

# Housing Price Problems in 23 Provinces and Municipalities in China based on Cluster Analysis

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## Abstract

The real estate industry has gradually become the pillar industry of China's economy. The research on real estate price reflects the development and changes of real estate industry and real estate policies. Therefore, it is of great practical significance to analyze the research trend of real estate price. In this paper, 23 provinces and municipalities in China are selected. Considering the rationality of the indicators and the possibility of data acquisition, certain representative indicators are selected. SPSS statistical software is used to perform cluster analysis on them.

## Keywords

Real Estate; House Price; Clustering Analysis.

## 1. Introduction

In recent years, China's real estate market has been in an unprecedented upsurge, and there is still a trend of continued development. At the end of 2015, the unsold area of commercial housing was 718.35 million square meters. In February 2016, the unsold area of commercial housing increased to 739.31 million square meters, reaching the highest point in history. In many first - and second-tier cities, housing prices remain high, and residents' housing price to income ratio has always been above 10. In 2013, the average housing price to income ratio of 35 large and medium-sized cities in China was 10.2, among which Beijing, Shanghai, Shenzhen and Fuzhou were far ahead, and Beijing ranked first with 19.1. By April 2016, the situation has improved, but first-tier cities are still 13.5, 9.7 and 9.3, respectively, in Shenzhen, Beijing and Shanghai. The growth rate of residents' disposable income still cannot compare with the pressure brought by rising housing prices. The high housing price can not guarantee the basic housing demand of residents, and inhibits the rigid demand and improvement demand of ordinary residents. Moreover, excessive housing pressure will reduce residents' demand for other consumer goods, compress the market space of other industries, and hinder the coordinated development of the industrial system of the national economy. Geographically, most of these cities are developed cities along the southeast coast, so high housing prices will accelerate the gap between urban and rural areas and make it difficult for migrant workers to transform into urban citizens. Throughout China's economic and industrial structure, the main industry is the real estate industry. In 2016, China's GDP growth rate was 6.7%, of which the real estate accounted for 6.5% of the total GDP, enough to see that the real estate industry plays a pivotal role in China's economy. This paper selects 2018 national 23 provinces and municipalities directly under the central government of the relevant data, mainly adopts the method of data analysis, respectively from the level of housing prices, housing price to income ratio, GDP, per capita GDP, average wage level, per capita disposable income, per capita consumption level and price index of eight dimensions of 23 provinces and municipalities directly under the central government of the country's housing problems in clustering analysis.

## 2. Data collection and processing

### 2.1. Data index selection

#### 2.1.1. House prices level

This paper mainly conducts cluster analysis on the housing price of 23 provinces and municipalities in China, finds out the similarities and differences between different types of housing prices, and predicts the trend of housing prices. Therefore, the housing price level is taken as an important indicator.

#### 2.1.2. Price-to-income ratio

Housing price to income ratio is the ratio between housing price level and per capita disposable income, calculated by the formula: housing price to income ratio = housing price level/per capita disposable income. For house buyers, after knowing the accurate ratio between their income and housing price, it is beneficial for people to decide a reasonable way of real estate consumption. Therefore, this paper chooses the ratio of housing price to income as the index variable

#### 2.1.3. GDP

GDP refers to the final output of productive activities of all resident units in a given period of time. For a region, it is called gross regional product or regional GDP. It is the measurement of the total amount of final products produced by all resident units of a country (region) economy in the accounting period, and is often regarded as an important indicator to show the economic situation of a country (region). Since the beginning of the 21st century, China's real estate industry has seen a new round of prosperity, and the house price continues to rise, which is driven by the good situation of national economic development to a large extent. As the macro economy enters the "new normal", China's construction industry, except for infrastructure, will face downward risks. However, the proportion of added value of the construction industry in GDP exceeded 7% for the first time since the reform and opening-up, indicating that the pillar position of the construction industry has been steadily consolidated, especially in the downturn of the real estate market in 2014, the construction industry still maintained rapid growth. China's GDP growth rate is around 8% per year, and the housing price growth rate is also around 5%. The decade of rising housing prices is actually a decade of rapid urbanization in China. GDP is an important factor in housing prices, rising from 48% in 2008 to 58% in 2018.

