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A Measure of China's Housing Price Bubble from the Perspective of Dynamic House-price-to-income Ratio

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Abstract. The objective of this study is to improve the current model for determining the upper limit of the static price-to-income ratio by considering multiple elements that impact the growth of residents' income throughout the duration of their mortgage. The technique being offered presents a model that incorporates a dynamic house-price-to-income ratio. The underlying principle of this concept is derived from the theoretical framework of the equitable maximum correlation between property prices and income. The range of the measured dynamic ratio between house prices and income spans from 2.0755 to 4.3662. The calculation of this ratio should be based on the average interest rate of loans for commercial real estate, the ratio of mortgage repayment to income, and the average rate of growth in per capita disposable income for Chinese banks. The study employed the dynamic house-price-to-income ratio approach to calculate the dynamic house-price-to-income ratio for 31 provinces in China. This was done by considering the provinces with the lowest per capita living area and those with a moderately livable area. The findings of the comparison demonstrate that, once the essential criteria for a reasonably adequate per capita living area are met, the housing prices in all provinces, with the exception of Inner Mongolia, Shandong, and Hunan, exceed the acceptable threshold of the dynamic ratio between income and house prices.

Keywords: Real Estate in China; Housing Price Booms; Dynamic Ratio of House Price to Income.

1. Introduction

As an important part of the property owned by residents, real estate is an important issue related to people's livelihood and an important part of the gross national product. The healthy development of the real estate industry is also an important guarantee for economic development, so housing prices have become an important factor to consider in national policy formulation. Housing price policy has been ups and downs, since 2008 when the monetary easing policy, four RRR cuts and five interest rate cuts, down the mortgage down payment ratio, boosted housing prices all the way up, and then in order to curb the soaring housing prices, the introduction of the four countries stopped the easing cycle, but the rapid housing prices are still in the inertia of the rise, the subsequent introduction of the national eleven and the new four continue to tighten housing prices, and after the face of the European debt crisis and other economic downturns, in order to stimulate the economy, the regulation and control of cautious relaxation, In recent years, the central bank's repeated open market operations to release monetary liquidity, as well as the "city-specific policies" in various places, are gradually liberalizing the real estate market. In general, while restricting investment in the real estate market and reducing the overall supply of real estate, the policy adheres to the principle of "housing for living, not speculation", curbing speculative demand in the real estate market, releasing the basic demand for house purchases, and promoting the destocking and deleveraging of the real estate market. After a series of adjustments, what level is the housing price now, whether it is still at a high price level, and how to measure the reasonable price of housing prices have become a hot topic for scholars.

2. Literature Review

Many facets of measuring house price bubbles have been examined by Chinese academics. Li Haihai and Fan Fangzhi (2011) [1] This study undertakes a theoretical analysis of the composition of land rent, drawing upon Marx's theory of land rent as its conceptual framework. The analysis determines that the predominant factor contributing to the escalation of home prices is the upward trend in land

transfer fees imposed by local governments. These fees constitute a significant portion of the disparity in land rent. The utilization of the multivariate statistical method represents one of the two principal methodologies employed in the assessment of the housing price bubble. An econometric model is constructed in order to ascertain the appropriate valuation of housing prices, utilizing selected fundamental data. Du Jiaxuan and Zhang Chao conducted a study in 2019 [2]. To assess the magnitude of the housing price bubble, a selection of six pertinent indicators were employed, encompassing stratification variables and top-level determinants. These indicators encompassed the ratio of house price to income, the proportion of real estate investment in gross domestic product (GDP), and the allocation of real estate fixed investment. The index approach offers several advantages in comparison to the multivariate statistical method, including its ease of calculation and the intuitive nature of its conclusions. Nevertheless, this phenomenon is not without its limitations. These include challenges in ascertaining an optimal value, frequent dependence on subjective assessments or universally accepted standards, and a dearth of reliability. The rent-to-sale ratio of residences is often calculated based only on first-hand transactions, a practice that might result in mistakes. Furthermore, obtaining accurate statistics regarding the dwelling vacancy rate can pose difficulties, while the replacement of sales area introduces factors related to speculative purchasing considerations. The real estate market will experience positive effects if house prices align with income levels. Failure to address this issue could pose significant challenges in maintaining purchasing power due to wage disparities and rapidly increasing housing costs. Consequently, an imbalance between the supply and demand for housing would likely emerge, leading to a structural mismatch. The presence of elevated housing prices will result in the displacement of some demand due to imbalances in the supply and demand dynamics, hence leading to the emergence of unoccupied houses. Nevertheless, the exponential increase in housing prices will inevitably generate heightened anticipations for swift economic expansion and foster speculative demand, thereby displacing the fundamental demand and contributing to the occurrence of the vacancy rate discrepancy. In order to assess the extent of a house price bubble in accordance with actual market conditions, it is imperative to employ a more precise metric. In broad terms, elevated home prices tend to result in a substantial accumulation of inventory within the real estate market. Moreover, in the context of elevated housing costs, the substantial valuation of property assets would lead to a disproportionate allocation of financial resources, thereby impeding the growth of alternative sectors and exerting an adverse impact on the overall progress of the socioeconomic landscape. This study presents the novel viewpoints of Chen Jie and Hao Qianjin (2008) [4] in assessing the capacity of people to afford housing expenses in light of their fluctuating income levels. Additionally, it computes the dynamic ratio of house prices to income. The determination of the appropriate range is based on Lv Hanlin's (2010) approach, which utilizes the reasonable upper limit of the house-price-to-income ratio.

This article comprehensively assesses the dynamic ratio between house prices and income by incorporating the income growth factors of residents during the duration of the mortgage repayment period, in accordance with the house-price-to-income ratio. The prevailing body of conventional research pertaining to the house-price-to-income ratio mostly revolves around the computation of said ratio within a static framework, disregarding pertinent factors such as the potential for residents' income to rise during the course of loan repayment and the inherent stability of housing prices subsequent to purchase.

2.1. Determining the Dynamic Property Price to Income Ratio's Appropriate Value

The existing model is enhanced by including the novel perspectives of Chen Jie and Hao Qianjian, building upon Lu Hanlin's upper limit model for the house-price-to-income ratio [3]. Within this context, it can be observed that disposable income experiences an increase throughout the duration of the mortgage repayment period. However, it is important to note that the price of acquiring a home remains fixed and does not correspondingly escalate in accordance with income development.

Definitional:

$$(1-\mathrm{k})\mathrm{P}=\sum_{n=1}^{N}\frac{X}{(1+r)^{n}} \quad (1)$$

$$\mathrm{X}=\mathrm{Is} \quad (2)$$

$$(\frac{p}{I})_{A}=\frac{1}{N}\sum_{n=1}^{N}\frac{P}{I(1+g)^{n}} \quad (3)$$

In the provided equation, P represents the price of the house, k denotes the ratio of the down payment, and the present value of the house price is determined by discounting each mortgage payment based on the interest rate of the bank loan. The variable r signifies the interest rate of the bank loan, n represents the number of periods, N denotes the duration of the mortgage, X represents the amount paid towards the mortgage in each period, I represents the current income, s signifies the proportion of the mortgage in relation to the current income, g represents the growth rate of income in each period. Lastly, the dynamic house price to income ratio is calculated as the average value over the duration of the loan term. The income of individuals experiences a gradual increase over the repayment period, while the price of the house remains constant from the time of purchase. The repayment amount for each period remains fixed and is not influenced by changes in income or external factors. Therefore, when determining the present value of housing prices, the current income is the primary factor considered. As residents' income increases, the burden of mortgage repayment decreases, resulting in an increase in purchasing power. Consequently, the appropriate value for the dynamic house price to income ratio is expected to be lower than the value calculated by Lu Hanlin for the reasonable house price to income ratio in China. The down payment ratio for the initial mortgage on residential properties in China has decreased to 20%. As a result, the regularly employed down payment ratios of 20%, 25%, and 30% are utilized for computation purposes. When the proportion surpasses 50%, the mortgage reaches a threshold of difficulty in terms of sustainability. Therefore, in order to choose a suitable limit, it is necessary to consider mortgage expenditures that account for 30%, 40%, and 50% of the income. The extension of the mortgage payback time has a positive impact on income development, leading to a reduction in the burden of mortgage payments and an enhancement of residents' purchasing power. To examine this phenomenon, we have chosen three different repayment periods, namely 15 years, 20 years, and 30 years, for comparison analysis. The calculation of the growth rate of household income is based on the average per capita disposable income data from the China Statistical Yearbook for the years 2013-2018. The average bank mortgage interest rate is 5.38%. The down payment proportions considered are 30%, 40%, and 50%, with corresponding mortgage terms of 15 years, 20 years, and 30 years. The objective is to determine the upper limit of the reasonable value for the dynamic house-price-to-income ratio.

