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Measuring the degree of speculation in the residential housing market: a spatial econometric model and its application in China

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ABSTRACT

Since the housing marketization reform, China's real estate industry has rapidly developed and commercial housing prices have risen sharply. The main reason for this is the speculative demand for housing, which breaks the equilibrium of supply and demand, leading to housing prices deviating from their basic value. The housing market in China is not isolated by province, since speculative behavior in one part of the country can affect other regions. This paper analyzes the spatial relevance in housing prices among different provinces in China by calculating Moran's I index and by measuring the speculation degree through spatial autoregressive model (SAR), a spatial economic model combined with a spatial weight matrix. For commercial housing speculation degree measurement and comparison, 31 provinces in China were chosen along with the following variables: housing prices, personal disposable income, one-year personal housing mortgage rates, housing prices growing rates, the rent, amount of residential investment, and the construction areas of houses. The results show that China's housing prices have a clear interaction among the selected cities, and that housing speculation behavior also influences each other in space. Although there are speculation activities in China, from a global perspective the degree of speculation, which varies from region to region, is still just within internationally acceptable limits. Although there are some regions with high degrees of housing speculation, the speculation is not yet China-wide.

Keywords: Commercial residential housing market; housing prices; speculation degree; Moran's I index; spatial econometrics; SAR model

1. Introduction

Housing prices in China have long commanded widespread attention. Providing affordable housing to every household is a tremendous task in China, not only because of its large population, but also because of its short history of housing marketization (Chiu, 2001; Rosen & Ross, 2000; Zhang, 2000; Zhao & Bourassa, 2003). The booming housing market is producing property wealth gaps, although it is not the only reason for the inequalities of the urban property regime (Chen, 2014). Maintaining the affordability of housing is essential for political consolidation and social stability (Wang, 2012).

Since 2000, the rate of housing price growth in China's major cities has been much higher than the rise in wages. In some cities, such as Beijing, Shanghai and Guangzhou, house prices have increased up to five-fold, while average wage growth over the same period was only 60% to 80% (Kuang, 2010), which clearly demonstrates the shrinking disposable income of Chinese families and the irrationality of house price growth. The price earnings ratio is generally recognized by academics as an important index for measuring the rationality of housing prices. At present, China's housing price-income ratio has far exceeded the internationally accepted limit compared to other industrialized and developing countries. The E-House Real Estate Institute noted that Chinese national commercial housing price earnings ratio for 2014 was 7:1 as reported in the "2014 national price earnings ratio report" released in 2015 Rapidly rising house prices have gradually pushed the cost of houses beyond the range of the average household's purchasing power, which has become a social issue.

Since 2005, the Central Bank and the State Department of China have introduced a number of macro-purchase policies, aimed at controlling the growth rate of house prices, but the policies have not restrained price increases. Problems such as active speculative investments and non-standardized trading market still exist.

Speculation can increase housing transaction costs. Some customers buy houses as speculators, which increases circulation in the housing market and ultimately increases buyers' transaction costs (Lou, 2006).

The explosion in housing demand has been widely attributed to China’s rapid house price growth (Chen, 2014). With the accelerated process of urbanization in China, a large number of rural migrants need housing in cities, so many of them join the ranks of home buyers thereby increasing the demand for housing.

In China, land and housing is supplied moderately, which maintains the dominance of housing sellers, and housing supply costs are kept high by local governments' practice of increasing land prices without warning. In addition, real estate developers often hold a lot of land or delay opening time to maximize economic benefits, which causes a false appearance of insufficient supply.

The result of speculation is to make the housing market appear as though supply is less than the demand, so that house prices continue to increase in order to make the balance of supply and demand. Speculative demand tends to lead to an overall demand surge.

Some degree of speculation is beneficial to stimulate economic growth and promote the prosperity of the real estate market, but too much speculation will lead to a real estate bubble hindering the healthy development of the housing market.

This paper provides valuable insights into speculative behavior in China's housing market, and proposes a speculation measurement system to help identify large imbalances between the economies of different provinces and show where the residential market is uneven. In China, the spatial linkage of the housing market is strong, and the spatial association is considered when the model is selected. The result reveals the correlation and mutual influence between different provinces in China, which shows that the housing market of each province is not independent, and their speculative behavior is diffuse. And the spatial distribution is not balanced. In this paper, the authors point out that by measuring the degree of investment in China's housing market, we find that there is spatial correlation between real estate prices in China and real estate speculation in the space also have mutual influence, but the previous studies pay more attention to speculative degree analysis.

2. Literature Review

Speculation is economic activity involving temporary buying and selling aimed at gaining profits through price changes, instead of buying for own use (Case & Shiller, 2003). Speculation in residential housing markets can be described as an arbitrage activity in residential housing trades, such that speculators obtain benefit in the form of buying low and selling high based on a change of housing prices in a relatively short period of time. There is a difference between residential housing speculation and investment. The former emphasizes making use of short-term market fluctuations to gain short-term benefit, while the latter refers to long-term possession to enjoy the utility. Speculation is usually considered to be a kind of irrational investment behavior that is distinguished from asset trading in terms of holding time and risk of revenue. However, in some cases there can be a mutual transaction (Refet & Urkayanak, 2008) such as when originally intending to buy a house for leasing out but then deciding to sell when housing prices show a rising trend and there is an opportunity to sell at a high market price. Conversely, if originally intending to again arbitrage but housing prices begin to fall, it might be more advantageous to rent out; speculators then become investors.

The degree of speculation can be quantitatively measured as speculation activity. This describes the impact of past house price growth on the expected price growth, which can be defined as the ratio of housing price change rate between the next period and last period. Many factors from the supply side and the demand side, as well as the external environment，influence the degree of speculation in the housing market.