#### 2.1.4. GDP per capita

Per capita GDP is a relative index considering the population factor, which is a factor to measure the national economic index. People often use per capita GDP to mark the wealth of a region. Similar to GDP, a higher per capita GDP reflects that a region has a higher level of economic development and economic strength, and is often an area with a relatively concentrated population and a large housing demand. House prices are highly correlated with GDP. The most direct is that the output of real estate industry is a part of GDP, and the housing price affects the output of real estate. Second, the level of housing price determines the structural purchasing power of residents, that is, the ability to buy housing. Whether commercial housing can be sold also affects GDP. Therefore, per capita GDP is also an important factor affecting housing prices.

#### 2.1.5. Average wage level

Average wage refers to the average amount of wages earned by each employee in a certain period. It shows certain period wage income of discretion degree, it is the main index that reflects employment personnel wage level. The calculation formula is: average wage = total wage of employed personnel/average number of employed personnel. Average wages, which reflect a region's rate of return on Labour, can reflect the degree of divergence between house prices and incomes. Therefore, the average salary level can be used as one of the indicators.

### 2.1.6. Per capita disposable income

Household disposable income refers to the sum of final consumption expenditure and savings available to residents, that is, the disposable income available to residents. It includes both cash income and in-kind income. Per capita disposable income can reflect the purchasing power of a region, and also reflects the affordability of a region to buy houses. When the per capita disposable income of a city is high, people in that city are more likely to buy a house, so the per capita disposable income is also taken as one of the indicators in this paper.

### 2.1.7. Per capita consumption level

Household consumption expenditure refers to the total expenditure of residents to meet the needs of household consumption in daily life, including cash consumption expenditure, also including physical consumption expenditure. Per capita consumption level can reflect the cost of living in a region, people must meet the basic living expenses before they can consider buying a house. Therefore, per capita consumption level is also taken as one of the indicators in this paper.

### 2.1.8. Price consumption index

The price consumption index is a relative number that reflects the trend and degree of price changes of consumer goods and service items purchased by urban and rural residents in a certain period. It is the result of a comprehensive summary calculation of urban consumer price index and rural consumer price index. The index can be used to observe and analyze the impact of retail prices of consumer goods and price changes of service items on the actual living expenses of urban and rural residents.

## 2.2. Data collection and processing

The data collected in this paper come from the data published on the website of the Bureau of Statistics, and the housing price level adopts the average price per square meter of each city. The data is shown in Table 1.

