Analysis of Real Estate Industry Based on H-P Filter and Tobit Model—— cited 3,614 trading days for 15 companies

Xin Su[#,*], Wenxin Che[#], Yingshi Cai[#]

[1] School of Economics, Beijing Technology and Business University, Beijing, China

[2] Research Institute of economy and management, South Western University of Finance and Economics, Chengdu, China

[3] Economic and Trade College, University of Electronic Science and Technology of China, Zhongshan Institute, Zhongshan, China

*suxin20220406@163.com

[#]These authors contributed equally.

Abstract. As an industry to enhance the national economy and improve people's lives, it is of great significance to accurately analyze the stock price of the real estate industry. Based on this, this paper takes 13 listed companies in the Chinese real estate industry as an example, using the H-P filtering method, OLS regression, and Tobit model to analyze the price of the real estate industry. There are three main research results: (1) After HP filtering analysis, the long-term trend and cyclical fluctuation curve of the stock prices of listed companies in the real estate industry are steep, indicating that China's real estate industry's real estate industry market fluctuates greatly. (2) When making a model prediction, the average daily price of each stock obtained after the Tobit test is the same as that of the OLS prediction, indicating that the core model also has good empirical robustness. (3) During the heterogeneity analysis of stock price, it is found that the regression model fits the residential development industry better than other industries.

Keywords: stock price valuation, real estate industry, H-P filtering method, Tobit model.

1. Foreword

As an important part of the capital market, the stock market is very active in the world economic market. The real estate industry plays a role in directly promoting economic growth, driving the development of related industries, and providing high fiscal revenue. Therefore, accurately valuing the stock price of the real estate industry plays an essential role in maintaining the stability of the financial market and ensuring the healthy development of the national economy. However, due to the large fluctuations of the real estate industry and the many uncertainties in the stock market, there are few related studies on the stock price valuation of the real estate industry. Therefore, this paper takes 13 listed companies in China's real estate industry as an example, uses 3614 sample data of nearly 278 trading days, decomposes the long-term trend and random fluctuation of the real estate industry through the H-P filtering method, and then fits and predicts the decomposed data through OLS regression, and uses Tobit model for robustness test, quantitative prediction model, and empirical test. Finally, the research conclusion shows that the stock price valuation model based on the H-P filtering method has practical significance and has good robustness.

2. Literature review

2.1 Real estate industry-related research

Real estate industry development affects the overall economic and industrial structure. Take China as an example. With the real estate industry's development, China's domestic output and other indicators show an upward trend[1]. Wang Bingqing used the main component regression model of standardized economic growth of the real estate industry and found a strong correlation between the consumption level of urban residents and the added value of the real estate industry[2].

Khodabakhshian Ania et al. have found that the real estate industry's stock price fluctuations are affected by the combined internal and external value[3]. Stock valuation is a relatively complex process, affecting many factors. There is no unified global unified standard. Jan Chutka et al. used the P / E model to improve the speed and accuracy of stock price valuation[4].

2.2 The Valuation method of the stock price

Based on the existing research of the traditional BC stock valuation model, Ming Dong et al. used the method of model estimation and performance comparison. They introduced a surrogate and more flexible GEVM model with yield adjustment parameter —— buffer yield and found that the model fitted well[5]. Ali Amiri et al. used the least-squares estimation regression equation of the monthly data of all listed companies in the Tehran Stock Exchange from 2008 to 2013 to compare the stock value valuation of the Tehran Exchange with other models to find the more optimized P / B model with the highest——adjustment coefficient of stock valuation model[6]。

Table 1 Summary table of the existing stock price valuation model

model	description	merit	shortcoming
P / E valuation method[7]	The so-called p / E ratio refers to a listed company's market price and earnings per share.	Simple, intuitive, and clear, very suitable for the performance of stable companies, bright prospects.	It cannot fully reflect the future fundamentals of a stock exchanges situation.
PEG technique of estimation[8]	It is obtained by dividing a listed company's p / earnings ratio by the earnings growth rate.	Suitable for moderate growth stocks or stocks with large fundamental changes.	The PEG valuation method may not suit companies with too low or too high earnings growth rates.
PB technique of estimation	refers to the ratio of the latest share price of a listed company to the net asset value per share.	Relatively simple, intuitive, and clear.	It cannot effectively reflect the intrinsic value changes when the fundamentals undergo profound changes[9].

2.3 Literature review

Scholars at home and abroad have conducted detailed research on stock price valuation from different perspectives and models. However, these studies did not deeply discuss the real estate industry valuation. The long-term trend of stock price and random fluctuations make a good explanation. Based on this, this paper on the Chinese real estate industry 13 listed companies, for example, using the H-P filtering method will share prices into long-term trend and random fluctuations, a more scientific and reliable real estate industry share price valuation.