On the demand side，disposable income，housing area, rent levels and so on are generally considered to affect the decision of speculators (Harrison, 2002; Xiao & Park, 2009). The price earnings ratio, and size of the household are all important determinants of housing demand (Han, 2010). Disposable income relates to both the individual housing decision and the socially desirable level of consumption (Jie, 2010). Fawley and Wen (2013) argued that because of speculation, the demand for housing might burst, even when income growth rates and savings rates start to decline. Chen, Guo, and Wu (2011) found that the migration of population from rural to urban areas has generated more pressure on housing prices in the coastal provinces than in the inland provinces. On the supply side, real estate investment, land costs, and construction costs of housing will affect the psychological expectations of speculators (Riddel, 2011; Mak, 2012).

At the same time the influence of external factors on housing speculation cannot be ignored, such as cultural psychology, monetary policy (Elbourne, 2008; Xu & Chen, 2011), interest rates (Adrian, 2004; Ye & Wu, 2008), and land supply (Kauko, 2003; Wu, 2012); The unique land auction and presale systems in China produces significant supply rigidity and helps to fuel sustained price inflation (Wang, 2012), which is key to understanding the dynamics of the country's housing supply (Chen, 2014). A high degree of speculation and the economic factors of rapid development are inseparable (Kawaguchi, Chen, & Patel, 2004; Collyns & Senhadji, 2002).

Different factors may have mutual relations. The Granger causality test reveals a significant impact relationship among output growth, the rate of price changes, income, and expected future prices (Miller & Peng, 2006). Zhang (2013) identified the effect of the constraint of fundamentals on housing price, by a three-sector model (agriculture, manufacture, and housing), while Barros (2013) found a relationship among the price, quality, location and delays of projects.

There are diverse standards and methods of measuring the degree of speculation. In general terms, the methods currently used include direct measurement, indirect measurement, and evaluation indicators. The direct measurement method is based on speculative housing prices, which is considered to be the sum of a deviation caused by speculative factors and the value of the base price (Levin & Wright, 1997). Because housing is speculation based on the expected behavior of house price changes, the degree of speculation can be indirectly measured by changes in housing prices. The upper limit of the variance test (Pesaran, 2004) for housing prices, the earnings reduction model tailed test (Himmelberg & Sinai, 2005), the recursive unit root test (Chen & Funke, 2013), and tails assay are relatively common methods (Lux & Sornette, 2002). Ren (2012) did not find the existence of a bubble when he applied the hazard rate-modeling framework to China's real estate market. Dreger and Zhang (2013) applied a panel co-integration model to draw an inference on the degree of speculation. House prices between different regions are not independent, but are rather interactive with each other. Through building a time and space model of house prices, the spatial effect of housing prices has been found to be a significant presence (Steven, 2004; Holly, Pesaran, & Yamagata, 2010; Saiz, 2010).

The aforementioned studies from multiple perspectives present the influencing factors of housing speculation in general. However, in view of the special nature of the Chinese residential market and the complexity of the environment, the theory is out of touch with the reality in China and there is a lack of assumptions, research methods and measurement indicators in line with China's actual situation. This paper proposes a speculation measurement system aimed at China's housing market, the indicators of which are suitable for the special nature of China.

Although a variety of methods have been provided for measuring speculation, and some scholars have even studied the correlation between housing prices in different regions, the level of economic development in different regions and the spatial relevance in speculation were not taken into account. The speculation measurement system in this paper considers the mutual influence among different regions in space and the degree of residential market speculation using quantitative methods. Standard metrological analysis techniques often fail when confronted with spatial autocorrelation, which often occurs in geographic or cross-sectional datasets. So spatial econometrics has been widely used in economic policy analysis, especially residential housing economy (Kim et al., 2003; Jianglin, 2010). Besides, we try to find the interaction and association of speculative behavior in residential housing market by measuring the speculative degree of Chinese residential housing market. And only the spatial econometric method can realize this purpose, so we adopt this method.

3. Theoretical Foundation

3.1. Residential speculation degree

3.1.1. Housing prices under speculation

Houses function as both dwellings and as investment properties (Lin, Lu, & Zhou, 2007). The housing price structure can be expressed as the following:

$$P_t = P_t^m + G_t \quad (1)$$

Where: P_t—housing prices in t period, P_t^m—basic value of the home, G_t—the residential real estate prices that cannot be explained only through the basic value; it is that part that deviates from the market value due to speculative factors.

Previous studies have shown that factors affecting housing prices consist of two parts, one is the factor affecting purchasing power P_t^m, and the second is the impact factor of speculative prices G_t. The factors were following the principles of comprehensiveness, availability, reliability and scientificity, and were adapted to China's national conditions. Housing price depends on the balance between supply and demand. Based on previous studies, Supply indicators included residential investment, land supply, residential construction area, residential construction costs, while demand indicators included urban per capita disposable income, rent and so on. Because the land supply policy in China is 'double-track', land from different sources may have huge difference in price. Real estate development investment, directly influenced by the land supply situation, can well reflect the supply of housing, which is used to represent the housing and land supply situation here. The housing market also can be affected by external factors like macroeconomic regulation and control, including GDP, bank loan interest rates, and real estate regulation policy. GDP, as an indicator reflecting the macroeconomic operation condition, can well measure the effect of the external environment on housing prices. At present, China's financial market is not perfect. Commercial bank loans are the main way for real estate developers to raise funds. Therefore, bank loan interest rates can impact housing prices in the two aspects of supply and demand, affecting both the cost of the real estate and the homeowners purchase expenditure. The housing regulation and control policy effect is not considered here, because many of them are difficult to quantitatively define. Due to speculative behavior affected by people's subjective expectations, factors affecting expectations include: the loan interest rate and housing price growth

So the dominant factors of P_t^m were elected as residential investment I_t, residential construction area s_t, construction costs C_t, per income y_t, rents R_t, and GDP G_t; and the factors affecting G_t were selected as actual growth rate of housing prices in pre-period g_{t-1}, and the interest rate of bank loans i_t. P stands for the price of residential sales, and P_t^m stands for housing prices when capital gains obtained from the user's use of the property is zero, normally, buying behavior is constrained by disposable income and bank lending rates. Increased revenue will induce expansion of individual housing needs, and further lead to demand shocks. If interest rates increase, the cost of borrowing of the individual also increases, this will reduce demand for residential and related products. P_t^m can be considered as a function of income and lending rates i, which can be expressed as:

$$P_t^m = f(I_t + s_t + C_t + y_t + R_t + i_t + G_t) \quad (2)$$

Based on Levin and Wright's (1997) measurement model, in (1) G_t represents the discounted value of the expected income from the housing as a commodity-based financial investment, which can be expressed as:

$$G_t = G_{t+1}^* / (1 + i_t) \quad (3)$$

Where: G_{t+1}^*——an expected capital gains.

