Research on the Measurement of China’s Adjusted House Price Index
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Abstract. In China, the national statistical office provides flow type house price index which is the price of periodical housing trade but, in most developed countries, the adjusted house price index is preferred which is the stock type price index and reflect the value of all houses rather than new houses. Although, in the long run, the flow type house price index converges to real value of all houses, due to the rapid development of Chinese economy in the past decade, the flow type price index is significantly biased in reflecting the value of all houses. This paper firstly summarizes the background and method of adjusted house price index. Then, based on the particular situations of China, a more appropriate method is developed. Given on the available statistics, China’s national and provincial adjusted house price indices are calculated and discussed.

Introduction

House price (or house price index) is the price of real estate, which refers to the market value of the building and the land it located at a specific time point or period. Under the market economy system, house price is a digital expression that reflects the value of the service of real estate. From a macro perspective, the house price index of a country or region should be the reflect of the quality of housing services in terms of money, that is, the comprehensive performance of the residential service or operating value of all real estate. Therefore, the house price index should be equal to the total value of all local real estate divided by the total area, that is, the house price of the housing stock. However, the original house price data published by many countries, including China’s Statistical Bureau, are calculated according to the trading volume and trading area of real estate within a certain period (a year, a quarter or a month), i.e. house price of new purchase of dwellings (house price of the housing flows). Along with the new real estate entering the market and the old real estate withdrawing from the market, the house price of the housing flows will keep moving towards the house prices of the housing stocks in the long run. However, due to the difference between the old houses of all stocks and new houses sold each period, there will be some deviation between the two in the short run and the house price of the housing flows cannot completely capture the house price of the housing stocks in reflecting the current real estate value.

To give an example of spatial illusion, if only one apartment was traded last year at the price 2,000 (yuan/m²) while the average price is 1,000 in this area. This house flow price index would give everyone the illusion that all the property in this area worth 2,000, and the same problem would also exist for the whole country or region. Another example of time illusion, the average house price of a city was 1,000 ten years ago, and the price of those buildings has now risen to 2,000. While the current price of new buildings is 4,000. From the perspective of flow prices, the price of buildings has quadrupled in the past 10 years, but we know that the reality is it has only doubled in the past 10 years. The deviation between the flow price index and the stock price index will give people wrong information, lead to irrational housing consumption and investment, affect the results of economic and sociological research, and even mislead the policy makers of real estate.

There are many factors that cause the deviation between the flow house price and the total house price. Different methods are used to correct the house price aiming at different influencing factors. The two most widely used basic house price correction models in the world are the Repeated Sale Method and the Hedonic Model. Repeated transaction method was put forward by Bailey and Nourse in 1963 [1]. As one of the most often used theories of house price correction in the world,
its basic principle is to calculate the changes of house price based on the transaction values of some houses at different times so as to correct house price errors. Many scholars have continuously improved the theory of repeated transactions according to different real estate market conditions in different countries. Dombrow et al. found that the absence of other relevant factors would lead to greater errors in the corrected index of house prices estimated by the repeated transaction method, and he proposed to select specific correction variables by the significance and stability of the estimated parameters [2]. Wang and Zorm found that the simplified repeated transaction method in actual operation is likely to be more accurate than considering more factors through theoretical and empirical research [3]. Pollakowski carried out his research from the aspects of data availability, sample size and information validity, stating that loan data is a good data source for building a housing price correction model based on repeated transaction method [4]. Another widely used method is Hedonic Model established by Rosen [5]. Its main purpose is to estimate the characteristic house price on the basis of the characteristics of real estate (such as location, public facilities, ecological environment, economic environment, etc.) by means of Econometric method. Many studies are devoted to improving the estimation accuracy [6].