3. Sample stock profile and research data

3.1 Sample stock profile

Shenyin Wanguo Securities divides the real estate industry into residential development, industrial real estate, commercial real estate, property management, real estate leasing brokerage, and real estate service. Because the real estate development industry accounts for the vast majority of the total volume of the real estate industry, in this paper, 9 companies are selected from the real estate development industry and 4 companies from the real estate service industry to make the data representation and better represent the situation of the whole real estate industry. At the same time, stocks are only traded on non-holiday working days, so the sample data selected in this paper is the average daily price of stocks on the trading day.

The 13 companies selected in this article belong to the 6 real estate industry types. It belongs to the residential development industry is Guangyu Group [E1 (1)], Sunshine City [E1(2)], Black Peony [E1(3)]. It also belongs to the industrial real estate industry in Shanghai Lingang [E2(1)], Zhangjiang Hi-Tech [E2(2)], and Haitai Development [E2(3)]. The commercial real estate industry is included in Lujiazui [E3(1)], New City Holdings [E3(2)], and Sunshine Shares [E3(3)]. The belonging to the property management industry is Narada Property [E4(1)], Investment promotion surplus [E4(2)]; Belong to the real estate rental brokerage industry has I love my family [E5(1)]; It belongs to the real estate comprehensive service industry [E6(1)].

3.2 Study data and the descriptive statistics

This paper selects 6 kinds of real estate industry classification of 13 companies' average daily price as a research sample, stock product-related data from the database, flush, Oriental wealth, and the listed company annual report. China's real estate industry was hit hard by COVID-19 in 2020. However, in 2021, the real estate industry gradually recovered, with the epidemic gradually under control. Therefore, on the premise that the epidemic is still spreading, selecting data from 2021 as the sample is representative. Sample data for 13 companies from January 4, 2021, to February 28, 2022 daily price data, after deducting the day, a total of 278 trading days, 3614 sample data.

Table 2 Descriptive statistical analysis of the sample stock price data

Stock classification	least value	crest value	average value	standard deviation	median
E1 (1)	2.67	4.563	3.033	0.264	2.946
E1 (2)	2.41	6.729	4.663	1.302	4.703
E1 (3)	5.79	13.18	7.404	1.045	7.127
E2 (1)	14.1	23.07	17.19	2.550	15.85
E2 (2)	13.7	20.49	16.74	1.438	16.96
E2 (3)	2.56	3.348	2.878	0.149	2.881
E3 (1)	10.0	15.95	11.36	1.086	11.02
E3 (2)	28.7	51.06	38.75	6.315	36.73
E3 (3)	2.65	4.338	3.295	0.315	3.276
E4 (1)	12.7	24.47	17.06	3.035	15.70
E4 (2)	11.2	24.98	17.22	3.231	17.22
E5 (1)	2.83	5.056	3.650	0.546	3.597
E6 (1)	3.35	8.243	5.016	1.350	4.448

4. Empirical analysis of the stock price forecast of the real estate industry

4.1 The long-term trend in real estate stock prices

The HP filtering analyzes a time series in the state space, equivalent to minimizing the wave variance[10]. HP filtering is an approximate high-pass filter whose theoretical basis is the time series spectral analysis method. This paper first uses HP filtering analysis of the raw stock price data, then does follow-up processing based on the long-term trend data.

It is assumed that the time series is Y = $\{y_1,y_2,\ldots,y_t\}$, The periodic data are T= $\{t_1,t_2,\ldots,t_t\}$, The trend element data is G= $\{g_1,g_2,\ldots,g_t\}$, Then Y =T + G, t=1,2,3 … n. Where, n is the size of the sample, g_t And, t_t All of these are non-observable values. In general, trends are often defined as the solution of the minimizing problem under equation (1).

$$\min\{\sum_{t=1}^{n}(y_t - g_t)^2 + \lambda\sum_{t=1}^{n}[(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})]^2\} \quad (1)$$

Where λ is the natural number, known as the smoothing parameter. Different values determine the different modes of random fluctuations and the different degrees of smoothing. In the data analysis of this paper, the degree data is 14400. The selected original stock price data is decomposed to obtain the periodic fluctuation data and trend elements. The software selected is Eviews 9. The results are shown in Figure 3 (take Guangyu Group as an example).

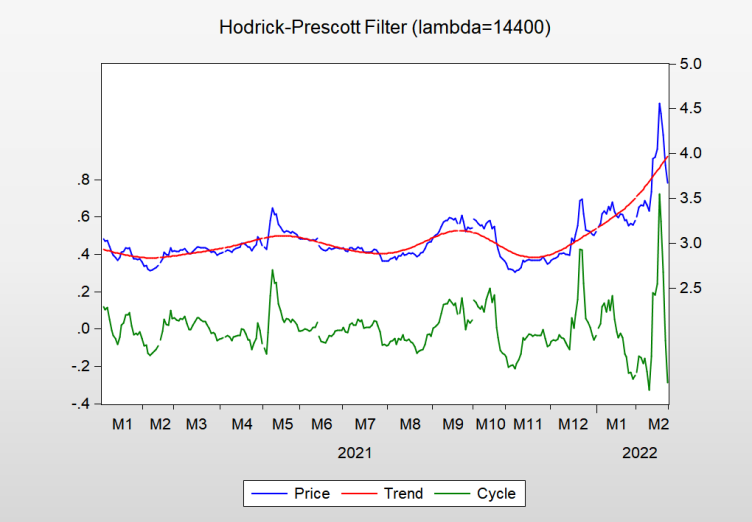

Figure 3 E1 (1) Long-term trend of stock prices

As can be found from Figure 3, the HP filter breaks down a smoother trend than the original net value trajectory, that is, the trend represented by the red curve, the green curve is the periodic fluctuation trend lower than the set cycle, the red curve indicates the trend element sequence G, the green curve represents the periodic element sequence T.

4.2 Forecast and analysis of the real estate industry stock price

After HP filtering analysis of the selected stock data, the decomposed data is fitted and predicted through O LS regression. The regression results are shown in Table 3, in which the explained variable is the stock price, and the explanatory variable is the days of stock trading days. Available in Table 3, each core parameter is significant at its significance level. However, OLS analysis of the selected stock data has two hidden dangers: first, the stock price data is not a normal distribution. Second, the absolute value of the core parameters is small. The value only starts at decimal or even 100,000 decimal. Therefore, this paper uses the truncated data Tobit model to predict the stock price. The general form of the Tobit model is:

$$y^* = \beta x_i + u_i; y_i = y^*, \text{if } y^* > L \quad (2)$$

$y^*$is the latent stress variable, it can only be observed when the latent variable is more remarkable than L. The value is y_i, x_i is the independent variable vector, βit is the coefficient vector, and the error term u_i follows a specific distribution.

Results of the Tobit model tests are shown in Table 3. Through the robustness test, we can conclude that the core coefficient obtained by the robustness test is consistent with the original core coefficient, which indicates that the original model has good robustness. There is no obvious difference between the Z and T-tests, indicating that the significance level is basically the same, so the core model still chooses the OLS method regression.

Table 3. Forecast analysis of the stock prices of the real estate industry economies

	OLS regression		Tobit model	
kernel variable	Core coefficient	T-value	Core coefficient	Z-value
E1 (1)	4.11E-06	231.79	4.11E-06	232.21
E1 (2)	6.32E-06	60.628	6.32E-06	60.737
E1 (3)	1.00E-05	146.87	1.00E-05	146.87
E2 (1)	2.33E-05	118.60	2.33E-05	118.81
E2 (2)	2.27E-05	208.14	2.27E-05	208.52
E2 (3)	3.90E-06	459.81	3.90E-06	460.64
E3 (1)	1.54E-05	210.33	1.54E-05	210.71
E3 (2)	5.25E-05	109.55	5.25E-05	109.74
E3 (3)	4.46E-06	209.81	4.46E-06	210.19
E4 (1)	2.31E-05	99.956	2.31E-05	100.13
E4 (2)	2.33E-05	98.508	2.33E-05	98.685
E5 (1)	4.94E-06	119.88	4.94E-06	120.09
E6 (1)	6.80E-06	66.649	6.80E-06	66.769

According to the analysis results, the core model is empirically predicted. The predicted days are the 1st and 6th trading days. The corresponding trading dates are March 1 and March 8, 2022. OLS regression is mainly used as empirical prediction, Tobit model is used for robustness tests. OLS regression was used to predict the average price of each stock. The average daily price of each stock obtained after passing the robustness test was the same as that predicted by the OLS. Contrasting the predicted values with the actual values, The maximum absolute value of the difference between the estimated and true values was 9.51 for 284 days. For the E3(2) forecast share price, The minimum is 0.07 for 279 days. For the E3(3) forecast share price, it can be found that the predicted values do not differ much from the actual values. To prove that the obtained model has practical significance in predicting future stock price trend changes in the short term.

4.3 Analysis of Heterogeneity of Real Estate Industry

In the empirical forecast of stock price, this paper finds that the prediction effect of the housing industry is better than that of other industries, indicating that there is industry heterogeneity in stock price valuation. Therefore, this paper analyzes the heterogeneity of the real estate industry. Based on removing its periodic fluctuations by HP filtering treatment and standardizing the data, the stock price conducts the model regression analysis using the least-squares method. The specific results are shown in Table 4.