Table 1. Expenditure as part of 30% of revenue.

Payment ratio	20%	25%	30%
15	2.2919	2.4447	2.6193
20	2.2922	2.4451	2.6197
30	2.0755	2.2139	2.372

As indicated in Table 1, when faced with a relatively challenging task of covering 30% of the expenses, an increase in the down payment ratio leads to a higher reasonable value for the dynamic house price to income ratio. This implies that the tolerable burden for individuals to purchase a house increases, along with their ability to do so. However, it should be noted that an increase in the actual down payment ratio unavoidably reduces buyer demand and intensifies the current purchasing pressure for residents. This deviation arises from the omission of the down payment difficulty when calculating the present value of the house price in determining the reasonable value of the dynamic house price to income ratio. A higher down payment ratio can indicate that individuals possess greater

levels of accumulated wealth savings. Consequently, in situations when wealth savings are substantial, an increased down payment ratio can help alleviate the overall burden associated with purchasing a house. The expansion of the loan duration The house price to income ratio exhibits an initial increase followed by a subsequent decrease. Additionally, the dynamic house price to income ratio experiences a slight increase from 15 years to 20 years. This suggests that an extended mortgage term can marginally enhance residents' capacity to purchase houses within a specific timeframe. However, as the years progress, residents' ability to afford houses diminishes rather than improves, leading to a decrease in the acceptable limit value. The evidence suggests that an extended duration for loan repayment has a negative impact on the individual's capacity to acquire a residential property, while simultaneously intensifying the urgency to make a purchase.

Table 2. Expenditure as part of 40% of revenue.

Payment ratio	20%	25%	30%
15	3.0559	3.2596	3.4925
20	3.0563	3.2601	3.493
30	2.7674	2.9519	3.1627

Table 3. Expenditure as part of 50% of revenue.

Payment ratio	20%	25%	30%
15	3.8199	4.0745	4.3655
20	3.8204	4.0751	4.3662
30	3.4592	3.6898	3.9533

Regarding the distribution of expenditures, as the proportion of income allocated towards loan repayment increases, residents' capacity to purchase houses is on the rise. Consequently, residents will allocate a larger portion of their income towards housing purchases, thereby enhancing their ability to afford housing prices. However, this comes at the expense of reduced consumption of other consumer goods. It is noteworthy that affording a 30% proportion of income towards housing payments is relatively challenging, while a 50% proportion is deemed highly difficult for residents. In brief, the range of home price acceptable among locals is 2.0755-4.3662.

3. Determining the Dynamic Property Price to Income Ratio's Appropriate Value

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Definitional:

$$(1-\mathrm{k})\mathrm{P}=\sum_{n=1}^{N}\frac{X}{(1+r)^{n}} \tag{4}$$

$$\mathrm{X}=\mathrm{Is} \tag{5}$$

$$(\frac{p}{I})_{A}=\frac{1}{N}\sum_{n=1}^{N}\frac{P}{I(1+g)^{n}} \tag{6}$$

In the provided equation, P represents the price of the house, k denotes the ratio of the down payment, and the present value of the house price is determined by discounting each mortgage payment based on the interest rate of the bank loan. The variable r signifies the interest rate of the bank loan, n represents the number of periods, N denotes the duration of the mortgage, X represents the amount paid towards the mortgage in each period, I represents the current income, s signifies the proportion of the mortgage in relation to the current income, g represents the growth rate of income in each period. Lastly, the dynamic house price to income ratio is calculated as the average value over the duration of the loan term. The income of individuals experiences a gradual increase over the repayment period, while the price of the house remains constant from the time of purchase. The repayment amount for each period remains fixed and is not influenced by changes in income or external factors. Therefore, when determining the present value of housing prices, the current income is the primary factor considered. As residents' income increases, the burden of mortgage repayment decreases, resulting in an increase in purchasing power. Consequently, the appropriate value for the dynamic house price to income ratio is expected to be lower than the value calculated by Lu Hanlin for the reasonable house price to income ratio in China. The down payment ratio for the initial mortgage on residential properties in China has decreased to 20%. As a result, the regularly employed down payment ratios of 20%, 25%, and 30% are utilized for computation purposes. When the proportion surpasses 50%, the mortgage reaches a threshold of difficulty in terms of sustainability. Therefore, in order to choose a suitable limit, it is necessary to consider mortgage expenditures that account for 30%, 40%, and 50% of the income. The extension of the mortgage payback time has a positive impact on income development, leading to a reduction in the burden of mortgage payments and an enhancement of residents' purchasing power. To examine this phenomenon, we have chosen three different repayment periods, namely 15 years, 20 years, and 30 years, for comparison analysis. The calculation of the growth rate of household income is based on the average per capita disposable income data from the China Statistical Yearbook for the years 2013-2018. The average bank mortgage interest rate is 5.38%. The down payment proportions considered are 30%, 40%, and 50%, with corresponding mortgage terms of 15 years, 20 years, and 30 years. The objective is to determine the upper limit of the reasonable value for the dynamic house-price-to-income ratio.

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payments is relatively challenging, while a 50% proportion is deemed highly difficult for residents. In brief, the range of home price acceptable among locals is 2.0755-4.3662.

4. Empirical Analysis

The study focused on the data from 31 cities in 2018. The housing price-to-income ratio was analyzed in relation to the average disposable income of people, in order to assess the level of affordability of urban housing prices.

Dynamic house-price-to-income ratio:

$$\text{ratio} = \frac{1}{N} \times \sum_{n=0}^{N} \frac{P}{I \times (1+g)^n} \tag{7}$$

The determination of house prices is influenced by various factors, one of which is the average real estate price multiplied by the per capita living area. Existing domestic studies primarily focus on calculating the house price to income ratio for residential areas measuring 70 and 90 square meters. However, these studies overlook the influence of residents' future income expectations and the traditional notion of home purchasing. Additionally, other factors, such as residents' preferences and the supply of real estate developers, also impact the choice of living area. Consequently, calculating the house price to income ratio solely based on the per capita living area of 70 or 90 square meters may result in an overestimation of the ratio, as it fails to account for these aforementioned factors. Accurately quantifying home price bubbles poses a challenging task. Certain scholars have additionally chosen to consider the annual per capita living space, which is evidently influenced by the aforementioned parameters, leading to an augmentation in the computation outcomes. This study use the minimum living area and the generally adequate living area as the primary metrics for assessing the extent of housing price inflation, while ensuring that normal demand is met. Regarding the per capita housing area standard, the minimum requirement of the American Urban Public Health Association for housing area is 24.66-37.20 square meters, but in view of the fact that the economic development level of the United States is not consistent with the situation in China, the reference significance is not great, so this paper refers to Wang Zhu (2016) [5] for the study of urban affordable housing living area, from the perspective of design standards, 15 square meters of per capita living area is the minimum living area, and Li Jing (2007) [6] for the study of the habitable area of urban families in China, China's resident families are mainly nuclear families composed of 3 people, and the corresponding living area is mainly 60-90 square meters and 90-110 square meters, which shows that 20 square meters to 33.3 square meters per capita is more in line with the relatively suitable per capita living area, so 15 square meters are selected as the minimum living area and 30 square meters are relatively suitable area, and the actual value of dynamic house price to income ratio in 31 provinces in China is measured based on the two housing areas. If the ratio between house prices and income remains within a reasonable range for a minimum living area, this implies that residents have the option to alleviate the pressure of purchasing a house by reducing the living area. Consequently, real estate developers can respond to market demand by increasing the availability of smaller properties.

The data presented in Table 4 have been sourced from the China Statistical Yearbook. The calculated value obtained above is 2.0755-4.3662. When considering a security level of 15 square meters of per capita living area, it is observed that Beijing exceeds the limit value, while Hainan, Tianjin, and Shanghai are close to the upper limit of the reasonable value. On the other hand, the remaining provinces fall within the upper limit of the reasonable value. However, when considering a comparatively appropriate area of 30 square meters, it is observed that, with the exception of Inner Mongolia, Shandong, Hunan, and a few other provinces, the limit values in the remaining provinces exceed significantly.

The present analysis involves a horizontal comparison of the fluctuation in housing price ratios across various mortgage terms. As the mortgage term lengthens, the burden associated with purchasing a house gradually diminishes. However, upon evaluating the reasonable value, it is deduced that the

capacity of residents to acquire a house does not improve with an elongated term. In fact, there may even be a decrease in purchasing ability. This suggests that, despite income growth, a prolonged payment period amplifies the pressure on residents to buy a house. Consequently, extending the mortgage term merely mitigates the burden of house acquisition, but fails to address the underlying issue.

5. Conclusion and Policy Recommendations

The aforementioned findings indicate that China's prevailing housing prices can be sustained when there is a fundamental demand for residential properties. However, under certain favorable conditions, these housing prices become challenging to accept. It is worth noting that the current real estate supply in China comprises housing units ranging from 60 to 110 square meters. In light of this, it may be more effective to encourage the availability of smaller housing units in the market as a potential solution. Merely reducing the down payment would only lower the threshold for purchasing, while extending the mortgage term would not enhance the purchasing power of residents. Even when considering income growth, reducing the down payment alone would not improve the purchasing power of residents. The subsequent recommendations provided lack empirical evidence to support their validity.

1.adhere to a sound monetary policy. The implementation of measures to limit the expansion of real estate investment and stimulate the growth of the real economy in various sectors by means of targeted reserve requirement ratio (RRR) reductions can have a positive effect on the increase of per capita disposable income. This, in turn, can directly influence the purchasing power of residents, leading to a reduction in the dynamic ratio of house prices to income. Consequently, such actions can alleviate the burden associated with purchasing houses and foster the stability and sustainable growth of the real estate market.

2. Facilitate the development of modest-sized real estate projects and encourage the provision of such properties. In the context of prevailing housing prices, the provision of small-sized real estate options can effectively lower the barriers to home ownership and alleviate the burden of loan repayment. This approach can contribute to reducing housing inventory, addressing the fundamental housing requirements of residents, and promoting the long-term viability of the real estate sector.

3. Limitations on the purchasing requirements of the secondary residence. The adherence to the principle of prioritizing housing for residential purposes rather than speculation aims to deflate the real estate speculation bubble and address the fundamental housing needs of residents. This approach seeks to effectively resolve livelihood issues and gradually deflate the housing price bubble.

It is imperative to conform to the policies that are specific to the city. The house-price-to-income ratio varies among the 31 provinces, with the majority of them being at a high level. In areas with relatively good living conditions, this ratio has significantly beyond the purchasing power of people.

One potential avenue for enhancement involves the optimization of public infrastructure building. Differential ground rent plays a significant role in the housing price bubble, as it represents the disparity between the cost price and the actual price of housing. This disparity primarily serves as compensation for the utilization of public resources by the real estate sector. By enhancing public infrastructure development and expanding access to public resources, it is possible to redirect housing demand and optimize the utilization of real estate across various geographical locations.

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