are affected by multiple factors comprehensive, taking Jinan as an example, the selection of 2004-2018 data of commodity house average price and its influencing factors of Jinan, modeling by economics method and use the analysis software Eviews econometric analysis, thus the study situation and its changes in 15 years, Jinan prices, the relationship between the influencing factors of Jinan index and use the 2010-2019 monthly data to establish GARCH, TGARCH model to study the volatility.

1. Introduction

In recent years, real estate has played an indelible role in the country's economic development, driving the development of all walks of life. At the same time expanding the real estate bubble phenomenon, in order to stabilize the housing price, dense policies since 2016 countries, and housing problem is the livelihood of the people, a stable housing prices is beneficial to people's livelihood, so through the study of the influence factors of real estate prices and volatility, to assist decision makers to solve economic problems and the livelihood of the people play a reference role. This paper aims to find out the key factors and explore their fluctuations through in-depth study of the factors affecting the price of commercial housing.

2. Multiple linear regression model

2.1. Data and variable selection

This paper selects the data of influencing factors of commercial housing prices in Jinan from 2004 to 2018. For variable selection of Jinan city GDP, M2 money supply, price index, loan interest rates, real estate development investment, real estate development enterprises purchase land area, construction of housing construction area, completed area, commercial housing sales area, at the end of the household register population, residents per capita disposable income, savings, and unemployment, a total of 13 variables, respectively to \( X_1, X_2, X_3, X_4 \cdots X_{13} \). Let \( Y \) be the average selling price of commercial houses in Jinan city, \( \beta_0, \beta_1, \beta_2, \beta_3 \cdots \beta_{13} \) be the parameter, and \( U_t \) be the random disturbance term. Thus, a multiple linear model is constructed:
2.2. Data and variable selection

In order to eliminate the influence of dimension, the first step is to take the logarithm of all the data, and then put the log-taken data into the econometric analysis software Eviews for running. The running results are shown in Figure 1.

\[ Y_i = \beta_0 + \beta_1 X_1 + \cdots + \beta_{13} X_{13} + U_i \]

According to Figure 1, although the goodness-of-fit $R^2 = 0.997576$ is higher, but the variable lending rate coefficient is 0.255415, and economics for the other conditions unchanged, if the loan interest rate increase 1 unit, commodity house average sales price will increase 0.255415 units, do not tally with the practical significance, therefore has the multicollinearity between considering all the factors. The correlation test also confirmed this speculation.

2.3. Stepwise regression

According to the correlation coefficient matrix of $X_1, X_2, X_3, \cdots, X_{13}$, the correlation coefficient between each explanatory variable is high, indicating that there is a serious multicollinearity in the data. The multicollinearity is modified by stepwise regression method,[1] and the results are shown in Figure 2.

Finally, it is concluded that the average selling price function of commercial housing should take $Y = f(\lambda X_4, X_5, X_8, X_9)$ as the optimal. The model is as follows:

\[ Y = 8.894237 - 0.68088X_4 + 0.917561X_5 + 0.193865X_8 - 0.90734X_9 \]

It can be seen from the results that the economic significance of variables all conforms to the theory, which indicates that the model has a good fitting degree, and the T-test values of all explanatory variables and constant terms pass, and there is no multicollinearity.[2]
2.4 Granger causality test
Granger causality test is to investigate the leader-lag relationship between variables in time, and the lag order is selected as 2. The results are shown in Tab.1.

Tab.1 Granger causality test results
| Null Hypothesis | F-Statistic | Prob |
|-----------------|-------------|------|
| X4 does not Granger Cause Y | 3.39941 | 0.0834 |
| Y does not Granger Cause X4 | 3.30199 | 0.0900 |
| X5 does not Granger Cause Y | 4.28963 | 0.0542 |
| Y does not Granger Cause X5 | 0.46280 | 0.6454 |
| X8 does not Granger Cause Y | 2.18738 | 0.1747 |
| Y does not Granger Cause X8 | 5.69434 | 0.0290 |
| X9 does not Granger Cause Y | 3.14707 | 0.0981 |
| Y does not Granger Cause X9 | 1.38047 | 0.3055 |

It can be seen from Tab.1 that, at the significance level of 10%, there is a two-way Granger causality between house price and loan interest rate. Development investment is the Granger reason of house price; The housing price is the Granger reason for the size of the house completed; Commercial housing sales area is the Granger reason for housing prices.

3. Study on housing Price Fluctuation
This paper selects the monthly data of the real estate price index of Jinan from January 2010 to December 2019 for analysis.

3.1 Verify data stationarity
(1) Descriptive statistics. Using the monthly data of the real estate price index from January 2010 to December 2019, the time series diagram and descriptive statistics Tab are made in Eviews, as shown in Figure 3 and Tab 2 respectively.

Figure 3 Time sequence chart of housing price index in Jinan city.