Table 4 Analysis of the heterogeneity of stock prices of real estate industry economies under different industries

kernel variable	Core coefficient	standard error	T-value	R2	P price
E1 (1)	0.6455	0.0514	12.539	0.3621	0.00
E1 (2)	-1.0073	0.0113	-88.818	0.9660	0.00
E1 (3)	0.8345	0.0357	23.348	0.6630	0.00

E2 (1)	-0.8641	0.0331	-26.106	0.7110	0.00
E2 (2)	-0.7304	0.0431	-16.909	0.5079	0.00
E2 (3)	0.5716	0.0511	11.184	0.3111	0.00
E3 (1)	-0.0021	0.0615	-0.0352	0.0000	0.97
E3 (2)	-0.8354	0.0356	-23.422	0.6645	0.00
E3 (3)	-0.1429	0.0609	-2.3447	0.0194	0.02
E4 (1)	-0.7564	0.0415	-18.207	0.5448	0.00
E4 (2)	-0.5715	0.0511	-11.182	0.3110	0.00
E5 (1)	-0.7042	0.0443	-15.875	0.4755	0.00
E6 (1)	-0.3301	0.0582	-5.6633	0.1037	0.00

Looking at the values after regression analysis in Table 4, the core coefficients of E1(1), E1(3), and E2(3) are positive. The days of stock trading days are positively correlated with the stock price. E1 (1) and E1(3) are divided into residential development industries. E1(2) is observed for another residential development stock's R2 Values, and standard error can conclude that the residential development industry's R2 values are generally greater than 0.5, indicating that the OLS regression model has a good fitting effect for the residential development industry. The error is also small. The relationship between the stock trading days and the stock price in the residential development industry is large. For the commercial real estate industry, on the contrary, the core coefficient of the regression is all negative, and R^2 values are below 0.2, and one is below 0.7, indicating that the effect of regression fitting is poor. The standard error value is generally large, indicating that the connection between the stock trading days of the commercial real estate industry and the stock price is small, and the changing trend is negatively correlated. Overall, the regression model fits the residential development industry is found better than other industries.

5. Research conclusion

Using the sample data of 13 sample companies in the real estate industry in nearly 278 trading days, this paper studies the stock price change and forecast based on the specific average daily price change, forecast model, and empirical analysis. After using the HP filtering method, OLS regression, and Tobit model, three main results are:(1) After HP filtering analysis. It is found that the long-term trend and cyclical fluctuation curve of the stock prices of listed real estate companies are steep, indicating that China's real estate industry is gradually moving to the silver era after experiencing a brilliant golden decade. The market is relatively volatile. (2) When making a model prediction, the average daily price of each stock obtained after the Tobit test is the same as that of the OLS prediction, indicating that the core model also has good empirical robustness. (3) During the heterogeneity analysis of stock price, it is found that the regression model fits better than other industries.

Meanwhile, there are also two shortcomings in this study: first, the research data only consider the changes of 278 trading days, the results may be accidental; second, the explanatory variable is relatively single, with only the number of stock trading days as the explanatory variable, did not consider the impact of other factors on the stock price.

References

[1] Zhang He. Research on the Impact Mechanism of the Real Estate Industry on the Overall Economic Industrial Structure in China [J].Social scientists, 2020 (11): 99-104.

[2] W.bingqing .Analysis of Real Estate Economic Growth Factor Based on Principal Component Regression[J].Statistics and Application,2019,08(02)

[3] Khodabakhshian Ania,Toosi Hossein.Residential Real Estate Valuation Framework Based on Life Cycle Cost by Building Information Modeling[J].Journal of Architectural Engineering,2021,27(3)

[4] Jan Chutka,Katarina Kramarova. Usage of P/E earning models as a tool for valuation of shares in condition of global market[J].SHS Web of Conferences,2020,74.

[5] Dong,M.and Hirshleider, D.(2005), A Generalized Earnings-based Stock Valuation Model. The Manchester School, 73:1-31. https://doi.org/10.1111/j.1467-9957.2005.00459.x

[6] Ali Amiri, Hamid Ravanpaknodezh, Akbar Jelodari. Comparison of stock valuation models with their intrinsic value in Tehran Stock Exchange[J].Marketing and Branding Research,2016,3(1)

[7] Aswath Damodaran (2007), "Valuation Approaches and Metrics: A Survey of the Theory and Evidence", Foundations and Trends in Finance: Vol.1: No.8, pp 693-784. http://dx.doi.org/10.1561/0500000013

[8] Jiang XQ,Kang Q.Cross-Sectional PEG Ratios, Market Equity Premium, and Macroeconomic Activity[J].Journal of Accounting Auditing and Finance.2020,35:471-500

[9] Cheng XS,Huang DY,Chen J,Meng Xiangsong,Li CY.An Investigation on Fact ors Affecting Stock Valuation Using Text Mining for Automated Trading[J].SUSTAINABILITY.2019,11(7)

[10] Phillips, Peter C. B.Business Cycles, Trend Elimination, and the HP Filter[J]. International Economic Review.2021(62):469-520