Assuming that house price speculation in the current period is only caused by the price change of the last period, then (4) would apply:

$$G_t = G_{t+1}^* / (1 + i_t) = f(g_{t-1}) / (1 + i_t) \quad (4)$$

Where g_{t-1} means the function of price changes on the expected impact on the current prices, and $\partial f / \partial g > 0$. Thus, the part that the actual residential sale price is higher than the fundamental value caused by speculation is expressed as:

$$G_t = G_{t+1}^* / (1 + i_t) = \alpha_3 [(g_{t-1}) / (1 + i_t)] \quad (5)$$

Putting (2) and (4) into (1), the following expression is obtained:

$$P_t = f_1(I_t + s_t + C_t + y_t + R_t + i_t + G_t) + f_2(g_{t-1}) / (1 + i_t) \quad (6)$$

In the house price model, generally $\partial P / \partial I_t$ >0, $\partial P / \partial S$ <0, $\partial P / \partial C$ >0, $\partial P / \partial y$ >0, $\partial P / \partial R$ >0, $\partial P / \partial G$ >0, $\partial P / \partial i$ <0 and $\partial P / \partial g_{t-1}$ >0.

In (6), t represents time, so when considering the panel data:

$$P_{jt} = \alpha_0 + \alpha_1 y_{jt} + \alpha_2 i_{jt} + \alpha_3 [(g_{t-1}) / (1 + i_t)]_{jt} + \alpha_4 R_{jt} + \alpha_5 I_{jt} + \alpha_6 S_{jt} + \alpha_7 C_{jt} + \alpha_8 G_{jt} + \mu_{jt} \quad (7)$$

The meaning of variables in (7) is as follows:

j=1,2,…n—different research area; t=1,2,…t—different time zones; P_{jt}—actual house prices of j area in t period; y_{jt}—per income of j area in t period; i_{jt}—one-year personal mortgage rates of j area in t period; g_{t-1}—growth rates of housing prices of j area in t period; R_{jt}—rent of j area in t period; I_{jt}—residential investment of j area in t period; S_{jt}—residential construction area of j area in t period; C_{jt}—residential construction costs of j area in t period; G_{jt}—GDP of j area in t period; μ_{jt}—random error term.

3.1.2. Speculation in the housing market

Authoritative academic speculation is considered to be when goods are temporarily bought not for their use but in order to obtain profits through price changes due to economic activity (Case & Shiller, 2003). Speculation does not create wealth for society; it is simply the transfer of wealth between different individuals using price differences at different times in order to make a profit.

The degree of speculation in the housing market reflects the impact of price growth over speculators' price growth expectations. Under the assumption of adaptive expectations, this paper defines the degree of speculation as the ratio of changing rate of house price, expected value on the next issue over the actual value on the last issue.

g_{t-1} represents the rate of growth of house prices, g_{t+1}^{n} represents speculators' expected future growth rate of housing prices, which can be expressed as:

$$g_{t+1}^{n} = \theta g_{t-1} \quad (8)$$

On both sides of the equation for derivative g_{t-1}, the relationship between g_{t-1} and g_{t+1}^{n} is obtained by the formula:

$$\partial g_{t+1}^{n} / \partial g_{t-1} = \theta \quad (9)$$

θ reflects the role that historical price changes play in future price expectations of investors. Investors' motivation for trading houses in the short term and housing price growth or decline is expected to have the same impact on prices. Namely:

$$\partial P_t / \partial i_t = \partial P_t / \partial g_{t+1}^{n} = -(\partial P_t / \partial g_{t-1}) / \theta \quad (10)$$

Respectively, for the partial derivative i and g, the following relationship is obtained:

$$\partial P_t / \partial i_t = \alpha_2 - \alpha_3 g_{t-1} / (1 + \mathrm{i}_t)^2 \quad (11)$$

$$\partial P_t / \partial \mathrm{g}_{t-1} = \alpha_3 (1 + \mathrm{i}_t) \quad (12)$$

When (11) and (12) are substituted into the equation, the following relationship is obtained:

$$\theta = [\alpha_3 / (1 + \mathrm{i}_t)] / [\alpha_2 - \alpha_3 g_{t-1} / (1 + \mathrm{i}_t)^2] \quad (13)$$

Since i_t and g_{t-1} are small enough to be considered negligible:

$$\theta \approx -\alpha_3 / \alpha_2 \times 100\% \quad (14)$$

Therefore, θ can be an approximate measure of the degree of influence the past price growth has on the expected price growth.

3.2. The spatial impact of residential speculation

3.2.1. Spatial effects of the housing market

Spatial dependence, the weaker situation of which is association, refers to things or phenomena that interdependently affect each other in space and are a function of geographic spatial effects. Since the flow of transportation technology, network information, labor and materials in different areas is closely linked, the market economy is not a closed market (Yuan & Song, 2008). So when selecting the commercial housing price influencing factors in a certain area, the external space effects arising elsewhere cannot be ignored. In reality, when a region presents a prosperous state in a residential area, the corresponding urban public infrastructure support will be improved, which will lead to the development of the housing market in neighboring regions. This region-gathered residential market determines that spatial econometric methods can better explain the reality of the development of the residential market.

