A Comparative Study of the Efficiency between Chinese and American Housing Markets—Based on the Run Test Method

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Abstract. The efficiency of the housing market is an important feature to measure whether the development of the housing market is healthy. The empirical test and comparative analysis of the efficiency on the housing market in China and the US was conducted by the run test method in this paper. The results demonstrate that both Chinese and American housing market are efficient, but overall, American market is more efficient than Chinese. Therefore, the experience of the US housing market plays an important role which contributes to the development of the Chinese housing market.

Introduction

The real estate industry is an industry that has strong correlation with other industries, on which the impact is often the same as the domino effect and even influence the whole economy. Therefore, the steady development of real estate industry has been always attracting serious concern of all social sectors. As a core component of the real estate industry, the housing industry no longer has residential properties in recent years. It has already become a kind of popular investment product, which has two major functions of boosting economy and safeguarding people’s livelihood. In the past 10 years, Chinese housing market has reached at a new peak of development and housing prices has been soaring. However, the increase of housing price is extremely irrational, which not only seriously affects the consumption level and living standards of ordinary residents, but also make the price exceed the reasonable value of the fundamental balance, triggering the asset bubble phenomenon and becoming an unstable factor affecting the sustainable development of the national economy. It can be seen that whether the housing market can promote the economy can be based on the premise of market efficiency (Feng, Zhang & Li, 2011). Therefore, studying the response of housing prices on the entire market information and testing the efficiency of the market are important for perfecting the real estate industry's regulatory policies (Hosios & Pesando, 1991) and promoting its healthy development.

Market Efficiency Theory and Random Walking Test

The theory of market efficiency stemmed from Fama (Fama, 1970), a financial scientist at the University of Chicago in the US. In 1969 (Fama, Fisher and Jensen et.al, 1969) and 1970, He published two papers in succession. In which he expounded and summarized the relevant theories of market efficiency, and then put forward the famous theory of "Market efficiency"(EMH). The assumption is that if all available information related to the stock market is not distorted and fully reflected in the stock price, then the market is efficient. Fama further believed that the market could be divided into three kinds of efficient forms: strong form, semi-strong form and weak form. The classification depended on the level of information subsets. Weak form efficiency means that asset prices can fully reflect historical information, and this form is the easiest to be actualized. Based on it, Semi-strong form requires asset prices to completely mirror all publicly available information. Strong form means that prices are entirely consistent with all obtainable news, consisting of historical, public and insider information. The last form is so extreme that Fama even think that there is actually no such form. At present, the research on market efficiency is related to a weak form on the whole and partly touches on a semi strong form.
According to the definition of market efficiency, we often reflect the specific information through the relevance between price and information, which makes it possible to express the correlation by price or return model, and further makes the test of efficient market model possible in reality. Thereby, it’s inevitable to choose a model that can characterize the formation process of price series or price behavior. In general, there are three models that can meet the needs: i) the expected return model (Hamilton & Schwab, 2006); ii) the martingale model (Chen, Chen & Yang, 2009); iii) the random walk model (Kleiman, Payne & Sahu, 2002). The random walk model is the most widely used and the easiest to understand, so it has almost become a spokesperson for the weak and efficient market. This paper is conducted by the theory of random walks.

As a basic consumer goods of the residents, the balanced housing price is proportional to the income of residents in principle (Xu & Sun, 2010). Therefore, if we want to measure the efficiency of housing, we just need to judge whether the housing price beyond those that can be explained reasonably by income is valid or whether it has the random walk trait (Yang, 2006). In terms of the results of no-arbitrage pricing theory and equilibrium analysis, there is the following relationship between reasonable house price and income:

\[ p_t = k_t I_t. \]  (1)

Therefore, the irrational part of the price that causes the market to be invalid is:

\[ p_t - E[k_t I_t]. \] Considering that housing price to income ratio is basically stable (it is a constant) in the ideal case and there is an intercept item, the equation can be rewritten as:

\[ p_t = a + kE[I_t] + \varepsilon_t. \]  (2)

Then, \( \varepsilon_t = p_t - (a + kE[I_t]) \) it is a random disturbance item. In light of the random walk theory, if the walk is random, the housing market is efficient and vice versa (Schindler, Rottke & Fuss, 2009).

**Empirical Test of the Efficiency of the Housing Market**

**The Source of Data**

The Chinese housing market and the US housing market are the subject of this paper. In order to measure the efficiency of the housing market, this paper selected the housing price index HPI, the consumer price index CPI and the per capita income PPI as the indicators of the run test. Since the construction methods and the degree of perfection of the Chinese and American databases are different, we processed the sample data with different ways in the selection of research units and time interval so that we can get as much data as possible. In the Chinese market, our paper chose the monthly data of 67 representative large and medium-sized cities nationwide and China as a whole from July 2005 to December 2017. Since the housing price index of three cities of Anqing, Dali and Yangzhou couldn’t be collected, only 67 of the 70 large and medium-sized cities specified by the National Bureau of Statistics were selected as research objects. Among them, the HPI was based on July 2005, and the per-capita income was replaced by the monthly average salary of the residents. As for CPI, we took the data of July 2005 as base. In the US market, data from 50 states in the US was included besides Washington and DC. There are a total of 52 research units. The sample data is from the first quarter of 1975 to the first quarter of 2014 at quarterly intervals. Relatively speaking, it is easier for the US markets to collect data on a state-by-state basis. Even in some major cities, the relevant data is difficult to collect, and there will always be problems of missing years and inconsistent data lengths. The population data is from 1975 to 2013. Both HPI and CPI are based on the first quarter of 1980. Per capita income was obtained indirectly by calculating the ratio of total household income to all population. Missing data was supplemented by linear interpolation. For the sake of eliminating the effects of seasonal factors, all data were seasonally adjusted.

