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The spatial distribution and spatial lag effect of commodity housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area

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Abstract

The spatial variation of the price of commercial housing in a region has become one of the hot issues discussed by scholars. This article uses spatial measurement methods to analyze the changes in eleven cities in the Guangdong-Hong Kong-Macao Greater Bay Area from 2003 to 2017. Panel data is analyzed, and the results of the study found that there is indeed a "positive spatial autocorrelation" in the regional distribution of commodity housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area, that is, areas with high housing prices are adjacent to areas with high housing prices, and areas with low housing prices are similar to areas with low housing prices. Neighboring phenomenon, the Guangdong-Hong Kong-Macao Greater Bay Area has a spatial lag effect in commodity housing prices, but this spatial lagging transmission direction is opposite to the actual price distribution law. Understanding the diffusion law of regional commercial housing prices can provide certain help to the development of China's real estate industry or designated regional real estate policies.

Keywords

Guangdong-Hong Kong-Macao Greater Bay Area commodity housing prices spatial measurement hysteresis effect.

1. Introduction

In recent years, China's real estate transaction market has seen a trend of excessive short-term housing price increases. In various regions of China, high housing prices have spread from first-tier cities to second-tier cities, and from provincial capital cities to neighboring cities. High housing prices have gradually spread in space. phenomenon. Changes in real estate prices have become the focus of attention of the government, residential real estate developers and other parties. Many scholars have used spatial measurement methods to analyze the price and diffusion of urban commercial housing from the perspectives of geography and economics. Certain research and analysis of the law and reason of urban commercial housing price changes in urban space.

To what extent will the changes in house prices in one area affect the changes in rooms in adjacent areas? What is the spatial transmission direction of this housing price? Is there a certain regular distribution of housing prices among cities in a region? To solve these problems, it is necessary to examine the spatial and temporal spillover effects of commercial housing prices and the spatial autocorrelation index (ie Moran index) of commercial housing prices. Many scholars in China have conducted research on the spatial correlation of housing prices.

Chinese scholars Wang He used the Moran index and Lisa statistics to test the spatial autocorrelation of China's housing prices, and believed that China's housing prices have spatial autocorrelation [1]. Scholars Ju Fang, Lei Yuliang, and Zhou Jianjun took From the perspective of spatial spillovers, we study the real estate prices of 31 provinces in China from 1999 to 2013, and introduce spatial measurement methods into the empirical study of economic openness on

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real estate prices, which explains the existence of "Balassa-Samuelson" in the real estate market in China. Effect [2]. Scholars Lan Feng and Zhang Chunmiao focused on the characteristics of the spillover of commercial housing prices in the Pearl River Delta region and its transmission channels, and believed that the size of the spillover effect of urban housing prices is closely related to the level of economic development. Scholars Wang Liping and Li Yanping used panel data of 31 cities in the Yangtze River Delta from 2000 to 2011 to explore the impact of urbanization and FDI on housing prices in the Yangtze River Delta based on a spatial lag model[3]. Scholars Zhou Jianjun, Dai Wei, Ju Fang, and Yang Yinghe not only used the traditional Moran index, but also used the spatial Gini coefficient to measure the degree of agglomeration of the real estate industry at the spatial level, and found that the development of the real estate industry in Hunan Province has a relatively high level of spatial dependence[4]. Scholar Li Guangdi and Shen Haojing narrowed the scope of the research and used ArcGIS software to match the spatial location and attribute information to draw a Moran scatter plot of the area inside the Shenyang City Ring Expressway, thereby observing the distribution of housing prices in various areas within Shenyang[5]. Scholars Mei Zhixiong and Huang Liang conducted a spatial autocorrelation analysis of the housing prices in Dongguan in 2006 and found that the prices of most general residential houses in Dongguan showed the characteristics of local spatial aggregation, but there were still a small amount of spatial heterogeneity presenting a local discrete pattern[6].

Most of the existing studies have confirmed the spatial correlation of commercial housing prices, but most of the existing studies have studied spatial autocorrelation, and there are few lag effects involving prices in neighboring cities. And there are few papers on the spatial spillover and spatial lag effects of commercial housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area.

