An analysis of the "direct effect" and "indirect effect" of urban housing prices on the upgrading of industrial structure——Based on data of 285 cities

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Abstract. In order to investigate the extent of the impact of changes in urban housing prices on the transformation and upgrading of industrial structure and the spatial related characteristics under the big data environment, this paper based on the sample data of cities at prefecture level and above in China from 2007 to 2016 establishes a spatial dynamic Durbin model with spatial geographical proximity, spatial geographic distance and spatial economic distance as weight matrix, so as to measure the direct impact of housing price fluctuation on industrial structure upgrading Indirect effect and indirect effect.

1. Introduction
The two yuan land structure of urban and rural areas in China determines the special status of the "Trinity" of local government state-owned land owners, suppliers and monopolists. In the process of urbanization, a large number of rural population has influx into the city, promoting the rapid rise of urban housing prices. In addition, since the reform of China's real estate market, real estate has become the pillar industry of the national economy. The prices of major cities have entered the accelerated rising channel, and the real estate market has opened a round of bull market. Whether the growth of housing price is an important factor affecting the upgrading of industrial structure has become one of the important issues studied by domestic scholars in recent years.

Looking at the research results of domestic and foreign scholars, it is rare for housing prices to directly affect the industrial structure. Most of the studies on housing prices affect the upgrading of industrial structure through intermediate variables. Therefore, the research on the upgrading of industrial structure can be divided into the following 2 aspects. First, housing prices affect consumption and thus industrial structure upgrading. Second, housing prices affect labor mobility and thus industrial structure upgrading. From the perspective of consumption, the increase of housing price will lead to the change of consumption structure, and consumption directly affects the development of related industries in the tertiary industry. Overseas research on the impact of housing prices on consumption focuses on the wealth effect. Apergis N (2014) conducted a panel co integration test based on the consumption data of South Africa from 1995 to 2011, and found that the rise in house prices will lead to an increase in consumption, which will bring about a certain housing wealth effect, and there is a two-way causal relationship between house prices and consumption ^1. Attanasio O P (2009) studied the growth of house prices and consumption and believed that the rise of house prices increased the wealth effect of households, and the growth of house prices reduced credit constraints by increasing collateral ^2. Attanasio O (2011) has been incorporated into the real characteristics of the...
British mortgage market. By building a real structural life cycle model of consumption and housing decision-making to explain the correlation between housing prices and consumption, the research found that the impact of housing prices should have a greater impact on the consumption of elderly families and the income impact of young families. From the perspective of labor force, the growth of housing prices leads to labor mobility, and the transfer of labor-intensive industries and technology is highly related to housing prices. The industrial development is largely affected by labor force. Dumais G (2002) believed that when the labor force can flow freely in different regions, workers will select regions according to their own actual situation, and industrial transfer and industrial upgrading will occur in the process, which is based on the consideration of workers on urban industrial transformation and upgrading. In the same view, Hanson G H (1996) believes that when the industry transfers, a large number of labor will flow into the corresponding regions along with the transfer of the industry. After Krugman put forward the new Economic Geography Standard model, Helpman introduced housing market factors on the basis of the standard model. Helpman believed that excessively high housing price would have a negative impact on the relative utility of workers, and the housing cost of residents would increase with the rise of housing price, which hindered the pull of population mobility and hindered the free flow of labor in various regions.

In summary, the existing research on the impact of housing price fluctuations on the industrial structure, mostly from the study of the wealth effect, labor flow, consumption preference and other aspects arising from the fluctuations of the sales price of commercial housing, indirectly derived the relationship between the fluctuations of the sales price of commercial housing and the industrial structure. However, due to the samples selected by the research, the time span is different, which reveals the relationship between housing prices and industrial structure adjustment from a certain perspective, but is still lack of systematicness. Although a few scholars have studied the direct effect mechanism of the fluctuation of the selling price of commercial housing on the evolution of industrial structure, few scholars have incorporated the spatial factors into the research on the influence of the fluctuation of the selling price of commercial housing on the evolution of industrial structure. Even though most of the researches on the spatial effect are based on the factors of geographical proximity and distance, the reality is that the layout of many industries does not completely present the layout characteristics of neighboring areas, and more cross provincial or even multinational, that is, the incomplete geographical factors should be taken into account when investigating the spatial factors. For the sake of the robustness of the results, the economic distance needs to be added to the framework in this paper. In the case that the spatial spillover effect may exist in the mechanism of the impact of housing price fluctuations on the industrial structure evolution, the empirical research that neglects the spatial effect cannot not only fully reveal the mechanism of the industrial structure evolution caused by the fluctuations in commodity housing prices, but also misjudge the situation due to the setting error of the model, resulting in the policy recommendations cannot effectively solve the existing problems in reality. Based on this, this paper attempts to use the panel data of 285 prefecture level and above cities from the perspective of spatial effect, and introduces 3 spatial weight matrix of spatial adjacency, spatial distance and spatial economic distance, comprehensively uses the spatial lag model (SLM), spatial error model (SEM) and spatial Dupin model (SDM) to conduct empirical analysis, and obtains the direct adjustment of housing price to industrial structure indirect and indirect effects. At the same time, the gap between the current situation of the industrial structure is wide, and the impact of housing prices on the industrial structure is bound to be regional diversity due to the imbalance of regional economic development in China. Therefore, the article also conducted studies on different regions, providing a certain basis for a comprehensive understanding of the relationship between them.
2. Materials and Methods

2.1. Spatial econometric model

At present, most of the spatial measurement models are mainly carried out between the spatial error model and the spatial lag model. With the deepening of the research, LeSage and Pace enriched and developed the spatial error model and the spatial lag model. It points out that the spatial Dupin model should be adopted if the effects of both the explained variable with spatial lag effect and the explained variable with spatial lag effect on the explained variable need to be considered. The model is a general form of the spatial error model and the spatial lag model, and the spatial Dupin model can effectively capture the direct effect and the indirect effect \(^1\). Therefore, the model mainly focuses on the direct and indirect effects of housing prices on the upgrading of industrial structure based on the research purposes and assumptions. In this paper, the spatial Durbin model (SDM) is used for research, and its basic form is set as follows:

\[
Y_t = \rho \sum_{j=1}^{N} W_{ij} Y_j + \alpha CHP + \beta X_i + \sum_{j=1}^{N} W_{ij}(CHP_j + X_j)\theta + \mu_i + \lambda_t + \epsilon_t
\]

Among them, \(Y\) is the explained variable (in this paper, RIS and LS are explained variables of industrial structure rationalization), \(i\) represents city and \(t\) represents time (year). \(W\) is the spatial weight matrix which has been standardized, CHP represents house price, \(\alpha\) and \(\beta\) are the parameters to be estimated, \(\mu_i\) and \(\lambda_t\) are individual effect and time effect, respectively, and \(\epsilon\) is the random error term.

2.2. Spatial weight matrix

"The first law of geography" points out that the geospatial observations have certain spatial dependence or spatial self correlation characteristics. That is, a certain economic and geographical phenomenon on a spatial section or a certain attribute value is related to the same phenomenon or attribute value on the adjacent spatial section, and the correlation between the closer observation value is greater than the far observation value \(^1\). From this idea, the spatial weight matrix in the spatial econometric model is introduced. In this paper, three spatial weight matrices are introduced to analyze the impact of housing price on industrial structure more accurately.

1. Spatial adjacency weight matrix (W1). The construction of spatial adjacent weight matrix follows the principle of Rook adjacent judgment, and the matrix elements are set as follows: the elements on the main diagonal are all 0, and the elements in other positions are 1 according to whether the regions are adjacent, otherwise they are 0.

2. Inverse distance square space weight matrix (W2). The distance calculation method is that we use the latitude and longitude of each city to calculate the distance \(d\) between them, so as to construct the inverse distance matrix.

\[
W_{ij} = \begin{cases} 
1/d_{ij}^2, & i \neq j \\
0, & i = j
\end{cases}
\]

3. Economic distance weight matrix (W3). The economic distance mainly considers that there are certain differences in the economic development degree of different regions, and the regions with high economic development degree often have stronger influence \(^1\). Based on the GDP of each region, this paper constructs the following economic distance matrix:

\[
W_3 = W_2 \text{diag} \left( \frac{\overline{Y}_1}{\overline{Y}}, \frac{\overline{Y}_2}{\overline{Y}} \cdots \frac{\overline{Y}_n}{\overline{Y}} \right)
\]

Among them, \(\overline{Y}_i\) is the average value of GDP of the \(i\) region during the inspection period and \(\overline{Y}\) is the actual average value of GDP during the inspection period.
2.3. Selection of indicators

2.3.1. Explained variable

The upgrading indicators of industrial structure include rationalization of industrial structure (RIS) and upgrading of industrial structure (LS): Here, we adopt the measurement index of industrial structure rationalization and industrial structure upgrading defined by the Taier index referred by Gan Chunhui (2011) 17. The specific measurement formula is as follows:

\[
RIS = TL = \sum_{i=1}^{n} \left( \frac{Y_i}{Y} \right) \ln \left( \frac{Y_i / Y}{L_i / L} \right) = \sum_{i=1}^{n} \left( \frac{Y_i}{Y} \right) \ln \left( \frac{Y_i / L_i}{Y / L} \right)
\]

(4)

\[
LS = \frac{Y_2}{Y_3}
\]

(5)

TL is a good indicator to measure the rationality of industrial structure. Where, Y and L represent output value and labor force respectively, and I represents 3 industries. Therefore, Yi and Li are the output value and labor force of the 3 industries respectively, and n represents the number of industries (n=1,2,3). According to the theory of classical economics, the productivity level of each industrial sector is the same when the economy is in a state of equilibrium. By definition, Y/L represents productivity. Therefore, when the economy is in equilibrium, Yi/Li=Y/L, thus TL=0. Meanwhile, Yi/Y represents the output structure and Li/L represents the employment structure. Therefore, TL is also a response to the coupling of output structure and employment structure.

2.3.2. Main explanatory variables

Residential price (CHP): According to the Helpman model and the theoretical analysis in this paper, the relationship between consumers and residential products is the most close, and the housing price will affect consumers' expectations for the future life. Therefore, we use the housing price of each city every year as the benchmark indicator.

2.3.3. Control variables

Gross product per capita (PGDP): Driving the long-term rational development of industrial structure, a stable economic development status is one of the important factors to promote its reasonable evolution. Most previous studies used GDP per capita to show the regional economic conditions. Here, we refer to the measurement method of Li Yonggang and Wang Meng (2015), and use the per capita GDP data of China's urban statistical yearbook to measure 36.

Fiscal freedom (MD): As a market economic system regulated by the state, the government plays a particularly important role in promoting the stable development of the national economy. When the market-oriented system is not fully mature, the government needs to strengthen the supervision and do a good job in the filling of market regulation. In particular, the rational development of regional industries cannot do without the guidance and support of the government. We take the ratio of fiscal expenditure in the government budget to GDP as the fiscal freedom of the government.

Fixed asset investment (IFA): Investment in fixed assets is an economic activity for the construction and purchase of fixed assets and an important way to expand social reproduction. It can not only increase the production capacity, expand the scale of production, adjust the industrial structure, but also form a demand for the production of various industries, which is a factor that cannot be ignored in the research on the rational development of industrial structure 19. The ratio of fixed asset investment in each city to GDP is used to measure.

Financial Support (ECO): The important role of the financial system in the process of industrial structure adjustment and economic growth has been confirmed by many documents 20. The financial system can adjust the urban industrial structure through resources allocation and reducing information asymmetry. At this stage, China's financial system is still dominated by the banking sector. