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Time and Space Analysis of House Price in Mainland China in the Last 10 Years

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Abstract

In this paper, time series analysis, geographic information, cluster analysis, causality test and other techniques and means are used to analyze the housing prices of mainland China in the past 10 years. Kmeans clusters after comparison of house prices between provinces and neighboring provinces, provinces of the same category are continuously distributed on the map; the highest price area and the lowest price area on the time series are also continuously distributed on the map; the time series-based causality test found that the growth rate of house prices in six provinces was affected by the surrounding provinces, and the growth rate of house prices in one province affected the growth rate of house prices in neighboring provinces.

Keywords

House Price, Time Series, Cluster Analysis, Neighbor Provinces, Causality Test

1. Introduction

In recent years, the house prices among all provinces, autonomous regions and municipalities across China show a clear inclining trend, but the patterns of incline vary a lot across regions. For example, the average sales price of residential commercial housing in Shandong Province increases from 2904.14 Yuan/m^2 (Year 2007) to 5855 Yuan/m^2 (Year 2016), with an overall growth rate of 6.45%; however, the average sales price of residential commercial housing in the Ningxia Hui Autonomous Region shows a lower rate of increment, which increases from 2722.58 Yuan/m^2 (Year 2007) to 5485 Yuan/m^2 (Year 2016) with an overall growth rate of 14.78%. This paper uses time series analysis, geographic information, cluster analysis, causality test and other techniques to study the relationship of house prices among the all provinces, autonomous regions and municipalities (except Hainan Province) across mainland China.

Previous researches in China have proved the practicability of using time series analysis in studying house prices. Xiuli Wu and Feng Zhang (2007), using the house price in Guangzhou as a subject, divide Guangzhou into extremely bustling regions, average bustling regions and non-bustling regions and create time series analysis models for house price prediction separately [1]. This research proved that time series analysis is reasonable in analyzing the trend of house prices. Li He (2014) predicted commercial residential housing price index in Beijing in 2014, using time series analysis [2]. Li Li and Jinwen Wu (2016) showed the application of time series model in the relationship between land prices and house prices [3]. Xuyi Xie (2006) used time series analysis to examine the viewpoint that house prices have a more apparent impact to land prices in the long term. Foreign scholars also use this method in analyzing house prices under foreign economies [4]. Willcocks (2009) uses time series analysis to study house price in the UK [5].

Space analysis also gains wide recognition in house price analysis. Introducing space variables into economic models has made them excellent alternatives to space-relating variables that are easily ignored. Modern development in GIS technology has provided great convenience in studying economics across regions. Zhixiong Mei and Xia Li (2007), using the house price in Dongguan as a subject, plotted the prices of residential houses in a grid graph and superimposed major roads buffer zones on to the house price distribution graph, in order to discover and explain the spatial variance in house prices of Dongguan [6]. Can (1998) used GIS technology to analyze the spatial relativity between the housing market and the mortgage market [7].

This paper conducts time series analysis and spatial analysis of house prices in mainland China in the past 10 years.

2. Data Sources

There are two main sources of our data. The first one is the house prices from 2007 to 2016 in the provinces. This is obtained from the National Bureau of Statistics website. According to the System of Statistics Reports on Real Estate Development (2018), the data are collected from all real estate developing and management legal entities. All surveyed entities report their data through the direct network reporting system monthly [8] (**Table 1**).

The second data source is a list of provinces adjacent to the provinces (**Table 2**). This is collected from the map of China. Since **Table 1** does not contain data for Hong Kong, Macau, and Chinese Taipei, we will not include these three regions in the next map analysis.

3. Related Technology

3.1. Geographic Information Technology

Geographic Information System (GIS) is a special-purpose digital database in

Table 1. Average sales price of commercial housing in the province from 2007 to 2016 (yuan/square meter).