Table 1. Relevant data of 23 provinces and municipalities in 2018

| Region                | GDP      | GDP Per capita<br>(Yuan/person) | Average<br>wage level<br>(YUAN) | Per capita<br>disposable<br>income (yuan) | Per capita<br>consumption<br>Level (yuan) | Consumer price<br>index | Price-to-<br>income ratio |
|-----------------------|----------|---------------------------------|---------------------------------|-------------------------------------------|-------------------------------------------|-------------------------|---------------------------|
| Beijing               | 30319.98 | 140211                          | 145766                          | 62361.22                                  | 39842.69                                  | 102.5                   | 0.547501957               |
| Tianjin               | 18809.64 | 120711                          | 100731                          | 39506.15                                  | 29902.91                                  | 102                     | 0.40638331                |
| Hebei province        | 36010.27 | 47772                           | 68717                           | 23445.65                                  | 16722                                     | 102.4                   | 0.327686373               |
| Shanxi province       | 16818.11 | 45328                           | 65917                           | 21990.14                                  | 14810.12                                  | 101.8                   | 0.310231313               |
| Liaoning province     | 25315.35 | 58008                           | 67324                           | 29701.45                                  | 21398.31                                  | 102.5                   | 0.253914876               |
| Jilin province        | 15074.62 | 55611                           | 68533                           | 22798.37                                  | 17200.41                                  | 102.1                   | 0.30710485                |
| Heilongjiang province | 16361.62 | 43274                           | 60780                           | 22725.85                                  | 16993.96                                  | 102                     | 0.303657729               |
| Shanghai              | 32679.87 | 134982                          | 140400                          | 64182.65                                  | 43351.3                                   | 101.6                   | 0.418961822               |
| Jiangsu province      | 92595.4  | 115168                          | 84688                           | 38095.79                                  | 25007.44                                  | 102.3                   | 0.282801328               |
| Zhejiang province     | 56197.15 | 98643                           | 88883                           | 45839.84                                  | 29470.68                                  | 102.3                   | 0.315075271               |
| Anhui province        | 30006.82 | 47712                           | 74378                           | 23983.58                                  | 17044.64                                  | 102                     | 0.293945274               |
| Fujian province       | 35804.04 | 91197                           | 74316                           | 32643.93                                  | 22996.04                                  | 101.5                   | 0.32438435                |
| Jiangxi province      | 21984.78 | 47434                           | 68573                           | 24079.68                                  | 15792.02                                  | 102.1                   | 0.282623772               |
| Shandong province     | 76469.67 | 76267                           | 73593                           | 29204.61                                  | 18779.77                                  | 102.5                   | 0.256163667               |
| Henan province        | 48055.86 | 50152                           | 63174                           | 21963.54                                  | 15168.5                                   | 102.3                   | 0.262147632               |
| Hubei province        | 39366.55 | 66616                           | 73777                           | 25814.54                                  | 19537.79                                  | 101.9                   | 0.329088568               |
| Hunan province        | 36425.78 | 52949                           | 70221                           | 25240.75                                  | 18807.94                                  | 102                     | 0.229584699               |
| Guangdong province    | 97277.77 | 86412                           | 88636                           | 35809.9                                   | 26053.98                                  | 102.2                   | 0.36507167                |
| Hainan province       | 4832.05  | 51955                           | 75885                           | 24579.04                                  | 17528.44                                  | 102.5                   | 0.591789997               |
| Chongqing             | 20363.19 | 65933                           | 78928                           | 26385.84                                  | 19248.47                                  | 102                     | 0.30572686                |
| Sichuan province      | 40678.13 | 48883                           | 77686                           | 22460.55                                  | 17663.55                                  | 101.7                   | 0.311104581               |
| Guizhou province      | 14806.45 | 41244                           | 78316                           | 18430.18                                  | 13798.06                                  | 101.8                   | 0.305844544               |
| Yunnan province       | 17881.12 | 37136                           | 75701                           | 20084.19                                  | 14249.93                                  | 101.6                   | 0.374298889               |
| Shaanxi province      | 24438.32 | 63477                           | 71983                           | 22528.26                                  | 16159.69                                  | 102.1                   | 0.367245406               |
| Gansu province        | 8246.07  | 31336                           | 70695                           | 17488.39                                  | 14623.95                                  | 102                     | 0.33052385                |
| Qinghai province      | 2865.23  | 47689                           | 85379                           | 20757.26                                  | 16557.19                                  | 102.5                   | 0.311781035               |

Due to the large difference in value range between different index data, in order to make data with different orders of magnitude can be compared together, it is necessary to carry out data standardization operation, and z-Score is adopted in this paper for data standardization processing. Z-score standardization can be performed according to Formula (1). The processed data conform to the standard normal distribution, that is, the mean value is 0 and the standard deviation is 1. The data results after processing are shown in Table 2. Standardization of Z (GDP) said GDP value, Z (per capita GDP) represent the standardized value of per capita GDP, the Z (per capita disposable income) per capita disposable income of the standardized value, Z (per capita consumption level) represent the standardized value of per capita consumption level, Z (consumer price index) said the standardization of the consumer price index value, Z (price-to-income ratio) represents the standardized price-to-income ratio.