Tab.2 Descriptive statistics of jinan housing price index
| JINAN | Std | Skew | Bk | J-B  | P-value |
|-------|-----|------|----|------|---------|
| HPI   | 6.574 | 0.50 | 2.499 | 6.31 | 0.0424 |

It can be seen from Tab 2 that the skewness is 0.50 and greater than 0, indicating that the distribution of housing price index in Jinan is skewed to the right, and the P value of J-B statistic is 0.0424, indicating that the data is non-normal. It can also be seen from Figure 3 that the housing price index of Jinan is not stationary.

(2) First-order difference and ADF test. From Figure 3 of the Jinan City House Price Index Time Series Chart, it can be seen that the Jinan City housing price index is not stationary, a descriptive analysis showing that the data is abnormal, so jinan City Housing Price Index data do first-order differential processing, as shown in Figure 4.
Figure 4 Sequence diagram after first order difference

According to the time series diagram of DHPI, it can be seen that the data of The Housing price index of Jinan fluctuates up and down the zero axis after the first-order difference. It is preliminarily considered that the data after the first-order difference is sTab[5]. Then, ADF test is performed on the data of first-order difference to check whether the data is sTab after first-order difference. The results are shown in Tab 3.

| t-Statistic Prob.* |
|--------------------|
| Augmented Dickey-Fuller test statistic | -4.117568 | 0.0001 |

Test critical values:
- 1% level: -2.584877
- 5% level: -1.943587
- 10% level: -1.614912

According to the ADF test results in Tab 3, it can be seen that THE ADF value is -4.117568, which is less than the critical value of T statistics at the confidence level of 1%, 5% and 10%, and the P value is 0.0001<0.05. Therefore, it can be considered that the housing price index data after the first-order difference is sTab[3].

3.2. Verify that GARCH utility exists for the data

(1) Autocorrelation test.

First, DHPI is autoregressed with different orders. The regression finds that the d-W value of second-order autoregressions is the largest, so it is considered that DHPI has a significant autocorrelation with its lagged 2nd order. Thus, the mean value equation can be determined as follows:

\[ \text{DHPi}_t = c + a \text{DHPi}_{t-1} + \beta \text{DHPi}_{t-2} + \epsilon_t \]

Then L-jungBoxQ statistic is used to test the residual and the square of the residual after fitting the mean equation. The autocorrelation diagram of the residual square shows that the information is not sufficiently extracted, and further Garch model needs to be established for research.

3.3. Build GARCH model

(1) GARCH(1,1) Model. The GARCH(1,1) model was established as the optimal lag number to the first difference of the Housing price index DHPI of Jinan city. The results are shown in Figure 5.

As can be seen from the Figure 5 above, the GARCH(1,1) process is sTab, and the impact of the past fluctuations of the housing price index on the future is gradually weakened[3].

(2) TARCH model. The TGARCH model is a volatility model that is often used to deal with leverage.
\[
\begin{align*}
\gamma_t &= \mu_t + \alpha_t \\
\alpha_t &= \sigma_t \epsilon_t \\
\sigma_t^2 &= \sigma_0^2 + \sum_{i=1}^{m} (\alpha_i + \gamma_i N_{t,i}) \sigma_i^2 + \sum_{j=1}^{s} \beta_j \sigma_j^2 \\
N_{t,i} &= \begin{cases} 
1 & \text{if } \alpha_{t,i} < 0 \\
0 & \text{if } \alpha_{t,i} \geq 0
\end{cases}
\end{align*}
\]

Where \( N_{t-i} \) is an indicator variable about whether \( \alpha_{t-i} \) is negative, \( \alpha, \beta, \gamma \) is a non-negative parameter. It can be seen from the model that the contribution of positive \( \alpha_{t-i} \) to \( \sigma_t^2 \) is \( \alpha \sigma_t^2 \), and the contribution of negative \( \alpha_{t-i} \) to \( \sigma_t^2 \) is \( (\alpha + \gamma) \alpha_{t-i}^2 \). Therefore, the model shows that negative disturbance has a greater impact and produces an asymmetric effect.

According to SIC and SC criteria, the first-order lag is selected as the optimal lag number to establish the TARCH model of Jinan housing price index after the first-order difference, and the parameter of \( RESID(-1)^2 < 0 \) is obtained as 0.007934, greater than 0. This suggests that bad news in the housing market causes more volatility than similarly large pieces of good news. In other words, when the market is negatively impacted, the conditional variance of the housing price index is too large and the volatility is great. When the market is impacted positively, the volatility decreases, indicating that there is leverage in the real estate price number in Jinan.

4. Conclusion

By establishing a multiple linear regression model, it can be seen from the results that there is a negative correlation between housing price and loan interest rate and sales area, and a positive correlation between housing price and development investment and completed area. The absolute value of the regression coefficient of investment is the largest, indicating that housing price is more sensitive to the change of investment. According to The Granger test, the housing price and loan interest rate influence each other. The investment amount and the selling area can affect the housing price, but conversely, the housing price cannot affect the investment amount and the selling area. The housing price can affect the completed area, but conversely the completed area cannot affect the housing price. The number of real estate prices in Jinan is leveraged, and the fluctuation caused by bad news is greater than that caused by good news of the same size.

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