Area	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Beijing	27497	22633	18833	18553	17021.6	16852	17782	13799	12418	11553.3
Shanghai	24747	20949	16787	16420	14061.4	14603.2	14464	12840	8195	8361
Tianjin	12830	10107	9219	8746	8217.67	8744.77	8230	6886	6015	5811.11
Zhejiang	11121	10525	10526	11042	10642.6	9838.06	9258	7826	6262	5786.03
Guangdong	11097	9796	9083	9090	8112.19	7879.17	7486	6513	5953	5914.3
Hainan	9878	9339	9315	8669	7893.8	8943.45	8735	6261	5443	4161.6
Fujian	9218	8881	9136	9050	8646.05	7764.29	6256	5427	4384	4684.34
Jiangsu	8805	7356	7006	6909	6726.78	6554.41	5841	4983	4049	4024.36
Hubei	6724	5863	5513	5266	5042.79	4486.39	3743	3532	3001	3053.12
Henan	6438	5759	5131	4897	4478.02	3982.85	3539	3263	2779	2585.77
Liaoning	6080	5758	5373	5122	4942.01	4732.65	4505	4034	3758	3490.15
Anhui	5924	5457	5394	5080	4824.95	4776.1	4205	3420	2949	2664.37
Shandong	5855	5560	5315	5049	4763.01	4447.73	3944	3505	2970	2904.14
Sichuan	5762	5475	5597	5498	5448.82	4917.88	4138	3509	3157	2840.45
Jiangxi	5709	5358	5288	5203	4744.66	4147.7	3144	2643	2136	2071.89
Chongqin	5485	5486	5519	5569	5079.93	4733.84	4281	3442	2785	2722.58
Shannxi	5471	5362	5166	5280	5155.88	4949.2	3759	3223	2952	2622
Qinghai	5400	5242	5081	4163	4048.54	3248.08	3005	2517	2460	2311
Jilin	5364	5476	5112	4483	4146.7	4363.89	3647	2917	2507	2302.47
Heilongjiang	5295	5144	4882	4738	4067.17	3966.4	3719	3241	2832	2471.32
Yunnan	5269	5300	4998	4494	4209.19	3635.38	3158	2931	2680	2454.98
Guangxi	5237	4960	4854	4593	4203.42	3772.47	3562	3260	2826	2538.64
Gansu	5201	4913	4544	3886	3570.15	3318.24	3042	2483	1958	2190.54
Tibet	5112	4111	5774	4174	3268.62	3474.51	2896	2452	3202	2704.12
Shanxi	4984	4870	4734	4433	3871.38	3432.71	3487	2707	2355	2249.61
Henan	4964	4611	4366	4205	3831.23	3500.8	3042	2666	2339	2253.43
Hunan	4640	4304	4227	4243	4048.62	3790.26	3146	2680	2302	2233.15
Xingjiang	4632	4653	4628	4268	3918.4	3548.79	3087	2604	2240	2081.13
Inner Mongolia	4546	4441	4333	4301	4053.05	3782.93	3521	2972	2483	2246.53
Guizhou	4307	4415	4312	4295	4115.67	3888.78	3357	2874	2339	2136.74
Ningxia	4241	4413	4117	4232	3947.88	3732.19	3304	3090	2435	2136.2

Table 2. List of adjacent provinces of mainland China.

Province	Adjacent provinces					
Anhui	Shandong	Jiangsu	Zhejiang	Jiangxi	Hubei	Henan
Beijing	Hebei	Tianjin				
Fujian	Zhejiang	Jiangxi	Guangdong			
Gansu	Xingjiang	Qinghai	Sichuan	Shannxi	Xingjiang	Inner Mongolia
Guangdong	Fujian	Jiangxi	Hunan	Guangxi		

Continued

Guangxi	Guangdong	Hunan	Guizhou	Yunnan				
Guizhou	Hunan	Guangxi	Yunnan	Sichuan	Chongqin			
Hebei	Liaoning	Inner Mongolia	Shanxi	Henan	Shandong	Beijing	Tianjin	
Henan	Hebei	Shandong	Anhui	Hubei	Shannxi	Shanxi		
Heilongjiang	Jilin	Inner Mongolia						
Hubei	Henan	Anhui	Jiangxi	Hunan	Chongqin	Shannxi		
Hunan	Hubei	Jiangxi	Guangdong	Guangxi	Guizhou	Chongqin		
Jilin	Liaoning	Heilongjiang	Inner Mongolia					
Jiangsu	Shandong	Anhui	Zhejiang	Shanghai				
Jiangxi	Anhui	Zhejiang	Fujian	Guangdong	Hunan	Hubei		
Liaoning	Jilin	Inner Mongolia	Hebei					
Inner Mongolia	Gansu	Xingjiang	Shannxi	Shanxi	Hebei	Liaoning	Jilin	Heilongjiang
Xingjiang	Inner Mongolia	Shannxi	Gansu					
Qinghai	Sichuan	Tibet	Xingjiang	Gansu				
Shandong	Hebei	Henan	Anhui	Jiangsu				
Shanxi	Hebei	Inner Mongolia	Henan	Shannxi				
Shannxi	Shanxi	Henan	Hubei	Chongqin	Sichuan	Gansu	Xingjiang	Inner Mongolia
Shanghai	Jiangsu	Zhejiang						
Sichuan	Chongqin	Guizhou	Yunnan	Tibet	Qinghai	Gansu	Shannxi	
Tianjin	Hebei	Beijing						
Tibet	Yunnan	Sichuan	Qinghai	Xingjiang				
Xingjiang	Tibet	Qinghai	Gansu					
Yunnan	Guangxi	Guizhou	Sichuan	Tibet				
Zhejiang	Jiangsu	Anhui	Shanghai	Jiangxi	Fujian			
Chongqin	Hubei	Hunan	Guizhou	Sichuan	Shannxi			

which a common spatial coordinate system is the primary means of reference. Comprehensive GIS require a means of: Data input, from maps, aerial photos, satellites, surveys, and other sources; data storage, retrieval, and query; data transformation, analysis, and modeling, including spatial statistics; data reporting, such as maps, reports, and plans [9].