Some developed countries and statistical agencies have noticed the serious consequences brought about by the house price deviation and have provided many house price correction indexes. The housing price index from the Housing Statistical Release published annually by the Department of Communities and Local Government of the British Statistics Bureau includes not only the flow house price, but also a series of Mixed-adjusted Average House Price Index including the adjusted house price index based on the type of buyers (new owner/owner of more than one house), the adjusted house price index based on the type of property (new house/second-hand house), the annual adjusted house price index based on quarterly changes, etc. The OFHEO house price index released by the U.S. Federal Housing Finance Agency is calculated on the basis of the down payment ratio and the data of house prices of households, and it will correct the influence of the down payment ratio on the house price (the higher the down payment ratio, the higher the circulation rate of the house market). Case-Shiller real estate price index is proposed by Schiller, who won the Nobel Prize in Economics in 2013. Compared with other real estate indexes, this index is calculated according to the weight of the qualities (type, age, city or village, etc.) of the houses newly traded and the housing quality information of the entire real estate market. Most empirical studies on American real estate economics use this price correction index. The Real Estate Association of Canada has been publishing data of flow house prices. Learning from Case-Shiller Index and combining it with the actual situation in the country, the National Bank of Canada has published the house price correction index since 2008. There are some other well-known house price correction indexes like the Halifax index of Britain, which started in 1989, and the INSEE index of France, which started in 1980. These are only some representative house price indexes with high usage. The revised house price index based on flow data will make the index closer to the total house price by eliminating the influence of various factors on the deviation. Obviously it is impossible for countries to consider all the influencing factors in the calculation of the correction index when building the correction method for house prices, which would be too much of work. When designing the actual calculation method, we should consider the characteristics of the local real estate market and the availability of data, as well as effect of correction.

In China, the house price data from China Statistical Yearbook, City Statistical Yearbook and other statistical data are typical flow house prices, and there is no widely used corrected house price index. Chen Jingdong et al. proposed the idea of setting up characteristic prices suitable for our country's characteristics [7]. Qian Yingying et al. put forward the theoretical thinking of compiling China's house price correction index based on the repeated transaction method [8]. Yang Nan summarized several representative models of house price correction index, and points out that the asymmetry of sample and overall information will cause correction deviation and affect the accuracy of house price correction index [9]. Wen Haizhen and Jia Shenghua compiled the residential price index of Xihu District in Hangzhou City. House price correction cannot simply apply ready-made methods. However, at present, there is no fundamental statistical study on the
main causes and influence degree of house price deviation between total price and flow price in China, and therefore there is no house price correction model designed according to the characteristics of China’s real estate market.

**Theory**

In this research area, the most commonly used methods are repeat sale method and Hedonic method. However, both of these two are not appropriate in estimating China’s true level of house price. Since repeat sale method is established under the statistics of the repeat sale houses, the price index indeed can reflect the price of housing stock. But repeat sale method has two problems: first, repeat sale houses are also depreciated between the two recorded date; second, the trade of some special houses such as investment houses, hotel style apartment, school district housing, are more rapidly. Typically, the shorter the repeat sale houses are selected, the biased the sample is. Hedonic method calculate the true price of house based on all futures of houses. Simply speaking, each future donates a certain living value and therefore the price is the (weighted) sum of all values of futures. To estimate the true level of house price, Hedonic method will turns out to be a huge effort on investigation and data collection. But, it is still possible to omit some key futures and the finally results will severely affected by the endogeneity among futures.

House price is consist of two parts: house’s own value and its external value, given by equation (1). No matter where the house allocated, its physics body has value and its allocation especially the surrounding environment determines the external value. Recently in China, as the development of construction technology and the increased residents’ preference, the quality of house also developed. Here, quality does not means how good or bad of a house, but it aims to the characteristic or feature of the house. In light of this, the price of new houses has an upward tendency. Due to the urbanization and economic development, externality of houses is also raise but the price of all houses increased. We can find that the former is the main reason of causing the gap in house prices between housing trade and housing stock. Therefore, in order to construct a more appropriate China’s house price index, the key is to eliminate the difference of house price between new and old houses.

\[ P = P_{\text{physics}} + P_{\text{externality}} \]  

According to the availability of China’s housing data and the main reason of price bias, China’s adjusted house price index can be theoretically derived in a similar idea of the overlapping generation model. For each period of time \( t \), the house price of the whole stock is the weighted sum of the prices of all the old houses and the price of all the new houses, shown by equation (2).