Spatial heterogeneity means that many economic agents are not evenly distributed in space, for example the economic situation of coastal cities in China will generally be better than inland cities; even in the same city, there are big differences in economic factors across different partitions. For example, downtown area and suburban area housing prices are significantly different. An econometric model can measure the interval difference to some extent, but it ignores the impact of space generated by interactions. It is therefore necessary to analyze the spatial effects with the spatial econometrics. Many scholars have analyzed the differences between residential markets, and therefore the focus of this paper is to consider spatial dependency rather than spatial heterogeneity.

3.2.2. Spatial correlation of residential market speculation

Spatial econometricians claim that the environments people live in consist of two dimensions, space and time, and that individual economic activity over time and space is not carried out independently but rather there is a certain relationship to each other. Previous studies have found that when a housing market boom occurs in a certain area, the rising prices in that area will drive up the prices of houses in the surrounding areas. This diffusion effect is called the 'ripple effect' and economists believe that the reasons for this effect are: family migration, housing transaction costs, search costs, arbitrage, and the lead and lag factors of prices. This housing space correlation also exists with speculation, which is carried along with price expectations. When a strong upward trend in prices is discovered in an area with short-term gains, there is an expectation that prices around the region would also increase (Shen, Feng, & Sun, 2010). By this time, there are fewer speculators entering this original area and the market has more room for development. So speculators will transform wealth and capital to the surrounding areas, which will increase the residential market demand in those areas and thus boost housing prices. Classic econometrics makes the following requirements for samples and data: no serial correlation, zero-mean, and same variance. During cross-section data analysis, spatial interaction cannot be reflected by classic econometrics, so that the model has little practical significance for practical problems. However, spatial econometrics has been widely used in economic problems across regions, and because home prices have significant space radiation and diffusion characteristics, the use of spatial econometric studies for residential space economy is necessary.

4. Research Methods

4.1. Spatial weights matrix

Spatial econometrics introduces spatial weight matrix for linkages between objects in research. Determining a scientific and rational critical spatial weight matrix is crucial for the accuracy of spatial analysis. The spatial location of the individual must be able to quantitatively be reflected in establishment of a spatial weight matrix, often by means of 'distance'. The distance setting must have practical significance, while the distance value size is limited to a natural and non-negative number. In this study, "rear adjacent" and "economic distance" are used (Li & Miao, 2011).

"Rear adjacent": For example, area i and j share the same encode and edge, then these two areas are called "rear adjacent", $\mathrm{W}_{ij} = 1$; otherwise $\mathrm{W}_{ij} = 0$。

"Economic distance" considers the indicators of economic fundamentals between different regions, and according to the different studies, selected indicators are also different. For example, regional GDP, the savings of the population, CPI and other indicators can be adopted when comparing differences in the level of economic development between two cities. If adopting the regional GDP, the economic distance can be presented as $d_{ij} = |z_i - z_j|$, with z_i and z_j representing the GDP of these two regions. When $z_i = z_j$, then $\mathrm{W}_{ij} = 0$。

In this paper, the "rear adjacent" method has been improved on the basis of weight. Each region has been given some weight to reflect differences in the level of economic development among different provinces. The weight matrix between adjacent regions can be expressed as:

$$\mathrm{W}_{ij} = \begin{cases} k, \text{i and j are not adjancent, k is the weight of j;} \\ 0, \text{i and j are not adjancent} \end{cases}$$

When considering the differences in the level of economic development among different provinces，the above matrix can be improved to：

$$W_{ij} = \begin{cases} 1/|k_i - k_j|, i \neq j \\ 0, i = j \end{cases}$$

The new matrix $\mathrm{W} = W_{ij} * B$ is obtained.

Finally, the spatial weight matrix *W* is row standardized to ensure that the sum of each row of the matrix is 1.

4.2. Speculation measurement model

4.2.1. SAR model

The general form of spatial econometric model is (Chen et al., 2011):

$$y = \rho W_i y + \beta X + \varepsilon, \varepsilon = \lambda W_2 \varepsilon + \mu, \mu \sim N(0, \sigma^2 I_n) \quad (15)$$

Where y —$n \times 1$ dimensional vector, β —Explanatory variables $k \times 1$ associated with the parameter vector

$X(n\times k)$; ρ —Spatial autocorrelation regression coefficients, if ρ values are significantly not equal to zero, then it means that obvious spatial interaction is between the object under study; *W₁*and *W₂*—Spatial matrix ; β —Independent variable coefficients, λ —Spatial auto regression coefficient of disturbance ε .

Compared with the classical econometrics, the spatial econometric model introduced spatial weight. So when considering spatial effects between samples, house price equation based on speculation has changed. According to the different value of ρ and λ , a spatial econometric model can be divided into two main models: a spatial lag model (SAR) and a spatial error model (SEM).

When λ =0, the model is SAR:

$$y = \rho W_1 y + \beta X + \mu \sim N(0,\sigma^2 I_n) \quad (16)$$

This SAR model is called the spatial lag model, where "lag" refers to the lag of the cross section of space, rather than the delay of time series in the classical econometrics. The model means that individual economic activity between different regions will be constrained and influenced by each other.

When ρ =0, the model is SEM. Unlike SAR, the correlation between different regions is reflected through the error term, using autoregressive spatial matrix with the disturbance term.

When the spatial dependence among independent variables is the key factor leading to spatial relevance, the spatial econometric model is expressed as SAR. It reflects the spatial interaction effects which exist in the reality, which is just the case of residential housing prices in provinces. In contrast, while spatial relevance is included in disturbance term instead of independent variables, which is called spatial nuisance dependence, SEM is used. Besides that, in SAR, the spatial relevance can be expressed in the parameter estimation results, which means the parameter ρ can reflect the total effect including spatial relevance effect. Thus, we use SAR in the paper to measure the spatial relevance.