This paper uses the map of China as geographical reference to analyze data in house prices of provinces in mainland China.

3.2. Time Series Analysis and Granger Causality Test

Time series analysis is a permutation combination of variable values with equal time intervals. There are two purposes for using time series analysis: understanding the underlying drivers and structures of observed data, finding suitable models, and predicting and monitoring [10]. This article will use the Granger causality test to analyze the changes in housing prices in mainland China in the past decade and the potential factors affecting housing prices. Granger causality is a statistical concept based on predictive causality. According to the Granger causality test, if X1 is the Granger of X2, the historical value of X1 should contain future values that help predict X2. The mathematical formula is based on a linear regression model of the stochastic process [11].

Analysis tool: This article uses the lmtest package for Granger causality testing. The code is implemented in R language version 3.5.

3.3. Cluster Analysis

Cluster analysis refers to the process of grouping a collection of physical or abstract objects into multiple classes of similar objects. The goal of cluster analysis is to collect data on a similar basis to classify [12].

Chen Jian (2007) briefly introduced the concept and principle of clustering analysis algorithm [13]. Cluster analysis is an ideal multivariate statistical technique, mainly consisting of hierarchical clustering and iterative clustering. Cluster analysis, also known as group analysis and point group analysis, is a multivariate statistical method for studying classification.

Two clustering methods, K-MEANS clustering and hierarchical clustering are used in this paper.

The K-MEANS clustering method [14] is a kind of iterative clustering. The K-MEANS algorithm is an algorithm that inputs the number of clusters k and a database containing n data objects, and outputs a minimum of k clusters that satisfy the minimum variance. The k-means algorithm accepts the input quantity k; then divides the n data objects into k clusters so that the obtained clusters are satisfied: the object similarity in the same cluster is higher; and the object similarity in different clusters Smaller.

Hierarchical clustering is a general term for a class of algorithms that continuously merges clusters from bottom to top, or continuously separate clusters from top to bottom to form nested clusters. This level of class is represented by a "tree" [15]. The Agglomerative Clustering algorithm is a hierarchical clustering algorithm. The principle of the algorithm is very simple. In the beginning, all the data points themselves are clustered, and then the two clusters closest to each other are found to be combined into one, and the above steps are repeated until the preset number of clusters is reached.

This paper uses KMeans in sklearn cluster for cluster analysis, and uses hierarchy in scipy cluster for hierarchical clustering. The code is implemented in Python 3.6. Sklearn is a commonly used python third-party module in machine learning that can be installed via pip. Scipy is a commonly used third-party python module for data analysis. It can also be installed via pip.

4. Monographic Analysis

1) Kmeans clustering of house price growth rate and ratio of surrounding provinces

On the basis of **Table 1**, a) Calculate the growth rate of house prices, and obtain the growth rate of house prices in each province from 2008 to 2016; b) Calculate the 9 years of neighboring provinces in each province by using the information of neighboring provinces in Table 2. The growth rate of housing prices, average; c) Calculate the ratio of the growth rate of house prices in each province to the average of the surrounding provinces, we get Table 3.

Clustering Table 3, performing kmeans clustering according to Category 5, we get the following figure.

