The Estimation of Per Capita Housing Area and Analysis of its Spatial and Temporal Characteristics in urban China

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Abstract: We apply Capital Depreciation Model to the estimation of per capita housing area in 31 provinces in China from 2005 to 2016, and we also analyzed its temporal and spatial distribution characteristics using Gini coefficient and Moran's I index. Here are our main finds: in 2016, Per Capita Housing Area of China urban residents ranges about 27 to 31 square meter. In the past ten years, the per capita housing consumption among 31 provinces in China is relatively balanced. The excessive prosperity of the housing market will affect the fairness of housing resource allocation. The spatial correlation of per capita housing area in China's provinces is increasing, and the housing market in neighboring provinces is more closely linked. Our research suggests that as the housing condition in China has changed so much in the past years, the housing policy in future should focus on the improvement of housing affordability and the management of sustainable management in the Chinese housing market.

1. Introduction

Since China's housing distribution monetization in 1998 and the marketization of the real estate industry, China's housing market has achieved great success, but its negative effects are also The spillovers into all aspects of China's social and economic development are mainly manifested in: the dislocation and imbalance of housing supply, the housing resources in metropolitan areas are tight and the housing supply in some areas is excessive; the distribution of housing resources within cities is unproper. The problem of housing affordability caused by excessive housing price increase, the excessive appreciation of housing assets has brought about a worsening income gap (Liu Jiayi, 2013), the imbalance in housing rental market and purchase market (Ye Jianping, 2015).

In order to promote the stable and healthy development of the real estate market, China's central and local governments have implemented a series of regulatory policies covering housing prices and transaction control, finance, land, taxation, etc. However, in the observation of a long period of time, China's housing problem has not been effectively resolved. Under this circumstance, the report of the 19th National Congress of the Communist Party of China pointed out that it is necessary to strengthen the construction of the social security system: insisting that the house is used for living, not for the positioning of speculation; and clearly stated that it is necessary to speed up the establishment of multi-subject supply and multi-channel guarantee. The housing system of renting and renting together allows all people to live and live.

Therefore, estimating the housing consumption in China and analyzing its spatial and temporal changes, it is very important to analyze the growth space of China's housing market development. This paper is organized as follow, the first part is introduction, then it is Literature review, Method

& Date, then we give out our result, in the end it is conclusion.

2. Literature review

The living condition for residents has always been a important question for researchers and policy makers to answer. Back to 1990s, the US Bureau of Economic Analysis (BEA) uses the Fixed Renewable Tangible Wealth Estimation method to analyze the national investment income data, national housing and non-residential building stock and flow data. The Fed's Comprehensive Economic Analysis Bureau conducts an asset valuation of this estimate and obtains a US real estate value against the balance sheet (Miles, 1990).

When it comes to the supply and consumption of urban housing in China .Li Wei (2014) calculated the time-series comparable data of urban per capita housing area in China using the data of the Ministry of Housing and Urban-Rural Development, and it presents the supply and demand relationship of China's residential market according to the Gompertz model. He found since 2001, the per capita housing area of urban areas has not increased and declined, so for a long period of time, China's real estate market will be in short supply. In terms of housing supply flexibility, Ye Jianping (2014) estimated the long-term supply price elasticity of new housing in 35 large and medium-sized cities in China.

At the same time, Zhang Yanqun (2015) pointed out that the survey data of the National Bureau of Statistics is biased. It is estimated that the per capita housing area in China is around 20 square meters in 2012, and the development space is huge. In a more recent study, Chen Yingnan (2018) estimates the residential capital stock of 285 prefecture or higher-level cities in China in the period of 1997 to 2016. Xu Xiaofan (2018) estimated the spatial and temporal cooperation of rural population and housing area in China from 2006to 2015. However, as far as we know, there is limited research on how living condition of resident in urban China has changed in long period in the perspective of spatial and time series analysis, this research will do contribution on this topic.

3. Method and Data

3.1 Perpetual Inventory Method

In this paper, we use Perpetual Inventory Method postponed by Goldsmith (1951) to estimate of per capita housing area in 31 provinces in China from 2005 to 2016. This model has been widely used to analyze to stock of certain kind of capital. This model is organized as Eq.1

$$R_t = \frac{S_t}{Pop_t}$$

Where

$$S_t = + S_{t-1}(1-\delta)$$

Where R_t represents the Per Capita Housing Area in one period, S_t represent the total stock of housing asset. D_t is the newly built housing in period t, an d S_{t-1} is the housing stock in last year of this area. δ is the Depreciation Rate.

Considering the speed of urban development and renewal in China in recent years, the value of δ is 5% and 3%; the per capita housing area is the sum of the housing construction area of the year plus the depreciation of the previous year's housing stock divided by the total number of urban population. As the pre-construction stock is not available, the relevant literature is set here to set the per capita housing construction area of 15 square meters in 1996 as the basis for estimating the building stock. From 1996 to 2004, we just analyzed the housing capital stock for the lack of urban population data. After 2005 analyses, the housing stock in each province of China is calculated.

3.2 Gini Coefficient

In the early 20th century, the Italian economist Gini proposed in 1922 the quantitative measure of the difference in income distribution. It is based on the Lorenz curve to find an indicator of the degree of equality of distribution. Reference form of the Gini coefficient, the formula for calculating the Gini coefficient of housing consumption is defined as follow:

$$G_t = \sum_{i=1}^{n} X_i Y_i + 2\sum_{i=1}^{n} X_i(1 - V_i) - 1$$

Among them, X_i represents the proportion of the population of each group, $Y_i$represents the proportion of Per Capita Housing Area of each group, V_i represents the cumulative proportion of Per Capita Housing Area of each group, i = 1, 2, 3, ..., n, n represents the number of groups of groups.

3.3 Moran's I Index

Here we use spatial correlation test to analyze the spatial distribution of China's per capita housing area. The theoretical basis of the spatial correlation test is the first law of the geography, which states that "all things are related, and things that are closer are more related" (Tobler, 1970). The Moran's I index is used here to measure the spatial correlation of real estate prices.

The spatial weight matrix is used to quantitatively express the spatial adjacency of geographical things. Usually, a binary symmetric spatial weight matrix is defined to express the spatial proximity of n locations.

$$w = \begin{bmatrix} w_{11} & \cdots & w_{1n} \\ \vdots & \ddots & \vdots \\ w_{n1} & \cdots & w_{nn} \end{bmatrix}$$

We define spatial neighboring weights based on region adjacency are established: if two spatial units have a common boundary of non-zero length, the two are considered to be adjacent, and are assigned a value of 1, otherwise 0.

The global spatial autocorrelation indicator is used to describe the average degree of association, spatial distribution pattern and significance of all spatial objects in the entire study area. The Moran's I index is used here; its expression is:

$$Moran'I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \overline{x})(x_j - \overline{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\sum_{i=1}^{n}(x_i - \overline{x})\ \text{^}2}$$

Where n is the total number of regions in the study area, w_{ij} is the spatial weight; x_i and x_j is the attributes representing the region i and the region j respectively. The value of Moran 'I is generally between -1 and 1. Less than 0 means negative correlation, 0 means irrelevant, and greater than 0 means positive correlation. The data used in this paper are the resident population (10 million square meters) of residential housing between 1997 and 2016 in 31 provinces of China and the resident population data between 2005 and 2016. The data is from the National Bureau of Statistics website.

4. Result

Using Eq.1, we estimate the Per Capita Housing Area in urban China, and we give out the result with two different Depreciation Rate. In Form1 , we give out how China urban per capita housing area changes from 2005 to 2016.From the above analysis results, it can be seen that from the estimation of housing construction stocks, China's per capita housing area is between 27 and 31, which is far lower than the data released by the National Bureau of Statistics in 2016 that the urban residential housing area reached 40.8. This aspect is the result of the data sampling survey of the Bureau of Statistics, so it may also have some deviations.

However, this shows that the per capita housing area in China is far lower than the level of housing consumption in the developed countries at the same time. The per capita housing area in Japan in 2013 was 39.6 square meters. The United States is 62.3 square meters (2011), the United Kingdom, France and Germany are 39.3 (2010), 43 (2011) and 44 square meters (2006) respectively; therefore, China's housing consumption development space is huge, coupled with the progress of China's urbanization process Whether China's housing market enters the stock market remains to be discussed. Fig.1 & Fig.2 which shows the estimated per capita housing area of provinces in some years in China. Detailed information shows in Appendix.

Table1 China urban per capita housing area changes from 2005 to 2016

	2005	2006	2007	2008	2009	2010
δ = 5%	19.08	19.76	20.37	21.03	21.86	22.57
δ =3%	20.94	21.87	22.73	23.64	24.72	25.64
	2011	2012	2013	2014	2015	2016
δ = 5%	23.41	24.28	25.13	25.84	26.36	26.58
δ =3%	26.73	27.84	28.98	29.96	30.75	31.23

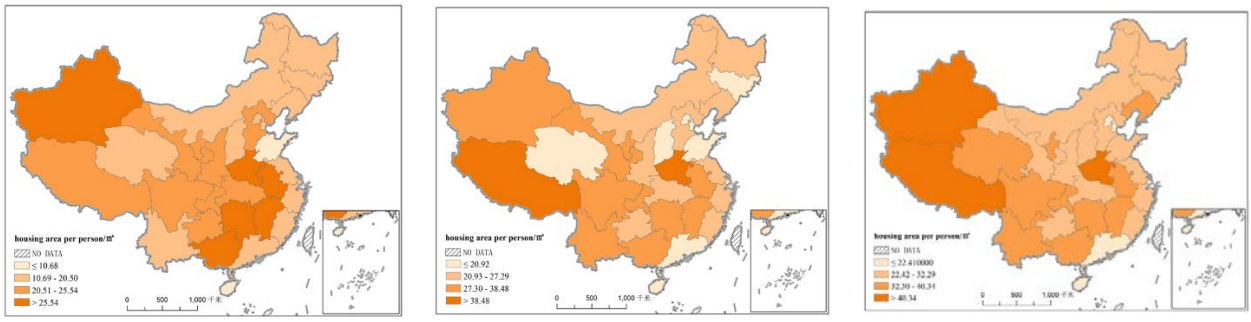

Fig1 a δ =3% in 2005 Fig1 b δ =3% in 2010 Fig1 c δ =3% in 2016

Fig.1 China urban per capita housing area changes from 2005 to 2016 δ =3%

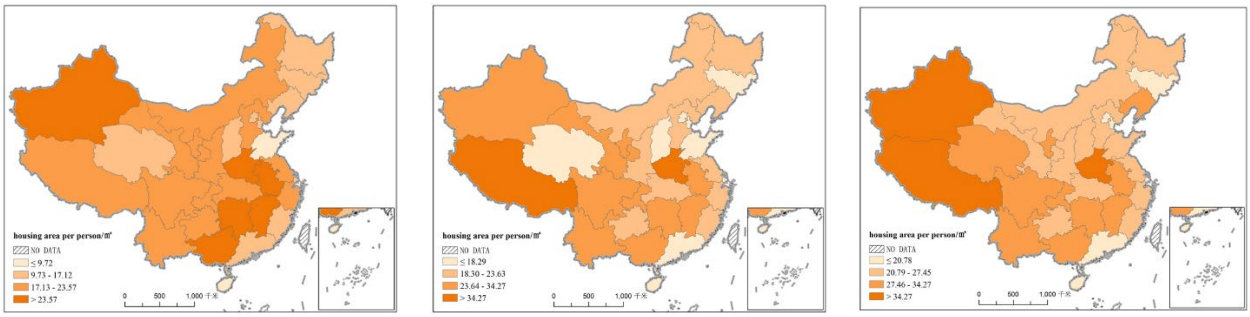

Fig 2 a δ =5% in 2005 Fig 2 b δ =5% in 2010 Fig 2 c δ =5% in 2016

Fig.2 China urban per capita housing area changes from 2005 to 2016 δ =5%

4.1. The quantitative characteristics of per capita housing area in China

According to the method mentioned above, the housing area data calculated by 5% depreciation is analyzed; the cumulative proportion of the population in 2016 is plotted on the abscissa, and the proportion of housing construction area in 2016 is plotted on the ordinate. China's per capita housing area Lorenz curve.

The red line is the distribution of housing resources in the ideal state among the provinces, and the blue line is the allocation of housing resources in the actual 31 provinces. The Lorenz coefficient of the per capita housing area between the provinces in China is the Lorenz coefficient of the area between the red line and the blue line. In this way, the Lorentz coefficients of each year in China are calculated and plotted.

Table 2 Gini coefficient of housing consumption in urban China

2005	0. 164475	2011	0. 158336
2006	0. 159799	2012	0. 156061
2007	0. 152318	2013	0. 154303
2008	0. 148184	2014	0. 150495
2009	0. 146407	2015	0. 147291
2010	0. 161431	2016	0. 172054

It can be seen that the Gini coefficient of per capita housing area between China's provinces from 2005 to 2009 and 2010 to 2015 showed a steady downward trend, but in 2010 and 2016, there was a sharp increase, offsetting the previous period. This may be due to the government's introduction of a large number of economic stimulus policies in the 2008 financial crisis, which promoted the prosperity of the real estate market, and to some extent, increased the imbalance of housing area between the provinces; in 2016, the government promoted The real estate destocking policy has

been carried out in the shantytowns under the support of a number of policy banks such as the National Development Bank, which has greatly promoted the rapid development of the real estate market.

From this, it can be concluded that during the period of steady development of the real estate market, the consumption of housing area between the provinces tends to be balanced; while during the period of excessive prosperity of the housing market, the uneven distribution of housing resources among the provinces will be aggravated; therefore, the central government is moderate. Regulating the housing market to make it develop steadily is conducive to the distribution of housing resources across the country and to social equity.

4.2. Spatial characteristics of per capita housing area consumption

We calculated the Moran index of per capita housing area in each province. The results and significance are as follows.

It can be seen that from 2005 to 2015, the spatial correlation of per capita housing area between provinces in China is increasing. the spatial correlation index rises from 0.149 to 0.368. This shows that the per capita housing area between the provinces in China is increasing in spatial correlation. This aspect reflects the concentration of provinces in the provinces where the development of the housing market is similar, indicating that China's housing market is constantly moving towards the city; The spatial relevance of China's housing market has increased, and the consumption of housing in the neighboring provinces has been closely linked and integrated in space.

In 2016, this trend fluctuated, and with reference to the violent fluctuations in the distribution of per capita housing area in the year, this may indicate that China's housing consumption market has undergone a qualitative change in 2016, and its long-term trend needs further observation.

At the same time, it can be seen that the Gini coefficient of housing consumption of the national residents has not increased significantly in the context of the increasing spatial correlation. This indicates that the population movement and the allocation of housing resources are relatively coordinated, which indicates that The effectiveness of housing supply in China; therefore, the focus of China's housing policy in the later period is to achieve a reasonable allocation of housing resources in space, and to ensure the affordability of housing to better achieve the housing of all people on the basis of ensuring the amount of housing consumption.

Table 3 Moran 'I values of housing consumption in urban China

	Moran ’I	P value		Moran ’I	P value
2005	0.169434	0.052275	2011	0.242044	0.039
2006	0.149347	0.11375	2012	0.280297	0.0716
2007	0.17915	0.09625	2013	0.314736	0.012875
2008	0.182945	0.08025	2014	0.353284	0.009
2009	0.212115	0.0525	2015	0.376744	0.007
2010	0.218934	0.0505	2016	0.36832	0.0065

5. Conclusion

This paper estimates the per capita housing area of 31 provinces and cities in China between 2005 and 2016 by using the capital depreciation model and analyzes the spatial and temporal

distribution characteristics using the Gini coefficient and Moran's I index. The main conclusions are as follows:

(1) China's per capita housing area in 2016 is between 27 and 31, which makes a great success in the improvement of housing condition;

(2) China's per capita housing area consumption is more evenly distributed among the provinces, showing a downward trend in a long period of time, but the excessive prosperity of the housing market in 2009 and 2016 has increased the uneven distribution of housing resources;

(3) The spatial correlation of per capita housing area in China's provinces between 2005 and 2016 is increasing, indicating that the housing markets in China's provinces are mutually integrated and the housing market is more mature.

Our research shows that China's housing resource allocation policy has guaranteed the long-term development of the housing market under the relative balance of per capita housing area to a certain extent. Therefore, the focus of China's late housing policy should be to ensure the affordability of housing, while paying attention to the housing market. Sustainable development to save investment and other social resources

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References

[1] Chen Yingnan, Ji Xiaomeng. The Estimation of Residential Capital Stock and the Return on Capital Ratio in Chinese Cities [J]. Statistical study, 2018,35 (10): 3-14.

[2] Di Pasquel. Urban Economics and Real Estate Market [M]. Economic Science Press, 2002. (in Chinese)

[3] Goldsmith R W. A Perpetual Inventory of National Wealth[J]. NBER Studies in Income and Wealth，1951(14) : 5 - 73.

[4] Hao Jinjin, Chen Jie. Housing Age, Depreciation Rate and Housing Price: An Empirical Study Based on Shanghai Data [J]. World Economic Literature, 2012 (06): 64-77. (in Chinese)

[5] Li Xin, Xu Yunqing. Trends of supply and demand and evolution of real estate: clarifying a statistical caliber [J]. Reform, 2014 (01): 33-42. (in Chinese)

[6] Shen Tiyan, Feng et al., Sun Tieshan. Spatial Econometrics [M]. Peking University Press, 2010.(in Chinese)

[7] Xiong Yanren. Foreign Housing Development Report (2017. General Volume 4) [J]. Urban Housing, 2017 (2). (in Chinese)

[8] Xu Xiaofan, Xin Liangjie. Spatial and temporal cooperation of rural population and housing area in China from 2006 to 2015 [J]. Journal of China Agricultural University, 2018, 23 (09): 171-185.

[9] Yang, S.; Guo, F. Breaking the barriers: How urban housing ownership has changed migrants' settlement intentions in China. Urban Studie. 2018, 1–19

[10] Ye Jianping, Li Jia. Perfecting the rental market: the inevitable choice for optimizing the structure of the housing market [J]. Guizhou Social Science, 2015 (03): 116-122. (in Chinese)

[11] Ye Jianping, Sun Bo, Yang Qiaomu. Estimation of long-term price elasticity of new housing supply in China: An empirical study based on 35 large and medium-sized cities [J]. China Real Estate, 2014 (20): 3-11. (in Chinese)

[12] Zhai Tengteng, Guo Jie, Ou Minghao, Kong Wei. Study on total allocation of construction land in Jiangsu Province based on Gini coefficient [J]. Population, Resources and Environment of China, 2015, 25 (04): 84-91. (in Chinese)

[13] Zhang Yanqun's estimation of per capita housing area and relative price bubble in.24 large and medium cities [J]. western forum, 2015,25 (01): 60-65. (in Chinese)

Appendix

Estimated Housing Area Per Capita in 31 Provinces in China in 2016

δ = 3%				δ = 5%			
Beijing	20.62	Hubei	30.89	Beijing	16.94	Hubei	25.84
Tianjin	22.41	Hunan	36.78	Tianjin	19.07	Hunan	31.04
Hebei	28.75	Guangdong	18.43	Hebei	24.49	Guangdong	15.41
Shanxi	28.71	Guangxi	40.35	Shanxi	24.78	Guangxi	34.28
Neimenggu	28.92	Hainan	20.86	Neimenggu	24.27	Hainan	18.73
Liaoning	34.52	Chongqing	37.36	Liaoning	29.32	Chongqing	31.96
Jilin	25.24	Sichuan	36.6	Jilin	20.78	Sichuan	31.22
Heilongjiang	28.85	Guizhou	31.72	Heilongjiang	23.77	Guizhou	27.35
Shanghai	17.41	Yunnan	37.37	Shanghai	13.97	Yunnan	32.74
Jiangsu	28.03	Tibet	47.21	Jiangsu	23.68	Tibet	40.49
Zhejiang	32.29	Shaanxi	31.87	Zhejiang	27.45	Shaanxi	27.09
Anhui	36.42	Gansu	32.03	Anhui	30.92	Gansu	27.12
Fujian	25.81	Qinghai	37.88	Fujian	21.81	Qinghai	33.57
Jiangxi	36.5	Ningxia	37.5	Jiangxi	31.08	Ningxia	32.36
Shandong	28.67	Xinjiang	52.57	Shandong	25.34	Xinjiang	45.87
Henan	48.26			Henan	41.29		