4.2.2. Speculation measurement model under SAR

SAR used in the paper is expressed as:

$$P = \rho W_1 P + \beta X + \mu \quad (17)$$

Where: *P* represents the n-column vector consisting of house prices; *X* represents a $m\times m$ matrix composed of independent variables (n represents the number of samples, m represents the number of indicators) ; $X = [y, i, g_{t-1}/(1+i_t), R, I, s, C, G]$; W_1 represents the matrix with spatial weight as $m\times m$ between the samples; ρ and β both are $n\times 1$ -column vector, respectively representing the lag and arguments coefficient vector; μ is on behalf of the regression error term. This paper selected eight indicators, so $\beta = [\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8], n = 8$; the definition of degree of speculation is the same as above, speculation measurement equation under spatial econometric model were as follows:

$$\theta \approx -\beta_3 / \beta_2 \times 100\% \quad (18)$$

θ reflects the role that historical price changes play in future price expectations of investors.

4.3. Criteria for judging the degree of speculation

Based on the research literature, this study used the following criteria for judging the degree of housing speculation.

(a) If $\theta > 0$, indicating the presence of the residential market speculation; if $\theta < 0$, indicating the presence of deflation in the housing market; if $\theta = 0$, indicating that the situation of housing market is ideal.

(b) When $\theta > 0$, depending on the size of speculative value θ of the residential market, the housing market can be divided into four cases: safety, warning, danger, and serious danger.

According to Zhou (2008), if $\theta = (0-10\%)$ the housing market is in a safe area; if $\theta = (11\% - 20\%)$ the housing market is in the warning area; if $\theta = (21\% - 30\%)$ the housing market is in the danger zone; and if $\theta > 30\%$, there is serious housing market speculation that is in the serious danger zone.

4.4. Spatial correlation test model

4.4.1. Global spatial correlation Moran's I index

Index Moran's I is generally used in spatial econometrics to test the similarity, dissimilarity (positive correlation, negative correlation) of objects in entire study areas, or that have no contact with each other(Helbich et al., 2011). Index

Moran's I includes the global spatial autocorrelation indices and local spatial autocorrelation indices. The global spatial autocorrelation index Moran's I is calculated as follows:

$$I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i-\overline{x})(x_j-\overline{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i-\overline{x})^2} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}(x_i-\overline{x})(x_j-\overline{x})}{s^2\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \tag{19}$$

Where: n —the number of researching areas; w_{ij} —spatial matrix; x_i and x_j —property of area i and j; $\overline{x} = \frac{1}{n}\sum_{t=1}^{n} x_i$ —the average of the property; $s^2 = \frac{1}{n}\sum_{t=1}^{n}(x_i-\overline{x})^2$ —the variance of the property.

The value of Moran's I is often between -1 and 1.

$I > 0$ expressed the correlation between samples is positive;

$I = 0$ expressed the property of all subjects are discrete distribution, no presence of effect of the space;

$I < 0$ expressed the correlation between samples is negative;

$I = 1$ expressed similar attributes of all subjects are together (the larger value is adjacent to the larger, the smaller value is adjacent to the smaller value);

$I = -1$ expressed the opposite attributes of all subjects are together (the larger value is adjacent to the smaller, the smaller value is adjacent to the larger value);

The value closer to 1 and -1 indicates that the similar (or different) attributes of more studying objects were together.

4.4.2. *Local spatial correlation Moran's I index*

Local Moran's I index, or LISA index, is used to test the cluster-localized situation between observations. The local index can be used when the analysis focuses on a certain area i calculation. Measure the impact associated with the adjacent region of space between the units is measured as follows:

$$I_i = \frac{(x_i-\overline{x})}{s^2}\sum_{j\neq 1}^{n} w_{ij}(x_i-\overline{x}) \tag{20}$$

$I > 0$ represents a larger value is surrounded by other large value (large - large), or smaller value is surrounded by (small - small) smaller.

$I < 0$ represents a smaller value is surrounded by large value (small - large), or larger value is surrounded by (large - small) smaller.

5. Empirical Research

5.1. *Measuring sample selection*

This study selected eight group metrics data from 31 provinces in China (except Hong Kong, Macao and Taiwan) between 1998 and 2011 as a sample to be empirically analyzed for the degree of speculation in the provinces and to observe for regional differences in housing speculation behavior. The spatial econometrics analysis software Geoda and Matlab was used for calculations, while statistical description of variables was achieved with SPSS16.0.

Table 1
Moran's I index of housing price for 31 provinces in China.

year	*M*oran	E(I)	average	standard deviation $s.d.$	P-value
1998	0.1795	-0.0333	-0.0368	0.0957	0.027
1999	0.1766	-0.0333	-0.0325	0.0964	0.027
2000	0.1878	-0.0333	-0.0323	0.0986	0.027
2001	0.1620	-0.0333	-0.0330	0.1000	0.052
2002	0.1805	-0.0333	-0.0367	0.1056	0.033
2003	0.2066	-0.0333	-0.0323	0.1009	0.030
2004	0.2194	-0.0333	-0.0335	0.1017	0.019
2005	0.3331	-0.0333	-0.0347	0.1044	0.005
2006	0.3801	-0.0333	-0.0327	0.1078	0.008
2007	0.3145	-0.0333	-0.0319	0.1031	0.007
2008	0.3231	-0.0333	-0.3200	0.1000	0.004
2009	0.3118	-0.0333	-0.0306	0.0191	0.027
2010	0.2995	-0.0333	-0.0282	0.1029	0.010
2011	0.3483	-0.0333	-0.0304	0.1035	0.001

5.2. *Housing price spatial correlation analysis*

This study first conducted a global space-related test of housing price index data for 31 provinces of China between 1998 and 2011. The spatial interaction in housing prices between provinces was then analyzed, the results of which are given in Table 1.

The above results show that housing prices in 31 provinces were correlated in space, Moran's I index is significantly not equal to zero at the level of less than 5%, verifying that housing prices in Chinese provinces are not randomly distributed in space; between them there is a positive correlation. Provinces that showed higher prices are adjacent to provinces with higher prices; the relatively low rates of housing in cities tend to be near provinces with lower prices. Therefore, housing prices are related in space and housing prices between provinces are not isolated.

To further analyze the spatial characteristics of China's 31 provinces and cities in housing price, a Moran's I scatter plot of residential prices for local spatial correlation analysis was drawn. Moran's I scatter plot divided house prices of each province and city into four quadrants: the first quadrant of the provinces shows provinces with higher prices of housing surrounded by higher prices (high - high) - similar to the third quadrant that is surrounded by a (low - low) combination; the second quadrant is surrounded by a combination of (low - high); and fourth quadrant comprises (high - low) combinations. If the sample observational values are evenly distributed in four quadrants, the housing prices between provinces are independent; there is no space effect between each other.

Fig. 1 indicates house prices on a Moran's I scatterplot, compiled with Geoda software, for 31 Chinese provinces and cities in 2011. The sample value of China's 31 provinces and cities is not randomly distributed in four quadrants, rather in a regular gathering distribution. Most Chinese provinces are located on the first and third quadrants, where people bear with higher housing prices and neighboring cities with higher housing prices, such as Beijing, Shanghai, Zhejiang, Jiangsu, and those provinces with lower housing prices and neighboring provinces with lower home prices, such as Chongqing, Guizhou, Hubei and Hunan. The spatial distribution of housing prices of different provinces is shown in Table 2.

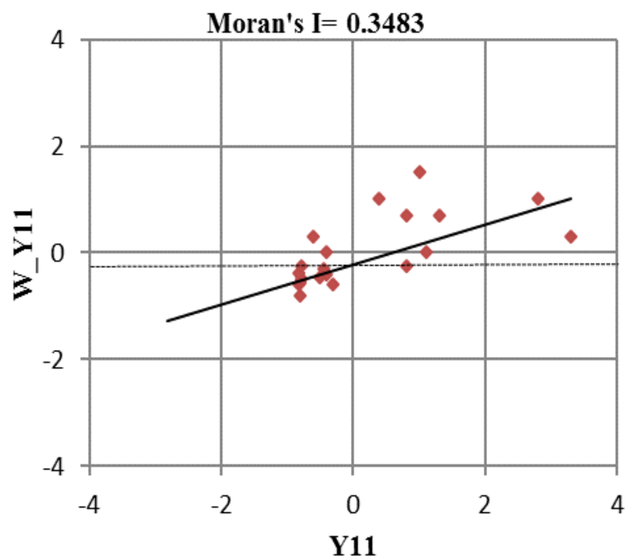

Fig. 1. Moran's I scatterplot for housing prices in 2011

Table 2
Spatial distribution of housing prices of 31 provinces in China

Quadrant	Model of spatial correlation	Distribution of 31 provinces in China
First quadrant	high - high	Zhejiang, Beijing, Tianjin, Fujian, Shanghai, Jiangsu
Second quadrant	low - high	Jiangxi, Hebei, Guangxi
Third quadrant	low - low	Yunnan, Xinjiang, Xizang, Sichuan, Shanxi, Shanxi, Shandong, Qinghai, Ningxia, Mongolia, Jilin, Hunan, Hubei, Heilongjiang, Henan, Guizhou, Gansu, Anhui, Chongqing, Liaoning
Fourth quadrant	high - low	Guangdong

5.3. *Residential market speculation measurement*

5.3.1. *Variable correlation test*

In order to avoid multicollinearity, a correlation test between variables needs to be conducted. The test results are shown in Table 3 below.

Table 3
Correlation analysis for indicators

		X1	X3	X4	X5	X6	X7	X8
	Pearson Correlation	1	-.020**	.144**	.695**	.569**	.502**	.387*
X1	Sig. (2-tailed)	-	.003	.001	.000	.001	.004	.012
	N	31	31	31	31	31	31	31
	Pearson Correlation	-.000**	1	.466**	.232**	.027*	-.094*	-.045**
X3	Sig. (2-tailed)	.001	-	.466**	.232**	.027*	-.094*	-.045**
	N	31	31	31	31	31	31	31
	Pearson Correlation	.144**	.466**	1	.258**	-.123*	-.182**	-.216*
X4	Sig. (2-tailed)	.001	.003	-	.001	.018	.004	.044
	N	31	31	31	31	31	31	31
	Pearson Correlation	.695**	.232**	.258**	1	.193**	.133*	.031
X5	Sig. (2-tailed)	.000	.000	.001	-	.008	.017	.037
	N	31	31	31	31	31	31	31
	Pearson Correlation	.569**	.027**	-.123**	.193**	1	.916**	.955**
X6	Sig. (2-tailed)	.001	.003	.000	.008	-	.000	.000
	N	31	31	31	31	31	31	31
	Pearson Correlation	.502	-.09	-.182*	.133**	.916**	1	.910**
X7	Sig. (2-tailed)	.004	.007	.028	.007	.000	-	.000
	N	31	31	31	31	31	31	31
	Pearson Correlation	.387**	-.45**	-.216**	031	.955**	.910**	1
X8	Sig. (2-tailed)	.002	.000	.004	.007	.000	.000	-
	N	31	31	31	31	31	31	31

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

5.3.2. Determination of space weight

In this study, based on the "rear adjacent" and "economic distance" method, certain improvements were made for determining the weights for each region, which reflect differences in the level of economic development among different provinces. The capital of China, Beijing, and four municipalities directly under the central government have a weight of 4; economically developed southern provinces, such as Guangdong, Fujian, and Zhejiang, have a weight of 3; economically developed provinces around the Yangtze River have a weight of 2; and the weight of western and eastern inland provinces is 1. The weighting assignments are shown in Table 4 below.