$$Z_i = \frac{x_i - \mu}{\sigma} \quad (1)$$

Table 2. Standardization of relevant data of 23 provinces and municipalities in 2018

|                       | Z (GDP)  | Z (GDP Per capita) | Z (Average wage level) | Z (Per capita disposable income) | Z (Per capita consumption Level) | Z (Consumer price index) | Z (Price-to-income ratio) |
|-----------------------|----------|--------------------|------------------------|----------------------------------|----------------------------------|--------------------------|---------------------------|
| Beijing               | -0.11269 | 2.34122            | 3.19431                | 2.72818                          | 2.52619                          | 1.36538                  | 2.58314                   |
| Tianjin               | -0.58528 | 1.70963            | 0.99019                | 0.84154                          | 1.21313                          | -0.27813                 | 0.86628                   |
| Hebei province        | 0.12093  | -0.6528            | -0.57665               | -0.48422                         | -0.52809                         | 1.03668                  | -0.09115                  |
| Shanxi province       | -0.66705 | -0.73196           | -0.71369               | -0.60437                         | -0.78065                         | -0.93554                 | -0.30351                  |
| Liaoning province     | -0.31817 | -0.32127           | -0.64483               | 0.03218                          | 0.08966                          | 1.36538                  | -0.98866                  |
| Jilin province        | -0.73863 | -0.3989            | -0.58566               | -0.53765                         | -0.46489                         | 0.05057                  | -0.34155                  |
| Heilongjiang province | -0.68579 | -0.79849           | -0.96511               | -0.54364                         | -0.49216                         | -0.27813                 | -0.38349                  |
| Shanghai              | -0.0158  | 2.17186            | 2.93169                | 2.87854                          | 2.98968                          | -1.59294                 | 1.01931                   |
| Jiangsu province      | 2.44417  | 1.5301             | 0.20501                | 0.72512                          | 0.56643                          | 0.70797                  | -0.63723                  |
| Zhejiang province     | 0.94976  | 0.99487            | 0.41032                | 1.36437                          | 1.15603                          | 0.70797                  | -0.24458                  |
| Anhui province        | -0.12555 | -0.65474           | -0.29959               | -0.43982                         | -0.48547                         | -0.27813                 | -0.50165                  |
| Fujian province       | 0.11247  | 0.7537             | -0.30262               | 0.27508                          | 0.30072                          | -1.92164                 | -0.13132                  |
| Jiangxi province      | -0.45492 | -0.66375           | -0.5837                | -0.43188                         | -0.65094                         | 0.05057                  | -0.63939                  |
| Shandong province     | 1.78209  | 0.27013            | -0.33801               | -0.00883                         | -0.25626                         | 1.36538                  | -0.9613                   |
| Henan province        | 0.6155   | -0.57571           | -0.84794               | -0.60657                         | -0.73331                         | 0.70797                  | -0.8885                   |
| Hubei province        | 0.25873  | -0.04246           | -0.329                 | -0.28867                         | -0.15612                         | -0.60684                 | -0.07409                  |
| Hunan province        | 0.13799  | -0.48512           | -0.50304               | -0.33604                         | -0.25253                         | -0.27813                 | -1.28466                  |
| Guangdong province    | 2.63642  | 0.59872            | 0.39823                | 0.53642                          | 0.70468                          | 0.37927                  | 0.36368                   |
| Hainan province       | -1.15916 | -0.51732           | -0.22583               | -0.39066                         | -0.42156                         | 1.36538                  | 3.12196                   |
| Chongqing             | -0.52149 | -0.06458           | -0.0769                | -0.24151                         | -0.19434                         | -0.27813                 | -0.35831                  |
| Sichuan province      | 0.31258  | -0.61682           | -0.13769               | -0.56554                         | -0.40371                         | -1.26424                 | -0.29289                  |
| Guizhou province      | -0.74964 | -0.86424           | -0.10685               | -0.89824                         | -0.91435                         | -0.93554                 | -0.35688                  |
| Yunnan province       | -0.6234  | -0.99729           | -0.23484               | -0.7617                          | -0.85466                         | -1.59294                 | 0.47594                   |
| Shaanxi province      | -0.35418 | -0.14413           | -0.4168                | -0.55995                         | -0.60237                         | 0.05057                  | 0.39013                   |
| Gansu province        | -1.01899 | -1.18515           | -0.47984               | -0.97598                         | -0.80525                         | -0.27813                 | -0.05663                  |
| Qinghai province      | -1.23991 | -0.65549           | 0.23883                | -0.70614                         | -0.54986                         | 1.36538                  | -0.28466                  |

### 3. Cluster analysis of housing price problem

As mentioned above, the original data in Table 1 is first standardized and changed, and the data is standardized in Table 2 after operation. The seven columns in Table 1 are standardized so that data of different dimensions and orders of magnitude can be compared together. Secondly, cluster analysis is conducted on the data of 23 provinces and municipalities after standardized processing in Table 2, as shown in Table 3. Finally, SPSS was used to complete the above operation steps and the cluster pedigree diagram of cluster analysis results was shown in Figure 1.

#### 3.1. K- means clustering algorithm

The core idea of K-means clustering is as follows: First randomly selected from the n data object given k objects as the initial clustering center, and for the rest of the other objects, then according to their similarity with the center of the selected k (distance), respectively, to give the most similar clustering, and then to calculate the clustering center of the cluster, repeat this

process until the standard measurement function began to convergence. In this paper, according to the classification of urban risk types, the K value is set as 4 and the maximum number of iterations is 100.

In this paper, basic data were firstly classified and processed, and 23 provinces and municipalities were classified into five categories: category 1, Category 2, Category 3 and Category 4. Finally, SPSS software was used for cluster analysis, and four classification results were obtained. Table 3 is k-means clustering city classification (K =4).

Table 3. Urban classification results of K-means clustering

| category | province                                                                                                                                                                                                                                                                       |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1        | Tianjin, Zhejiang province                                                                                                                                                                                                                                                     |
| 2        | Hebei province, Liaoning province, Jiangsu province, Shandong province, Henan province, Guangdong province                                                                                                                                                                     |
| 3        | Shanxi province, Jilin province, Heilongjiang province, Anhui province, Fujian province, Jiangxi province, Hubei province, Hunan province, Chongqing, Sichuan province, Guizhou province, Yunnan province, Shaanxi province, Gansu province, Qinghai province, Hainan province |
| 4        | Beijing, Shanghai                                                                                                                                                                                                                                                              |

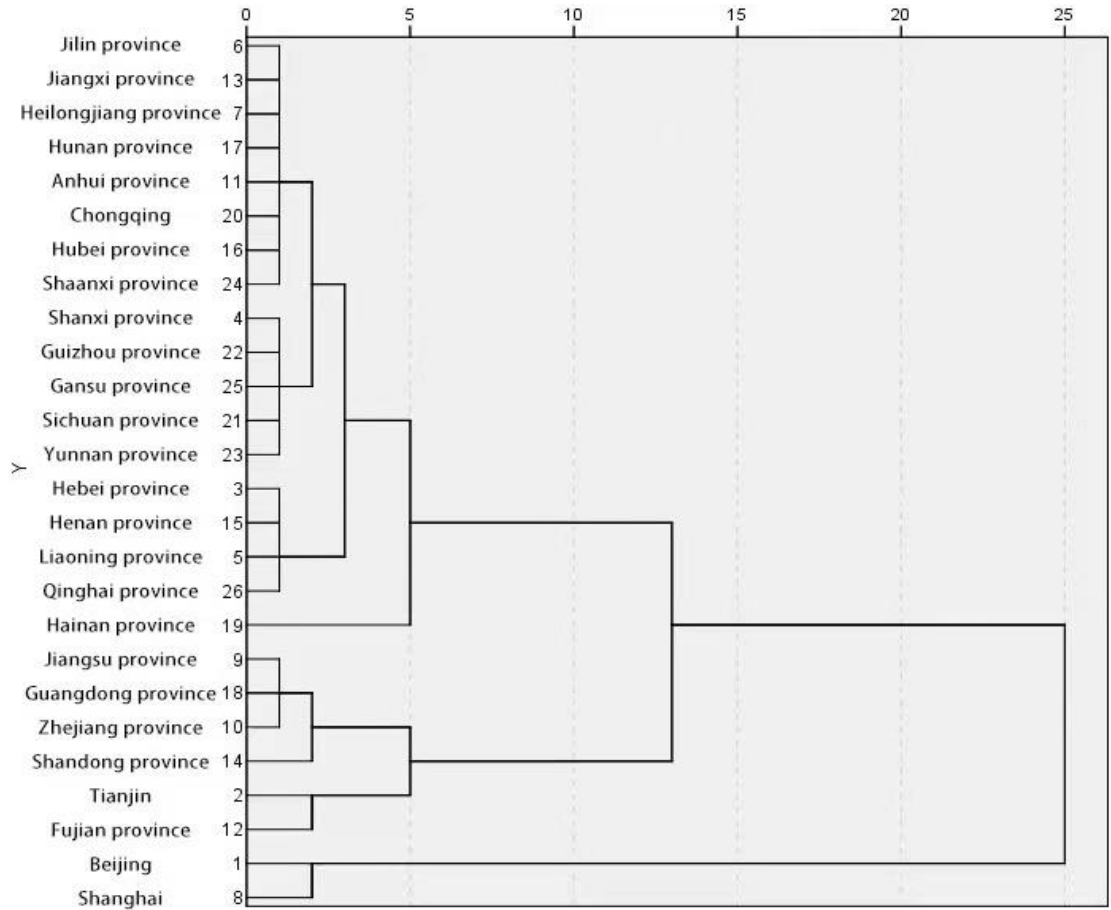


Figure 1. Cluster pedigree diagram

3.2. Family tree clustering algorithm

Cluster analysis is to directly divide a dataset S without category label into several subsets  $C_i(i = 1,2,\cdots,k;k \leq n)$  according to some similarity measure, the similarity between the data objects in each subset is very high, while the similarity between the objects in different subsets

is not or very low. This paper mainly adopts the systematic clustering method in SPSS to realize the clustering analysis based on the calculation of the shortest distance. The shortest distance method is to find  $d_{pq} = \min\{d_{ij}\}$ ,  $1 \leq i \leq m$ ,  $1 \leq j \leq m$  in the off-diagonal elements of the distance matrix  $m \times m$  between pairs of objects. Thus, the classification objects  $G_p$  and  $G_q$  are not treated as the new class  $G_r$ , and then the distance between the original class and the new class is calculated according to the settlement formula (1), so a new  $(m - 1)$  order distance matrix is obtained. The minimum  $d_{ij}$  is selected from the new distance matrix, and  $G_i$  and  $G_j$  are merged into new classes. The distance between each class and the new class is calculated, and so on, until each class object is grouped into a class.

$$G_{rk} = \min(d_{pk}, d_{qk}) \quad k \neq p, q \quad (2)$$

After cluster analysis by using SPSS software for systematic clustering, the tree graph as shown in Figure 1 is obtained, and The clustering classification results of family tree are shown in Table 4.

Table 4. Clustering and classification results of family tree

| category | provinces                                                                                                                                                                                                                                                                                                                                                                                    |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1        | Tianjin, Fujian province                                                                                                                                                                                                                                                                                                                                                                     |
| 2        | Jiangsu province, Guangdong province, Zhejiang province, Shandong province, Jilin province, Jiangxi province, Heilongjiang province, Hunan province, Anhui province, Chongqing, Hubei province, Shaanxi province, Shanxi province, Guizhou province, Gansu province, Sichuan province, Yunnan province, Hebei province, Henan province, Liaoning province, Qinghai province, Hainan province |
| 3        | Beijing, Shanghai                                                                                                                                                                                                                                                                                                                                                                            |
| 4        |                                                                                                                                                                                                                                                                                                                                                                                              |

## 4. Cluster analysis results

### 4.1. Analysis results of K-means clustering algorithm

The first category is Tianjin and Fujian Province. The per capita disposable income of these two provinces is high, the housing price to income ratio is within the range of 0.3-0.4, and the per capita GDP of these two provinces and municipalities is also among the top among the major provinces and municipalities in China. Residents in these two cities have a shorter average struggle to buy a house.

The second category is Hebei province, Liaoning province, Jiangsu province, Shandong province, Henan province and Guangdong province. The housing price of these cities is reasonable when the housing price to income ratio is between 0.25 and 0.35. The reason may be that the population of these cities is relatively small, so the per capita GDP and per capita disposable income of families are relatively higher when the total GDP is not high, and the housing price of these cities is relatively low.

The third category is Shanxi province, Jilin province, Heilongjiang province, Anhui province, Fujian province, Jiangxi province, Hubei province, Hunan province, Chongqing province, Sichuan province, Guizhou province, Yunnan province, Shaanxi province, Gansu province, Qinghai province and Hainan province. In terms of GDP, GDP per capita, housing price to income ratio, and household per capita disposable income, these cities are generally in the middle position and the housing price of these cities is basically the same.

The fourth category is Beijing and Shanghai. The two cities housing price to income ratio is above 0.4, the two cities in GDP, per capita GDP, the housing price to income ratio, family per capita disposable income on indicators are on top, but the high-speed economic development at the same time, the real estate market also exist some problems, in the two cities of some unreasonable prices. These two cities both represent the level of domestic economic development, with a large inflow of migrant population and too many real estate developers

pursuing high-end housing development, so the housing price is relatively high and there is no downward trend in the long run.

#### **4.2. Analysis results of family tree clustering algorithm**

The first category is Tianjin and Fujian province. This set of two provinces of per capita GDP and per capita disposable income in the top few, prove that the economy of the two provinces with high sample and the level of economic development, has maintained a high energy and economic growth, but the average salary for the two provinces in the provinces and municipalities directly under the central government is not in the front of the plane, and in the economic growth at the same time, But income per head has not kept growing at the same rate as the economy, so housing prices are inflated.

The second category is Jiangsu province, Guangdong province, Zhejiang province and Shandong province. This group is the cities in the economically developed areas along the eastern coast, with high level of economic development and good living environment, which have attracted many migrants. In particular, shenzhen in Guangdong province, Qingdao in Shandong province and Wenzhou in Zhejiang province have a higher level of economic development and a suitable living environment, attracting more people. There are many out-of-towners who buy vacation houses for investment. Cities in this group have higher per capita GDP and average per capita wages.

The third category is Shanxi province, Jilin province, Heilongjiang province, Anhui province, Fujian province, Jiangxi province, Hubei province, Hunan province, Chongqing province, Sichuan province, Guizhou province, Yunnan province, Shaanxi province, Gansu province, Qinghai province and Hainan province. Most of the provinces in this group are in the central and western regions, where the per capita wage level is not too high and the housing price is also at a relatively low level. The probability of the price-to-income ratio is less than 0.3, so the bubble is smaller and there is less room for decline. Although there is a gap between the economy of these provinces and that of the east, they are all economic centers and have a strong attraction to the migrant population, so they have a great demand and will prevent the decline of housing prices.

The fourth category is Beijing and Shanghai. Among China's major provinces and municipalities, Beijing and Shanghai had the highest per capita GDP in 2018, proving that the two cities have relatively high economic strength and level of economic development. The leading position of Beijing and Shanghai in Chinese cities is also unshakable. The two cities also have the highest per capita wages in the country, as well as the highest housing prices. The high housing prices in these two cities are partly driven by economic development and partly by booming demand. As the national and regional economic centers and cultural centers, these cities have a large number of migrant population and have a large and rigid demand for houses, which leads to high housing prices.

### **5. Conclusion**

This paper analyzes the housing price of 23 provinces and municipalities in China by using the cluster analysis method, which can classify these administrative regions in a more scientific and reasonable way, so as to find out their similarities and discover the rules. Macro-control of the real estate market should be guided according to different circumstances. For the areas with too large development scale and too much empty space, we should encourage them to control supply, reduce vacancy and prevent overheating. In areas where housing prices are rising too fast and the price structure is unbalanced, we should guide the development of low - and medium-priced houses, reduce development costs, and regulate the rise of housing prices. In order to promote regional economic growth, it is necessary to vigorously support the

development of real estate industry from all aspects in areas with greater market demand potential.

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