The units of the research object are sorted to simplify expression, the overall market of China and the US is marked as No. 1, and the rest are sorted by the first letter of the cities and the states. If the first letter is the same, it depends on the second place and so on. In the end, the Chinese market were numbered 1, 2 ..., 68, and the US market were numbered 1, 2, ..., 52.
Test Method

As we all know, there are various methods for random walking, such as unit root test, auto correlation test, variance ratio test, run test and so on. In this paper, the run test is applied which is also called "coherent test" and make a judgment according to the number of runs formed by the arrangement of sample performance. The run test is a non-parametric method, which does not need to consider the numeric value of the observed objects, but only tests its positive and negative trend. Consequently, it is regarded as a method based on symbol statistics.

The reason why it is called the run is there is a continuous time series with the same characteristics. If the feature changes at a certain time, the run ends and then enters the next run. For example, two kinds of different data are marked by 0 or 1. As long as any one of these two features is continuously maintained, it can be seen as the same situation. Once switched, it will enter another run. The number of consecutive signs is called the length of the run.

Run test has many functions. On the one hand, we can use it to test whether the two population distributions are the same; on the other hand, you are able to test the randomness of the samples. This paper takes advantage of the latter function and mark the time series following some characteristics. For instance, we mark the ups and downs of the housing price series (the steady situation is very rare, we ignore it here and count it as down) with 1 and 0 respectively. Thus, $n_1, n_2$ represents the number of rises and falls in the time series and the total number of runs is $n = n_1 + n_2$. Owing to the relevant statistical theory, if the change of time series exhibits random walk fluctuations when $n \to \infty$, we can think the number of runs approximately follows the normal distribution, i.e.

$$r \sim N \left( \frac{2n_1n_2}{n} + 1, \frac{2n_1n_2(2n_1n_2 - n)}{n^2(n - 1)} \right).$$

After standardization, we have

$$z = \frac{r - \frac{2n_1n_2}{n} - 1}{\sqrt{\frac{2n_1n_2(2n_1n_2 - n)}{n^2(n - 1)}}} \sim N(0, 1).$$

Given the significant level $\alpha$ of a known sample $n$, the critical value $Z_{\alpha/2}$ of the statistic $z$ can be derived. If we get $|z| > Z_{\alpha/2}$ from the sample, we can reject the original hypothesis, that is, the time series is not random, and the market does not reach a weak efficiency. Otherwise, we accept the original hypothesis. In other words, the time series is random, and the market is weak-form efficient. Equivalently, the adjoint probability $\pi = 2\Phi(z < Z_{\alpha/2})$ can be calculated. Under this circumstance, if $\pi < \alpha$, it is indicated that the original hypothesis can be rejected, that is, the time series is not random and the market is not weak efficient. By contrast, it means that the time series is random and the market is weak efficient.

Test Results

The validity of the housing market in China and the US is tested by run test method through the residual in formula (2). The results are presented in the form of adjoint probability, as shown in Figures 1 and 2, respectively.
As can be seen in Fig.1, when the significant level $\alpha = 0.05$ is given, the adjoint probability of Chinese overall housing price is almost zero in the run test, which suggests that Chinese overall housing market is inefficient. Moreover, there are only 9 cities (Guilin City (No.14), Hefei City (No.18), Kunming City (No.27), Luoyang City (No.30), Nanchong City (No.33), Quanzhou City (No.40), Tangshan City (No.44), Shaoqguan City (No.49) and Zunyi City (No.68)) with an adjoint probability more than 0.05 in 67 cities. The rest of all is less than 0.05, so we can conclude that the housing prices of China as a whole and most cities are not random walks, and the housing market is not efficient. In the new list of Chinese urban classification in 2017, only Hefei (No.18) and Kunming (No.27) are second-tier cities, while the other cities are third-tier or below. This shows that the markets of those cities who have more developed economy and stronger comprehensive strength are more likely to be inefficient. On the contrary, those cities with general economic development level has stronger ability to reflect market information. The five cities with the smallest adjoint probability are Yueyang City (No.62), Shenzhen City (No.45), Beihai City (No.4), Beijing City (No.5) and Shanghai City (No.43). Among them, Beijing, Shanghai and Shenzhen, as the old first-tier cities, rank at the forefront of the country in terms of comprehensive strength, but the housing market is inefficient, which is not consistent with the level of development of the city itself.

It can be seen from Figure 2 that the US housing market is more efficient than China. At the same significant level, although the overall housing market in the US has not reach efficient, nearly half of the states are weak efficient. Only 26 states do not have random housing prices. In the weakly efficient markets in the US, most cities are concentrated in the east and West coasts with relatively developed economy and dense population, such as Alaska (No.2), Delaware (No.10), West Virginia (No.51), South Carolina (No.42) and Wyoming (No.28).

**Conclusion**

According to the results of the run test, it can be found that although the overall housing market in China and the US are both inefficient. Nearly half of the states in the US are in a weakly efficient state based on the sample data, while there are only 9 cities in China. To a certain extent, the conclusion shows that the US housing market is more efficient than China, and the housing policy of US has some reference significance for China. The inefficiency of Chinese overall housing
markets in and that of many cities exposes the current lack of information response and imperfect information disclosure mechanisms in Chinese real estate market. Therefore, the government should strengthen the supervision of the transparency of information in the real estate market, improve the liquidity of market information, strive to create a fair, open and fair market environment, and establish a housing trading system with uniform standards, transparent prices, standardized sales and smooth information.

References