Table 4
Weight table of 31 provinces or cities

name	weight	Name	weight
Beijing	4	Hubei	2
Tianjin	3	Hunan	2
Hebei	1	Guangdong	3
Shanxi	1	Guangxi	3
Mongolia	1	Hunan	3
Liaoning	1	Chongqing	3
Jilin	1	Sichuan	2
Heilongjiang	1	Guizhou	2
Shanghai	4	Yunnan	2
Jiangsu	3	Shanxi	1
Zhejiang	3	Gansu	1
Anhui	2	Qinghai	1
Fujian	3	Ningxia	1
Jiangxi	2	Xinjiang	1
Shandong	3	Tibet	1
Henan	1	-	-

5.3.3. Results of speculation measurement

According to (17) previously described: $P = \rho W_1 P + \beta X + \mu$. The indicator variable $X_1, X_2, ..., X_6$ and the weight matrix are substituted into the model. Doing regression analysis using Geoda spatial econometric software packages, the regression equation indicates that the variable X_5, X_6 is not significant.

Table 5
Comparison of regressions and after excluding variables

Parameters	before excluding	After excluding
ρ	1.142 (0.000)	1.000 (0.000)
C	2637.420 (0.000)	2847.152 (0.000)
β_1	0.197 (0.000)	0.247 (0.001)
β_2	-1350.918 (0.000)	-1392.228 (0.000)

β_3	95.622 (0.000)	94.812 (0.000)
β_4	929.162 (0.000)	1005.075 (0.000)
β_5	0.705 (0.592)	—
β_6	-0.252 (0.648)	—
R^2	0.642	0.631

After deleting these two variables, the goodness-value R^2 of the equation had no significant reduction, indicating that the significance and goodness of the equations improved.

Measurement results of speculation are in shown in Table 6 and Fig. 2 below.

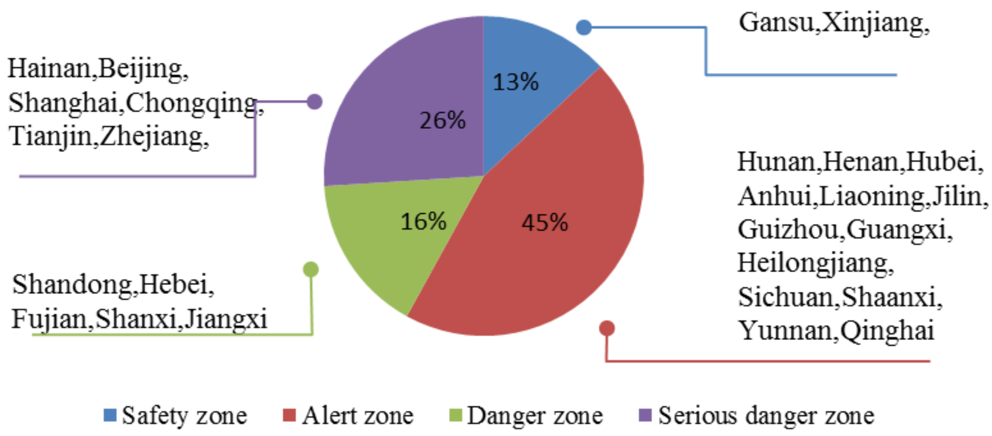

Fig. 2. Housing speculation zoning of 31 provinces

Table 6
Housing speculation degree of 31 provinces and cities of China

Name	Speculation degree	Name	Speculation degree
Beijing	0.530	Hubei	0.188
Tianjin	0.370	Hunan	0.200
Hebei	0.254	Guangdong	0.330
Shanxi	0.234	Guangxi	0.159
Mongolia	0.111	Hunan	0.600
Liaoning	0.180	Chongqing	0.480
Jilin	0.121	Sichuan	0.133
Heilongjiang	0.148	Guizhou	0.176
Shanghai	0.570	Yunnan	0.105
Jiangsu	0.340	Shanxi	0.117
Zhejiang	0.370	Gansu	0.090
Anhui	0.186	Qinghai	0.107
Fujian	0.244	Ningxia	0.070
Jiangxi	0.210	Xinjiang	0.080
Shandong	0.272	Tibet	0.050
Henan	0.193	-	-

Note: The degree of speculation in the table is a regression analysis of the provinces, the sample contains the provinces' 14-year data from 1998 to 2011.

6. Results and Discussion

Measurement results of speculation are matched with the economic development of Chinese provinces and cities, particularly in residential development. Hainan has the highest degree of speculation, which is related to its unique tourism resources. In recent years, a lot of speculators in Hainan buy villas, houses and so on, leading to the rapid growth of speculative demand in Hainan's residential market, which has the highest rate of housing price increase in China. Jiangsu Province as the most developed eastern coastal province, adjacent to Shanghai, has many star cities like Nanjing, Suzhou, Yangzhou, and Wuxi. The rise of the city of Nantong in recent years led the development of the residential market in this province. Guangdong Province, as China's earliest open province, also with most foreign worker population, is a modern market economy where the housing market has become the target of speculators. Of the five provinces in the speculation danger zone, Shandong, Hebei, Fujian, Shanxi, and Jiangxi, Shandong and Fujian provinces are coastal and therefore economically strong. Jiangxi is surrounded by Zhejiang, Fujian, and Guangdong, three economically developed coastal province in the southeast, and adjacent to Hunan, Hubei, and Anhui, three inland provinces in the east and west. Consequently, Jiangxi is one of the provinces that adjoin the most number of provinces in China and its external resources and information flow has led to the development of its residential market.

Most provinces in the warning area are inland provinces, with economic resources and infrastructure being continuously improved and the housing market on the rise. Economic development of the provinces in a safe area is lagging behind, so people are buying houses to improve their living standards. With less speculative factors, the housing market is in a period of initial development, and the corresponding support for building houses remains to be further improved.

At present, the degree of housing speculation around China is not the same, showing a regional agglomeration distribution. Speculative behavior is more common in municipalities and in eastern coastal provinces where speculative demand for housing has resulted in too strong a demand in the market. By contrast, the housing market in the western and central inland provinces appears relatively deserted, in line with the real situation of the country's economic development. Municipalities in the eastern region have a unique location and economic advantages as the production of raw materials, capital and labor from the various regions tend to flow here. It is easy to see how expansive speculation is expressed in the changing performance of housing prices. According to the size of the housing speculation of China's 31 provinces, a quartile figure is shown as Fig. 3. The darker colors refer to the larger speculative values in residential areas.

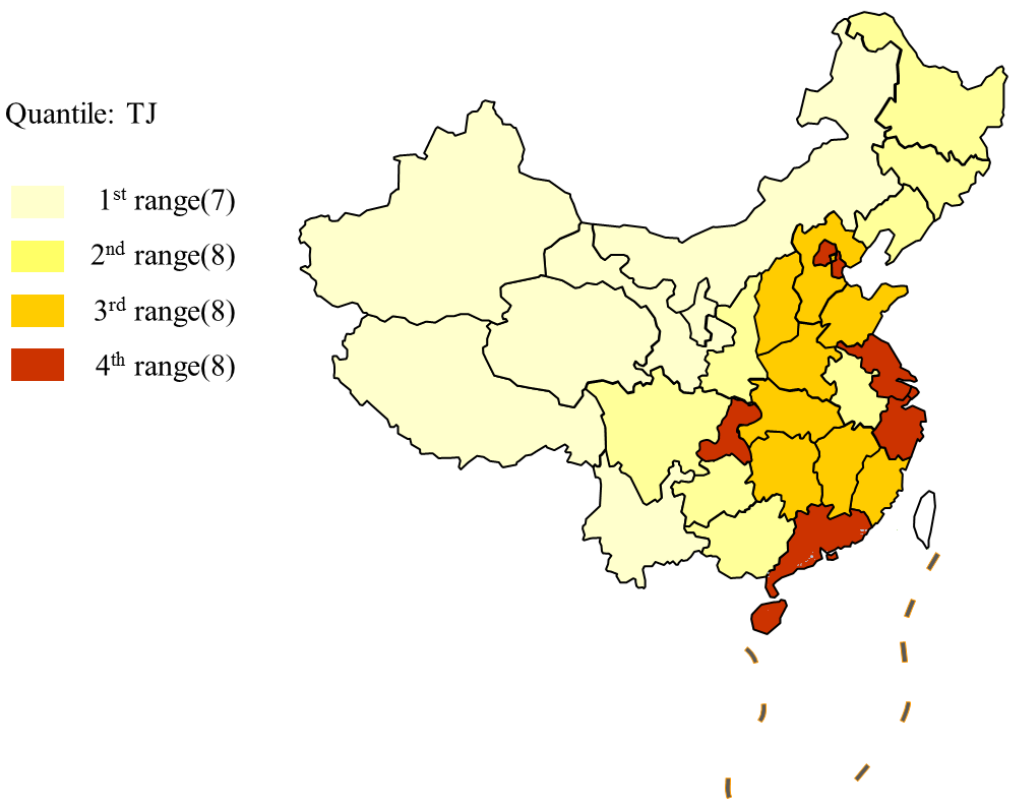

Fig. 3. Quartile map of degree of housing speculation in China's 31 provinces.

There is a spatial effect in speculation. Residential speculation is often accompanied with changes in housing prices. The spatial correlation between house prices in different provinces has been previously validated, so it is not hard to understand the spatial correlation in degree of speculation. Although economists have no scientific quantitative analysis and interpretation for the spatial effects, some possible explanations might be: migration, arbitrage across different areas, property exchange, information dissemination, and economic differences.

China's major population movements are from the economically less developed areas to economically developed areas, or between economically developed provinces. Inflows of foreign population will increase demand for housing, thus causing housing prices rise. This one-directional flow of migrants means that housing prices in inland provinces and cities are often lower than in coastal areas. If housing prices are beyond the purchasing power of residents, people will choose to buy houses in neighboring provinces. This population movement causes residential demand in housing prices in the neighboring provinces. Housing prices between the two adjacent provinces tend to gradually reach an equilibrium point in a dynamic process, which often exhibits a high-high or low-low mode. Information dissemination and spatial arbitrage also have an impact on the spatial effects of price and speculation at the equilibrium point. Given the widespread access to information channels, speculators have access to information in all the surrounding housing markets. Speculators make price comparisons and consider expected future earnings available to seek arbitrage opportunities. The adequacy of information and the expanding spending power of buyers have led to the spread of speculation in space. The process of this linkage effect is that a city's housing market price increases significantly, which leads to speculation expansion of residential housing in the area, which leads to changes of consumer expectations in other adjacent areas, which finally leads to increased housing speculation elsewhere. Because this space linkage, housing prices and speculation between adjacent areas often exhibit convergence, which makes it difficult to, show a spatial mode of high - low prices or high - low degree of speculation.

This paper described a study that compiled a measurement index for the spatial correlation of speculation degree in China's housing market, and established a speculation housing price model. In analyzing the speculation and considering the spatial correlation between different regions, a spatial weight matrix was used to reflect the impact of space speculation so that the proposed model of speculative measurement is more scientific and adaptable. However, a limitation of the study is that it did not consider the spatial correlation between cities within provinces due to the non-availability of data in this respect; there is often a big difference between cities in the same province, as the speculative demand for housing in capital cities and some star cities is much higher than other cities. Future related research should therefore refine the indicators as well as measure the inter-provincial spatial correlation of speculative degree and housing price.

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