\[ P_{\text{true}, t} = w_{\text{old}, t} P_{\text{old}, t} + w_{\text{new}, t} P_{\text{new}, t} \]  

\[ w_{\text{old}, t} = \frac{((1-\delta) H_{t-1}) H_t}{H_t} \quad \text{and} \quad w_{\text{new}, t} = \frac{H_{\text{new}, t}}{H_t} \]  

\[ H_t = (1-\delta) H_{t-1} + H_{\text{new}, t} \]  

\[ P_{\text{old}, t} = (1 + r_{\text{externality}, t}) P_{\text{true}, t-1} \]  

\[ r_{\text{externality}, t} = r_{\text{new}, t} - r_{\text{physics}, t} \]  

(where: \( \delta \) is the housing depreciation rate)

In equation (2), \( w_{\text{old}} \) and \( w_{\text{new}} \) are the weights of the old houses and the new houses, which can be calculated by the statistics of the housing stock (areas) and the new purchase of dwellings (areas), shown by equation (3). The data of the areas of the new houses (\( H_{\text{new}, t} \)) is available but there is no stock (\( H_t \)) data. Since housing stock is unavailable, the Perpetual Inventory (Stock) System, given by equation (4), is used to estimate the housing stock and then help to calculate the weights. The price of the new houses (\( P_{\text{new}} \)) in equation (2) can be fully captured by the price of the current sales, since more than 90% of the sales are new houses and the sales of the second-hand houses only
occupy less than 10%. The old houses at period t is the total houses at period t-1, so the price of the old houses at period t (P_{\text{old},t}) is the price of the whole houses at period t-1 (P_{\text{ture},t-1}) inflated with the rate of externality (r_{\text{externality},t}), given by equation (5). Because current old houses are still the houses at period t-1, their cost are almost unchanged (but if the during period from t-1 to t is longer enough, depreciation should also be considered). And therefore, due to equation (1), we can roughly estimate the inflation rate of externality as equation (6), where r_{\text{new}} is the growth rate of the price of the new house and r_{\text{physics}} is the growth rate of the housing physical value. This equation shows that the price inflation of the new houses is the sum of the increased housing physical value and externality, thus the growth of externality can be calculated.

Empirically, house price of new houses are approximated by the price index of the temporal housing trade, the physical price of the new houses are captured by the cost of construction (yuan/m2). Based on the related data provided by China Statistical Yearbook, the adjusted house price index can be calculated. Fig. 1 shows the China’s national house price index, our calculated adjusted house price index and their difference. Since provincial level indices are also calculable, we select Beijing and Shandong as examples which are respectively given by Fig. 2 and Fig. 3.

Fig. 1 reflects that the difference of the house prices between the housing trade and housing stock has an upward trend but recently converge to a certain level. Thus, the use of housing flow price index does not have a huge power in misleading residences irrational housing purchase behavior. Compared between Fig. 2 and Fig. 3, the difference is almost unchanged in Shandong after 2009, which implies that housing quality development is relatively stable and the use of the housing flow price index does not have a significant effect. However, the difference in Beijing is keeping increasing. This point out that the cost of construction or the quality of new houses sharply increased in Beijing in the past 20 years but this will also give the potential homebuyers a wrong impression that the values of all houses in Beijing are inflated. It is more necessary for rapidly developed regions to apply and spread the adjusted house price index.

Conclusion

This paper firstly summarizes the background of the adjusted house price index and analyzes the advantages and disadvantages of the repeat sale method and Hedonic method. In terms of China’s housing market system and situations, a more appropriate method of estimating China’s adjusted house price index is provided. Condition on the availability of data, the adjusted house price index in both of the national and provincial levels are calculable. Two particular provinces are selected and discussed, and evidences support the view that it is necessary to use and spread the adjusted house price index since the flow type price index is significantly biased which will cause irrational housing consumption and investment behavior and therefore lead to housing market “irrational exuberance.”
Figure 1. China’s House Price, The Calculated Adjusted House Price Index and Their Difference.

Figure 2. Beijing’s House Price, The Adjusted House Price Index and Their Difference.
Figure 3. Shandong’s House Price, The Adjusted House Price Index and Their Difference.

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