Table 3. Comparison with surrounding provinces (average).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Anhui	0.796	0.852	0.816	0.871	0.869	0.810	0.809	0.851	0.834	0.823
Beijing	2.752	2.824	2.719	3.022	2.648	2.681	2.720	2.625	2.853	2.854
Fujian	1.020	0.916	0.959	0.944	1.065	1.104	1.072	1.101	1.038	0.990
Gansu	0.923	0.747	0.832	0.877	0.823	0.806	0.840	0.943	0.996	1.038
Guangdong	2.052	2.044	1.860	1.859	1.618	1.499	1.575	1.546	1.667	1.790
Guangxi	0.797	0.852	0.869	0.831	0.786	0.821	0.830	0.858	0.833	0.828
Guizhou	0.835	0.851	0.908	0.918	0.933	0.895	0.880	0.856	0.865	0.816
Hebei	0.593	0.602	0.625	0.557	0.613	0.671	0.680	0.688	0.695	0.675
Henan	0.841	0.825	0.814	0.805	0.806	0.817	0.841	0.838	0.842	0.841
Heilongjiang	1.087	1.135	1.101	1.038	0.974	0.992	1.079	1.034	1.037	1.069
Hubei	1.258	1.164	1.173	1.041	1.039	1.093	1.068	1.104	1.150	1.253
Hunan	0.727	0.725	0.722	0.738	0.787	0.776	0.748	0.734	0.720	0.722
Jinlin	0.842	0.829	0.854	0.932	1.049	0.952	0.950	1.051	1.071	1.011
Jiangsu	0.816	0.795	0.722	0.733	0.779	0.785	0.735	0.737	0.692	0.739
Jiangxi	0.511	0.516	0.539	0.553	0.646	0.689	0.713	0.723	0.717	0.703
Liaoning	1.468	1.451	1.322	1.262	1.171	1.169	1.123	1.106	1.102	1.116
Inner Mongolia	0.896	0.921	0.953	0.971	0.932	0.949	0.928	0.887	0.852	0.844
Ningxia	0.908	0.988	1.068	0.960	0.929	0.927	0.943	0.880	0.900	0.836
Qinghai	0.942	0.932	0.911	0.913	0.851	0.999	0.934	0.989	1.095	1.043
Shandong	1.008	0.981	0.978	0.949	0.946	0.959	0.958	0.971	0.959	0.896
Shanxi	0.927	0.893	0.893	1.006	0.847	0.884	0.949	0.997	0.966	0.931
Shannxi	1.065	1.151	1.057	1.053	1.241	1.184	1.130	1.067	1.070	1.044
Shanghai	1.705	1.590	2.005	1.916	1.782	1.619	1.829	1.915	2.343	2.484
Sichuan	1.160	1.203	1.233	1.233	1.263	1.295	1.208	1.107	1.100	1.113
Tianjin	0.822	0.792	0.807	0.772	0.839	0.764	0.746	0.769	0.712	0.756
Tibet	1.117	1.216	0.848	0.865	0.905	0.742	0.906	1.138	0.796	0.971
Xinjiang	0.866	0.882	1.048	1.036	1.060	1.080	1.048	0.902	0.978	0.884
Yunnan	0.961	0.930	0.969	0.905	0.906	0.988	0.969	0.973	1.118	1.032
Zhejiang	1.327	1.442	1.335	1.365	1.300	1.364	1.294	1.207	1.096	1.022
Chongqing	1.056	1.013	1.088	1.180	1.074	1.067	1.133	1.112	1.079	1.019

According to Figure 1, all provinces, autonomous regions and municipalities, except Hainan Province, in mainland China are put into four clusters in the choropleth map. The average value of the annual rate of increase of residential housing prices within the province divided by the average annual rate of increase of residential housing prices among its neighboring provinces is 0.754 among the first-cluster provinces; the average is 0.962 among the second-cluster provinces; the average is 1.187 among the third-cluster provinces; the average is 2.146 among the fourth-cluster provinces.

The rates of house price increment are relatively slow in the first-cluster provinces compared with their neighboring provinces. These provinces, for example Hebei Province, Jiangsu Province, and the Guangxi Zhuang Autonomous Region, are mostly the neighboring provinces of the fourth-cluster provinces. They are left behind in the process of urbanization in the context of China's high-speed development of urbans. Also, net outflow of population appears in these provinces. The population emigrated from the first-cluster provinces mainly end up in more economically advanced regions, especially in the fourth-cluster provinces. This movement of population decreases the rigid demand for housing in the first-cluster provinces, while increasing the demand for housing in the fourth-cluster provinces, resulting in a speed-up in house prices growing in the fourth-cluster provinces, and a slow-down in the first-cluster provinces.

In the second-cluster provinces, the rates of house price increment stay almost the same with their neighboring provinces. These provinces are mainly located in the Northeast, the North, the Northwest, the West, and the Southwest. Little variance of economical development is shown among a second-cluster province and its neighboring provinces. And population flow is not significant among them.