The structure of this article is: Part 2: Introducing the theoretical hypothesis and research design of this article. The third part: According to Moran Index to study the distribution law of commodity housing prices in Guangdong-Hong Kong-Macao Greater Bay Area. Part IV: Use the Spatio-temporal Dynamic Panel Model (SDMLE) to study the spatial lag effect and analyze the results.

2. Theoretical assumptions and research design

2.1. Theoretical hypothesis

The lag of commodity housing prices that this article is studying is actually a variable that studies the time and space spillover effects of commodity housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area. Spatial spillover effect refers to the fluctuation of real estate prices in a certain area in a certain area and may affect the real estate prices in neighboring areas through such spatial spillover effects. Use ordinary panel models in the case of spatial spillover effects. Analysis and recommendations will produce certain deviations. The introduction of the lag term on the basis of the spatial spillover effect is to show that the impact of this spillover effect is not only an impact on the value of the current period, and there may also be some impact in the subsequent periods, so the introduction of the lag term may be more important. Close to reality. =

So what does the house price itself indicate for its own time-space spillover effect? In fact, the spatio-temporal spillover effect of commodity housing prices itself mainly illustrates the transmission law of commodity housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area. If the conduction effect is confirmed to exist, then the price of commercial housing will show a certain distribution law in space. That is, the high house price is adjacent to the high house price, and the low house price is adjacent to the low house price in a relatively large range.

This situation is called positive spatial autocorrelation. Based on this article, two assumptions can be made:

(1) There may be a positive autocorrelation in the prices of commercial housing in various cities in a large area.

(2) The price of commercial housing in cities may have a spatial lag effect.

3. Empirical strategy

The goal of this article is to explore the spatial spillover and spatial lag effects of commercial housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area, so spatial measurement methods should be used. Spatial measurement is an analysis method that considers the possibility of spatial dependence between variables. In general regression between variables, it is considered that the variables are spatially independent, but if the changes between the corresponding variables in different regions are spatially dependent, then the regression results may be biased. However, there are many spatially dependent data in actual research. If the spatial relationship between variables is ignored, the research may be inaccurate. To solve this problem, spatial measurement methods can be used in research.

The empirical analysis of this article is divided into two parts. The first part uses Moran index and Moran scatter plot to analyze the spatial distribution of commodity housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area, and the second part uses a spatial panel model to analyze commodity housing in the Guangdong-Hong Kong-Macao Greater Bay Area. The spatial lag effect of price.

3.1. Moran index and Moran scatter plot

Spatial autocorrelation refers to a certain economic phenomenon or attribute value in a region under study that has a correlation with the corresponding economic phenomenon or attribute value in the adjacent region.

If there are similar variable values in adjacent areas in space, it can be called "spatial autocorrelation", if the area with high value is concentrated with the area with high value, it is "positive spatial autocorrelation", if the value is high If the region of is adjacent to the region with low value, it is "negative spatial autocorrelation". If the distribution of high and low values is completely random, there may be no spatial autocorrelation.

Generally speaking, before determining whether a research should use spatial measurement methods, the first thing to consider is whether there is a spatial dependence relationship between real variables, and spatial measurement methods can only be used when the spatial dependence relationship truly exists. There are two methods to measure the degree of spatial correlation of an economic phenomenon, one is Moran's I statistic, and the other is LISA statistic.

The most common method used when discussing spatial autocorrelation is the Moran's I statistic, also known as the Moran index:

$$I = S^2 \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \quad (1)$$

In this equation, S^2 is the variance of the sample $\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n}$, w_ij is the (i, j) element of the spatial weight matrix, the spatial weight There are many ways to define a matrix, which will be explained below. The sum of all spatial weights represented by $\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}$. If the spatial weight is standardized, then $\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij} = n$. The standardized Moran's I is:

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$$I=\frac{\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{\sum_{i=1}^{n}(x_i-\bar{x})^2} \tag{2}$$

The Moran index ranges from -1 to 1. If the value is greater than 0, it is "positive spatial autocorrelation", and the value is less than 0 as "negative spatial autocorrelation". If the value is equal to 0, the distribution is completely random. Then there may be no spatial autocorrelation relationship.

If the observed value of the data and its spatial lag are plotted as a graph, a "Moran scatter plot" can be obtained. The slope of the regression line of the scatter plot is the Morran index.

Although the global Moran index can reflect whether there is a spatial autocorrelation relationship as a whole, we cannot see the specific distribution characteristics from the Moran index obtained. The Moran scatter plot can help observe the local spatial autocorrelation.

The Moran scatter chart is divided into four quadrants: the first quadrant is the high-high region (HH), the second quadrant is the low-high region (LH), and the third quadrant is the low-low region (LL). The fourth quadrant is the high-low type area (HL). Take house prices as an example. If the observed value falls in the second quadrant, it means that an area with low house prices is surrounded by surrounding areas with high house prices. If it falls in other areas, it can be deduced by analogy.

3.2. Space panel model

Ordinary slm model, sem and sdm model are generally used in cross-sectional data. If you want to analyze panel data, you need to expand on the basis of these three models. The general spatial autoregressive model of panel data is:

$$y_{it}=\rho\mathbf{w}_i^{'}\mathbf{y}_i+\mathbf{x}_{it}^{'}\boldsymbol{\beta}+u_i+\varepsilon_{it}(i=1,\ \ldots,n;t=1,\ldots,T) \tag{3}$$

In this model, $\mathbf{w}_i^{'}$' represents the i-th row of the spatial weight matrix, then$\mathbf{w}_i^{'}\mathbf{y}_i$ represents $\sum_{j=1}^{n}w_{ij}\,y_{jt}$, where $w_{ij}$is the (i , J) element; and u_i is the individual effect of area i. $\rho\mathbf{w}_i^{'}\mathbf{y}_i$is the spatial lag term. If the spatial lag term is removed, the model becomes a standard static panel model. If u_i and x_{it} are related, it is a fixed effect model, if not, it is a random effect. Then the general spatial panel model is set as:

$$\begin{cases} y_{it}=\tau y_{i,\ t-1}+\rho\mathbf{w}_i^{'}\mathbf{y}_i+\mathbf{x}_{it}^{'}\boldsymbol{\beta}+d_i^{'}X_i\delta+u_i+\gamma_i+\varepsilon_{it} \\ \varepsilon_{it}=\theta\mathbf{m}_i^{'}\varepsilon_i+v_{it} \end{cases} \tag{4}$$

In this model, $y_{i,\ t-1}$ is the first-order lag term of the dependent variable $y_{i,\ t}$. When τ is not equal to 0, it is a dynamic panel. If the non-dynamic panel is studied, $\tau=0$. $d_i^{'}X_i\delta$ represents the spatial lag of the independent variable, $d_i^{'}$is the ith row of the corresponding spatial weight matrix; $\gamma_i$represents the time effect, and $\mathbf{m}_i^{'}$ represents the ith row of the weight matrix.

The above expressions are general expressions based on the slm model, sem and sdm models. In some cases, they can become the corresponding panel models of the slm model, sem and sdm model:

1. If θ=0, the model becomes a panel SDM model
2. If θ=0 and δ=0, the model is an SLM model.
3. If τ=ρ=0, and δ=0, then it is the SEM model

This article studies whether the changes in housing prices in cities in the Guangdong-Hong Kong-Macao Greater Bay Area have a lagging effect on neighboring areas. For example, in a city in the Guangdong-Hong Kong-Macao Greater Bay Area, such as the increase in housing prices

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in Guangzhou, will it affect the housing prices in Foshan next year or the next year? Is this spatial impact positive or negative?

Since the study is a dynamic panel, it is not clear whether the control variable also has a spatial effect, so first use SDM to establish a simple basic model, which is a spatiotemporal dynamic panel model (SDMLE) with a lag term and a spatial weight matrix. The basic model for:

$$P_t = \alpha_0 W_n P_t + \alpha_1 W_n P_{t-1} + \alpha_2 W_n P_{t-2} + \beta_1 P_{t-1} + \beta_2 P_{t-2} + \gamma_1 X_t + \gamma_1 W_n X_t + c_0 + \varepsilon_t \quad (5)$$

In this model, P_t is the price of commercial housing per square meter in cities in the Guangdong-Hong Kong-Macao Greater Bay Area, P_{t-1}, and P_{t-2} are the price of commercial housing per square meter in the previous period and the previous two periods, and W_n is the model The set spatial weight matrix. X_t is the control variable for period t, $c_0$is the individual fixed effect vector, and if the random effect model is adopted, it is a constant term. ε_t is a random disturbance term. The term$\alpha_0 W_n P_t$ is the space lag of the price of commercial housing, which represents the autocorrelation effect of price, whether the price of immediate commercial housing itself is spatially dependent, $\alpha_1 W_n P_{t-1}$、 $\alpha_2 W_n P_{t-2}$ indicate It is the time and space lag of commodity housing prices, that is, the positive or negative impact of changes in housing prices in one area on housing prices in neighboring areas. $\beta_1 P_{t-1}$、 $\beta_2 P_{t-2}$) excluding the spatial weight matrix W_n represent the impact of a city's own commercial housing price changes on the next and next period of the city's commercial housing prices. The reason why $\gamma_1 W_n X_t$ is added is because the influence of control variables on the price of commercial housing may also have a spatial dependence on it.

3.3. Selection of indicators

1. Selection of spatial weight matrix

Before conducting empirical analysis, we should first select the spatial weight matrix. The setting of the spatial weight matrix reflects the degree of correlation between regions and is one of the cores of spatial measurement. There are five setting methods commonly used for spatial matrix: binary adjacency weight matrix, negative exponential distance weight matrix, economic distance weight matrix, gravitation weight matrix, and asymmetric influence weight matrix. This article adopts a binary adjacency weight matrix:

$$w_{ij}\begin{cases} 1 & \text{adjacent} \\ 0 & \text{Not adjacent} \end{cases}$$

The i and j of this matrix respectively represent two regions. If the two regions are adjacent, the weight value is 1, and if they are not adjacent, it is 0,. This matrix is also called 0-1 matrix, and is the most commonly used spatial weight matrix. Compared with other matrices, the binary weight matrix has a better ability to reflect the spatial connection, but the establishment and operation of the matrix are relatively simple and easy to understand, and it is often used in areas with relatively close spatial distances.

2. Selection of control variables

The selected commercial housing price is the average price per square meter of housing calculated in RMB in each city. The control variables were selected from the perspective of supply and demand, and the completed area of houses (square meters) in each city and the per capita income of each city (yuan). Foreign scholars KR and Rainer believe that no matter how the house price fluctuates, the core is the family (demand side). It is determined jointly with the construction unit (supply side), and the most important variable that affects the demand side is income, and the supply side is the number of houses [7]. Based on actual experience, generally speaking, if the completed area of houses increases and the supply increases, if the demand changes little, it should have a negative impact on the price of commercial housing. If the completed area of houses decreases and the supply decreases, it will have an impact on the price of commercial housing. Is positive; the impact of income on the price of commercial housing is opposite to the direction of the completed area of housing. If income increases, the demand for housing will increase. If the supply of housing does not change much, it will have a positive effect on the price of commercial housing, and vice versa. to.

3.4. Data source and data processing

The area studied in this article is the Guangdong-Hong Kong-Macao Greater Bay Area, so data from 11 cities in Guangzhou, Shenzhen, Zhuhai, Foshan, Huizhou, Dongguan, Zhongshan, Jiangmen, Zhaoqing Pearl River Delta and the two special administrative regions of Hong Kong and Macau are selected. . Since Shunde was merged into Foshan in 2003, for data continuity, the time frame of the data is 2003-2017. The data of nine cities in the Pearl River Delta of Guangzhou, Shenzhen, Zhuhai, Foshan, Huizhou, Dongguan, Zhongshan, Jiangmen, and Zhaoqing come from the Guangdong Statistical Yearbook. The price of commercial housing in Hong Kong comes from the Midland Property Network (https://www.midland.com.hk/) and the remaining data comes from the Hong Kong Statistical Yearbook. Macau's data are all from the Macau Statistics and Census Bureau (https://www.dsec.gov.mo/ho-me_zhmo.aspx). The units of measurement are all converted to RMB and the impact of inflation is eliminated. Since the price of commercial housing, per capita income and completed area of commercial housing may have exponential growth trends, non-linear relationships and multi-collinearity, and in order to reduce the magnitude of the data, logarithmic processing is performed on the original data.

4. The spatial distribution of commodity housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area

This part uses stata 13 software to conduct spatial autocorrelation tests on the original housing price data of eleven cities in the Guangdong-Hong Kong-Macao Greater Bay Area, and conduct an overall analysis of the spatial distribution of commercial housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area. It is divided into two parts. The first part obtains the Moran index result, and the second part analyzes the Moran scatter chart.

4.1. Moran Index

Table 1 shows the Moran's I value and the corresponding P statistics of the price (yuan/square meter) of commercial housing in 11 cities in the Guangdong-Hong Kong-Macao Greater Bay Area from 2003 to 2017.

Table 1 2003-2017 Guangdong-Hong Kong-Macao Greater Bay Area Moran Index

Year	Moran'I	P	Year	Moran'I	P
2003	0.152	0.021	2011	0.205	0.055
2004	0.130	0.025	2012	0.158	0.094
2005	0.155	0.040	2013	0.142	0.108
2006	0.155	0.040	2014	0.124	0.116
2007	0.197	0.050	2015	0.202	0.067
2008	0.171	0.059	2016	0.241	0.049
2009	0.190	0.050	2017	0.233	0.051
2010	0.148	0.030			

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From Table 1, we can see that the Moran's I value in the Guangdong-Hong Kong-Macao Greater Bay Area from 2003 to 2017 is positive, which means that the sales price of commercial housing in the Guangdong-Hong Kong-Macao Greater Bay Area has always maintained a positive autocorrelation as a whole. This shows that in general, the price distribution of commercial housing in the Guangdong-Hong Kong-Macao Greater Bay Area shows a spatial agglomeration: areas with high housing prices are adjacent to areas with high housing prices, and areas with relatively low housing prices are relatively low Are adjacent to each other. Further observation can be found that if at the 10% significance level, only the spatial autocorrelation in 2013 and 2014 is not significant, but at the 5% significance level, it can be found that the significance level of the spatial correlation relationship from 2012 to 2014 is significantly reduced. This may have been caused by policies that tried to curb housing prices in 2011, such as the implementation of government housing purchase restrictions, differentiated housing, housing credit and taxation, and increased land supply [8]. These policies disrupted The law of housing price agglomeration and distribution reduces the spatial correlation of commercial housing prices. Before and after 2015, the P value has been stable at around 5%. But in general, the Moran Index in Table 1 has shown that actual commercial housing price data is spatially dependent, and further spatial econometric analysis can be carried out.

All in all, by observing the Moran scatter plot and the commercial housing price line chart from 2003 to 2017, it can be seen that there is indeed a "positive spatial autocorrelation" in the regional distribution of commercial housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area.

4.2. Spatio-temporal dynamic panel model (SDMLE) analysis

This part uses the Spatio-temporal Dynamic Panel Model (SDMLE) to analyze the spatial lag of commodity housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area. It is divided into three parts. The first part is the pre-test, and the second part is the regression of the Spatio-temporal Dynamic Panel Model (SDMLE). As a result, the third part is an analysis of the spatial lagging effect of commodity housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area.

1 Stability test LLC (levin-Lin-Chu) and Hausman test

Stability test

The panel model used in this article is a dynamic panel. In order to avoid the possibility of spurious regression, a robustness test is required before the quantitative analysis. If the data is stable, it can be used directly, if it is not stable, it is necessary to observe whether there is a co-integration relationship. The table is the use of stat13 on the logarithmic commercial housing price (Lprice), the lag period of commercial housing prices (the lag phase is Lprice2; the lag phase is Lprice3), per capita income (Lincome), and the completed area of commercial housing (Lq). levin-Lin-Chu method) robustness test:

Table 2 LLC robustness test results

variable	Statistic	p-value
Lprice	-4.0329	0.0000
Lprice2	-1.9308	0.0268
Lprice3	-6.2226	0.0000
Lincome	-2.7795	0.0027
Lq	-2.6978	0.0035

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From Table 2, it can be observed that the logarithmic commercial housing prices, the lag period of commercial housing prices, per capita income, and the LLC statistics of the completed area of commercial housing are all at the 5% significance level. The null hypothesis that the data is not stable can be rejected, so the data is considered It is stable and can be directly used in the measurement analysis below.

Hausmann test

Through global robustness analysis, the spatial correlation of Lprice3 is excluded. However, before further analysis, since the global robustness analysis did not take into account the problems of random effects and fixed effects, a Hausman test (Hausman) should be performed to determine whether the model should use random effects or fixed effects. Table 4 shows the application The output result of Hausmann test performed by stata software:

Table 4 Hausman test results

Hausman	P
-4.84	0

Table 4 shows that the statistics of Hausmann's test are negative, so the null hypothesis of random effects can be accepted. The random effects model will be used for analysis below.

4.3. Regression results of the empty dynamic panel model (SDMLE)

Table 5 Random effect regression results of the spatio-temporal dynamic panel model

variable	coefficient	Standard deviation	P
Lprice2	0.727462	0.16616	0
Lprice3	0.156915	0.151895	0.302
Lincome	0.094535	0.047173	0.045
Lq	-0.01615	0.008395	0.054
constant	0.370137	0.355937	0.298
Spatial coefficient	coefficient	Standard deviation	P
WLprice2	-0.09126	0.049964	0.068
WLprice3	-0.03994	0.046894	0.394
WLincome	0.024194	0.013823	0.08
WLq	-0.01262	0.004784	0.008
Global	coefficient	Standard deviation	P
Rho	0.130493	0.020859	0.000

First of all, we will give an explanation of the table. The variables Lprice2, Lprice3, Lincome and Lq in the first part of the table refer to the items of ordinary panel regression without spatial correlation, namely β_1Lprice2、β_2Lprice3、γ_1Lincome andγ_2Lq. The value of the coefficient refers to the corresponding value of β_1、β_2、γ_1, andγ_2. WLprice2, WLprice3, WLincome, and WLq in the space coefficient column of the table refer to $\alpha_0 W_n$Lprice、$\alpha_1 W_n$Lprice2、$\alpha_2 W_n$Lprice3、$\gamma_1 W_n$Lincome$_t$ and$\gamma_2 W_n$Lq. The corresponding coefficients are α_0、α_1、α_2、γ_1 and γ_2. Rho in the third column represents the spatial correlation of the distribution of commercial housing prices itself, which represents the term $\alpha_0 W_n$Lprice. If the coefficient α_0 of this term is not significant, it proves that the spatial distribution of commodity housing prices itself does not exist during 2003-2017. There is no way to talk about regularity and spatial econometric analysis.

First observe the Rho item in the global column. The P=0.00 coefficient is significant and greater than 0, indicating that there is a "positive spatial correlation" in the overall commodity housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area.

Then the P values of lprice2, lproce3, lincome, and lq in the first column are 0.00, 0.302, 0.045, 0.0054 from the global robustness analysis, respectively. All the variables are significant except for lprice3 which is not significant. The coefficients of these four terms are 0.727, 0.156, 0.094 and -0.016, respectively. It shows that for the same city itself, the price of commercial housing in the previous period has a significant impact on the price of commercial housing in the current period, but the price of commercial housing in the previous two periods may have a relatively weak impact on the price of commercial housing at that time. The significance of Lprice2 and Lprice3 explains The effect of the lag period on the current price is positive, and the more the number of periods lags, the smaller the effect, which is consistent with the reality; the positive coefficient of Lincome indicates that the higher the per capita income, the higher the price of commercial housing; the negative coefficient of Lq indicates The more completed area of commercial housing, the lower the price of commercial housing. In this model, the Lincome term and Lq are added as two control variables on the demand side and the supply side. From the model results, the relationship between these two variables and the dependent variable is consistent with the actual supply and demand relationship.

Then pay attention to Rho and WLprice2, WLprice3, WLincome, WLq. First observe Rho, P=0, so at the 5% significance level, it can reject the null hypothesis that its coefficient is not significant, and the coefficient 0.130493 is positive, indicating that the distribution of commercial housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area from 2003 to 2017 is “positive”. relationship". Then observe the P values of WLprice2, WLprice3, WLincome, and WLq, which are 0.068, 0.394, 0.08, and 0.008, respectively. Among them, the obviously insignificant item is WLprice3, which shows that the removal of WLprice3 has little effect on the model. In the case of lagging three periods, the spatial correlation of commercial housing prices is almost negligible. This is found by scholars Wang He, Pan Aimin, and Zhao Wei The temporal and spatial variation patterns of commercial housing prices in eastern cities in China are basically the same [9]. The coefficient of lprice2 shows that the price of commercial housing in a city in the Guangdong-Hong Kong-Macao Greater Bay Area in the previous period will have a negative impact on neighboring cities in the current period. The coefficient of lincome shows that the increase in per capita income of a city in the Guangdong-Hong Kong-Macao Greater Bay Area will have a positive impact on neighboring cities. The coefficient of lq shows that the completed area of commercial housing in a city in the Greater Bay Area is negatively correlated with the price of commercial housing in neighboring cities.

4.4. The space lag effect of commercial housing prices

As far as the model established in this article is concerned, the current period of commercial housing prices have a negative impact on adjacent areas, indicating that the price of commercial housing in a city is rising, and the price of commercial housing in adjacent areas may fall. This model reveals the transmission direction of the spatio-temporal spillover effect of commercial housing prices. However, according to the general logic, if the price of commercial housing in a city rises, then the demand for purchasing commercial housing in the city should be reduced according to the principle of supply and demand, and the reduced demand should probably go to Neighboring areas with relatively low housing prices eventually lead to an upward trend in the prices of commercial housing in adjacent cities, thereby reducing the gap between the prices of commercial housing in the two cities. The actual transmission direction is the opposite of the theory, and the gap is widened.

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One possible explanation is that when the price of commercial housing in a city begins to rise, more funds flow into the city's real estate market, while the next period of capital outflows in neighboring cities will result in less market demand in the next period. Make the price of commercial housing have a negative impact.

But on the other hand, we can find that the coefficient of Rho is positive through the Rho item. The essence of the Rho item is the spatial correlation of non-lagging commercial housing prices to itself. It represents the distribution law of commercial housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area. , The coefficient is positive, indicating that the overall price distribution of commercial housing in the Guangdong-Hong Kong-Macao Greater Bay Area is a distribution of "high-price areas adjacent to high-price areas, and low-price areas adjacent to low-price areas". However, this article finds that the spatio-temporal spillover effect of commercial housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area is in the opposite direction, which will cause the price gap of commercial housing in adjacent cities to continue to widen.

This shows that although there is a spatiotemporal spillover effect of commercial housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area, it is more likely that this city will be affected by other factors than it is affected by changes in the price of commercial housing in neighboring cities. The price of commercial housing in the district shows the law of "positive spatial autocorrelation", it is possible that a certain factor in a city already has a "positive spatial autocorrelation" distribution in the Guangdong-Hong Kong-Macao Greater Bay Area, that is, the higher the value and the higher value High neighbors, low values and low values are neighbors. These factors have a relatively large impact on the city's own commercial housing prices. This is similar to the research conclusions of scholars Lan Feng and Zhang Chunmiao. Scholars Lan Feng and Zhang Chunmiao believe that the size of the spillover effect of urban housing prices is closely related to the level of economic development. Among the cities in the Pearl River Delta region (excluding Hong Kong and Macao), the spatial spillover effects of commercial housing prices in Guangzhou, Shenzhen, and Zhuhai, which have relatively strong economic strengths Relatively strong [10].

5. Conclusion

This paper analyzes the panel data of eleven cities in the Guangdong-Hong Kong-Macao Greater Bay Area from 2003 to 2017 by using the Moran index, the Moran scatter plot and the Spatio-temporal Dynamic Panel Model (SDMLE), and draws the following conclusions:

1. The regional distribution of commodity housing prices in the Guangdong-Hong Kong-Macao Greater Bay Area does have a "positive spatial autocorrelation", that is, areas with high housing prices are adjacent to areas with high housing prices, and areas with low housing prices are adjacent to areas with low housing prices. Shenzhen, Macau, and Hong Kong are areas with high housing prices, and housing prices are far behind other cities. If you consider the remaining eight cities as a whole and analyze them internally, you may get a more accurate conclusion on the spatial distribution of commercial housing.

2. The Guangdong-Hong Kong-Macao Greater Bay Area has a spatial lag effect in the price of commercial housing, but the transmission direction of this spatial lag is opposite to the actual price distribution law (the transmission direction makes the price gap between adjacent commercial housing There is a "positive spatial autocorrelation relationship" in the price distribution), indicating that the city is more likely to be affected by other factors as it is affected by the price changes of commercial housing in neighboring cities.

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