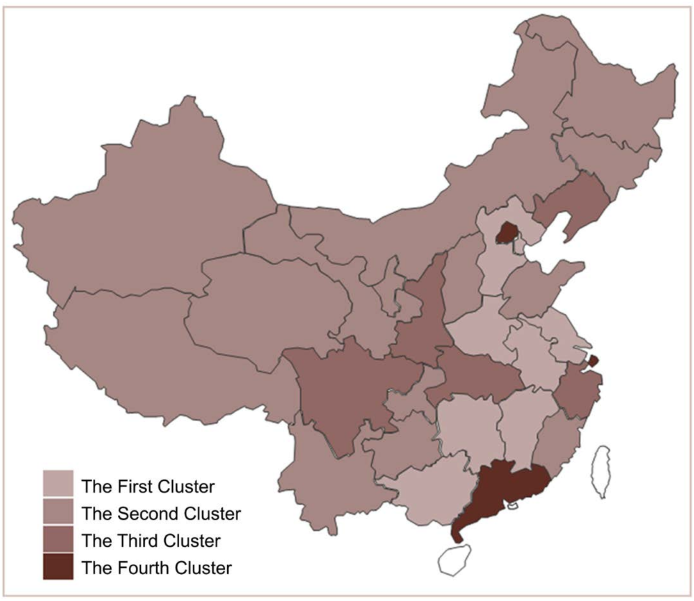

Figure 1. Cluster display comparing house prices in neighboring provinces.

The rates of house price increment of the third-cluster provinces are slightly higher than their neighboring provinces, but the differences are trivial. The third cluster includes Sichuan Province, Shaanxi Province, and Hubei Province in the Middle, Liaoning Province in the Northeast, and Zhejiang Province in the East.

The fourth-cluster provinces are clearly shown on the map, which are the three cores of house price increasement: Guangdong Province, Shanghai Municipality, and Beijing Municipality. They are also the cores of economic advancement and highly urbanized regions in mainland China.

2) Hierarchical clustering of house price growth rates

On the basis of **Table 1**, the house price growth rate is calculated, and the house price growth rate of each province from 2008 to 2016 is obtained. The hierarchical clustering of the nine-year house price growth rate in each province, we get the following picture.

Referring to the above **Figure 2**, we can draw the following conclusions.

Shanghai Municipality, Beijing Municipality, Jiangsu Province, and Tianjin Municipality can be sorted into one cluster. Because all of them are highly developed in their economies, huge net migration inflow and active housing property investment make them similar in the pattern of house price increasement. In addition, when the central government starts controlling the house prices, the policies are made similar among these provinces.

Tibet, as an ethnic minority autonomous region assigned by Beijing, holds a large population of minorities. Population inflows and outflows of Tibet have rigidity. Its cultural and political differences from other provinces make it a special case.

Other provinces are similar in their pattern of house price fluctuation.

4.1. Analysis of the Highest and Lowest Price Maps in Time Series

The average selling price of residential commercial housing across all provinces in mainland China is highly polarized. The two municipalities of Beijing and Shanghai have the first and the second highest average selling price of residential

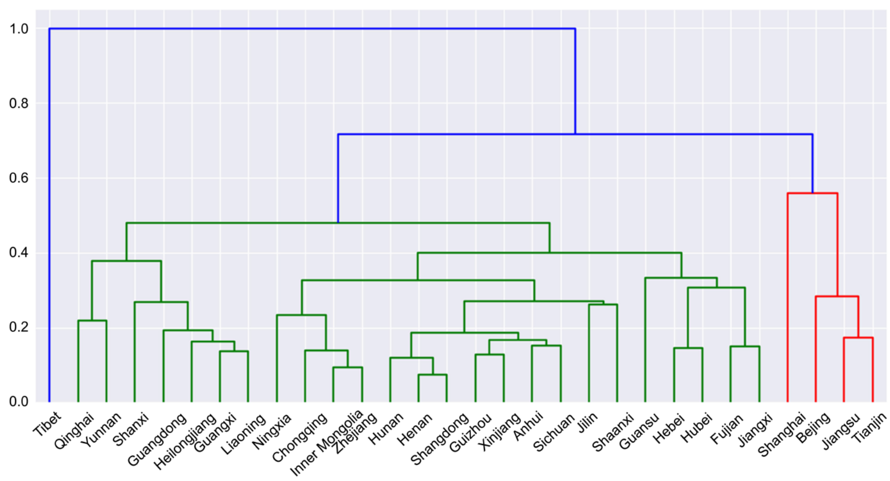

Figure 2. Hierarchical clustering result.

commercial housing since 2007. Gansu Province, Guizhou Province, Henan Province, Hunan Province, Jiangxi Province, the Inner Mongolia Autonomous Region, the Ningxia Hui Autonomous Region, Qinghai Province, the Xinjiang Uygur Autonomous Region, and Tibet Autonomous Region once have been one of the least three provinces in the average selling price of residential commercial housing between 2007 and 2016. In 2016, the average selling price of residential commercial housing in Beijing Municipality (28,489 Yuan/m^2) is 6.7 times more than that in Guizhou Province (3704 Yuan/m^2).

That Beijing and Shanghai become provinces with very high house prices are partially because of the specificity of municipalities. According to Constitution of the People's Republic of China, municipalities are at the same level with provinces and autonomous regions. In the study of this paper, municipalities are directly compared with provinces and autonomous regions. Thus, the data of the average selling price of residential commercial housing in Beijing and Shanghai can only reflect the house prices within these two cities' administrative areas, without any indication of the situation in bigger areas that are, on the other hand, indicated in the data of bigger provinces and autonomous regions. If the data studied are the average selling prices of residential commercial housing, the house price in Shenzhen, Guangdong Province, is much higher than that of Beijing and Shanghai (the average selling price of residential commercial housing in Shenzhen is 45,498 Yuan/m^2 in 2016).

By coloring the provinces with very high house prices and the provinces with very low house prices on the map, it clearly shows that none of the provinces with very low house prices is costal (Figure 3). Most of the provinces with very

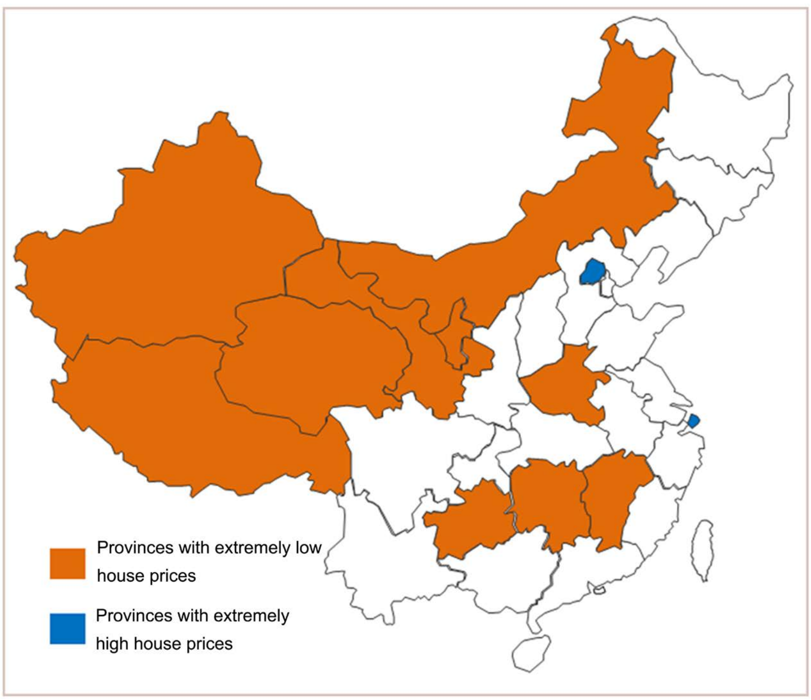

Figure 3. Highest and lowest price map analysis.

low house prices are located in the Northwest part of China. They are located far from the ocean, and at high attitudes, with vast areas of grasslands, plateaus, deserts, and an arid environment. Harsh natural environments and economic conditions make these provinces unsuitable for human dwelling, and decreases the qualities of residential housing inside these provinces.

Guizhou Province, Hunan Province, and Jiangxi Province are located in the south-central China, with some distance from the major coastal cities, such as Shenzhen in Guangdong Province, Fujian in Xiamen Province, and Hangzhou in Zhejiang Province. With the high-speed economic development in their neighboring provinces, these relatively under-developed inland provinces have huge net emigration into the coastal provinces. Thus, their relatively low rigid demand in Guizhou Province, Hunan Province, and Jiangxi Province, contributes to a depression of house prices in these provinces.

4.2. Pulling Analysis with Neighboring Provinces

First, calculate the growth rate of house prices in each province from 2008 to 2016; then, according to Table 2, calculate the growth rate of house prices in all provinces from 2008 to 2016 (the tie value of all neighbors). Finally, the Granger causality test is used to calculate two time series of house price growth rates in each province and its neighboring provinces.

1) Pulled by neighboring provinces

The calculation results show that there are four provinces in the delay parameter Order = 1, namely Henan, Fujian, Yunnan and Jilin. In the case of the delay parameter Order = 2, there are two provinces, Tianjin and Shanghai respectively, as shown in Table 4 below.

In the above table, the P values of Henan and Yunnan provinces are less than 0.001, which is very significant. We draw the actual growth rate curve of house prices, as shown in Figure 4.

From Figure 4, we can see that with the rise, flatness, decline and rise of neighboring provinces, the growth rate of housing prices in Henan Province also responded with changes, and the time interval was very short. Looking at Yunnan, with the decline, rise, flat, decline, rise and fall of neighboring provinces, the growth rate of housing prices in Yunnan Province also responded to changes, a difference of about 1 year.

Table 4. Granger causality test driven by neighboring provinces (only listed with significant P values).

		P-Value	Order
1	Henan	0.005917	1
2	Fujian	0.04752	1
3	Yunnan	0.007524	1
4	Jilin	0.02032	1
5	Shanghai	0.008439	2
6	Tianjin	0.04876	2

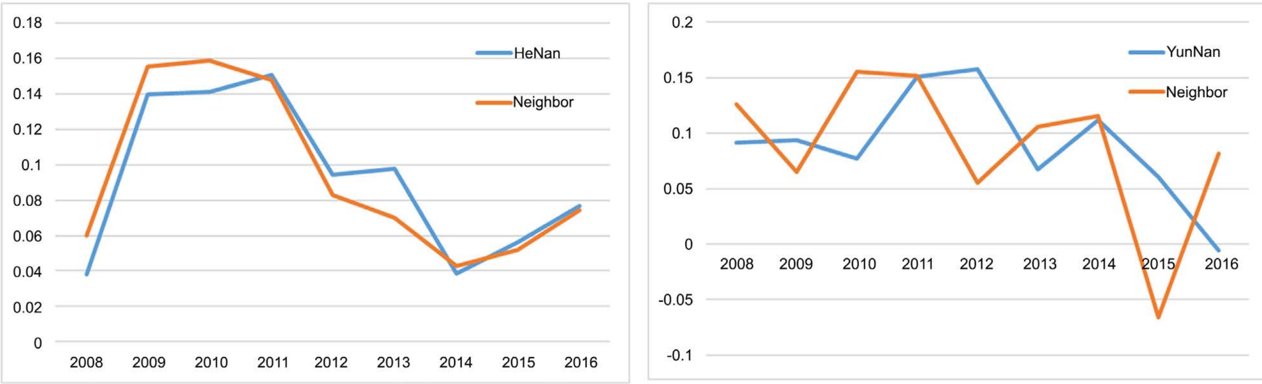

Figure 4. Growth rate curve of house prices.

2) Pulling the surrounding provinces

The calculation results show that in the case of delay parameter Order = 1, the P value of Inner Mongolia Autonomous Region is less than 0.05, which is very significant. We draw the actual growth rate curve of house price, see the chart below (**Figure 5**), and the growth rate of house prices in neighboring provinces along with Inner Mongolia Autonomous Region. Change and change. In the case where the delay parameter Order = 2, no region where the P value is less than 0.05 is found.

5. Discussion

Tianjin's high house price is partly due to its centralized economical, political and cultural significance, and high qualities of residential housing. It is also affected by its neighboring provinces, Hebei Province and Beijing Municipality. Beijing, as the province with the highest house prices of all time in mainland China, definitely pushes up the house price in its neighboring municipality of Tianjin. Beijing, the ancient and contemporary capital of China, accommodates many historical sites, national agencies, foreign embassies, shopping malls, and cooperation headquarters in its limited urban area. A total population of 13.629 million (data at the end of 2016) in Beijing exacerbates contradictions of using space. In recent years, with the process of Beijing-Tianjin-Hebei integration, industries that previously located in Beijing are continuously moved to Hebei Province and Tianjin, causing the high house price centered at Beijing to dimple in its neighboring regions. There are two major reasons why the housing market in Tianjin is also affected by Beijing: 1) Some industries in Beijing are moved to Tianjin, and aggravate the competition for land among industries, business, and residentials. This increases the developing cost for real estate developers, which then eventually increases house price. 2) More Beijing residents are buying or investing houses in Tianjin to avoid the unaffordable house price in Beijing, while maintaining the proximity to Beijing. This then increases demand for housing in the Tianjin housing market. Because the supply of housing is lack of elasticity, this leads to an uptick in real estate market of Tianjin.

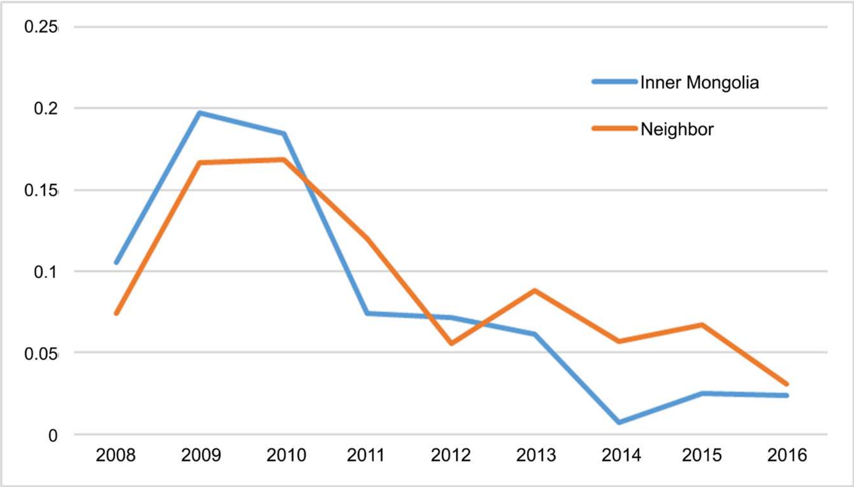

Figure 5. Price growth rate curve of Inner Mongolia and surrounding provinces.

Shanghai, as the municipality with the second highest house price, has more obvious influence to the house prices of its neighboring provinces. Unlike the Beijing-Tianjin-Hebei region, the cities inside Yangtze River Delta Economic Zone are more closely connected in terms of population liquidity, economic activities, etc. The Yangtze River Delta metropolitan area is now one of the six metropolitan areas in the world. This also means the house price in Shanghai is interdependent with the cities in its neighboring provinces, Jiangsu Province and Zhejiang Province. The growing Shanghai house price pushes local citizens in Shanghai to buy houses in the near Jiangsu Province or Zhejiang Province, instead of buying or renting houses in Shanghai, while maintain their jobs in Shanghai. The highly-advanced network of high-speed railway has already created a one-hour commuting circle around Shanghai. In addition, the stretch-out of the Shanghai metro system further connects the city with other cities nearby. The convenience of transportation and the fusion of the economies explain the huge impact to the house price of Shanghai from its neighboring provinces.

This article mainly analyzes the data of mainland China, excluding data from Taiwan, Hong Kong, Macau, and Hainan Province. The shortcomings of this paper are as follows: 1) The house price collected is only 10 years. 2) The spatial scale is not detailed enough, data collection and analysis are carried out by province, and no city data is analyzed.

6. Conclusions

Geographic location is verified to be an important factor in determining the house prices. Regions with harsh environments are typically associated with low house prices, while those along the coast are mainly high-house-price regions.

The neighboring effect of house prices is mainly because of the following reasons: firstly, industries moving out of regions with high land prices, pushing up land prices in the neighboring regions; secondly, improved transportation system increased the demand for the neighboring houses from regions with high house prices.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Wu, X.-L. and Zhang, F. (2007) Application of Time Series Analysis in House Price—The Case of Guangzhou City. *Science Technology and Engineering*, **7**, 5631-5635.

[2] He, L. (2014) Forecast of Beijing Commodity Housing Price Index in 2014 Based on Time Series Analysis. *Oriental Enterprise Culture*, No. 3, 305.

[3] Li, L. and Wu, J. (2016) The Internality and Interactive Relationship between Land Prices and House Prices—Analysis Based upon Time Series Model. *China Business Update*, **7**, 38-39.

[4] Xie, X. (2006) Empirical Analysis on the Relationship of House Price and Land Price in Shanghai. *East China Economic Management*, **8**, 88-91.

[5] Willcocks, G. (2009) UK Housing Market: Time Series Processes with Independent and Identically Distributed Residuals. *The Journal of Real Estate Finance and Economics*, **39**, 403-414. https://doi.org/10.1007/s11146-008-9117-3

[6] Mei, Z. and Li, X. (2007) Research of the Spatial Disparities of Realty Price Based on Geostatistical Analysis. *Journal of South China Normal University*, **4**, 120-126.

[7] Can, A. (1998) GIS and Spatial Analysis of Housing and Mortgage Markets. *Journal of Housing Research*, **9**, 61-87.

[8] National Bureau of Statistics (2017) System of Statistics Reports on Real Estate Development. National Bureau of Statistics, Beijing.

[9] Foote, K.E. and Lynch, M. (2018) Geographic Information Systems as an Integrating Technology: Context, Concepts, and Definitions. The Geographer's Craft Project, Department of Geography, The University of Colorado at Boulder. https://www.colorado.edu/geography/gcraft/notes/intro/intro.html

[10] (2018) NIST/SEMATECH e-Handbook of Statistical Methods. https://www.itl.nist.gov/div898/handbook/pmc/section4/pmc41.htm

[11] Granger, C.W.J. (1969) Investigating Causal Relations by Econometric Models and Cross-Spectral Methods. *Econometrica*, **37**, 424-438. https://doi.org/10.2307/1912791

[12] https://baike.baidu.com/item/%E8%81%9A%E7%B1%BB%E5%88%86%E6%9E%90/3450227?fr=aladdin

[13] Chen, J. (2007) Analysis of Common Cluster Analysis Algorithms. *Journal of Anhui Electronic Information Vocational and Technical College*, **1**, No. 6

[14] MacQueen, J. (1967) Some Methods for Classification and Analysis of Multivariate Observations. *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability*, *Volume* 1: *Statistics*, California Press, Berkeley, 281-297.

[15] Theodoridis, S. and Koutroumbas, K. (2006) Pattern Recognition. 3rd Edition, Elsevier, Amsterdam.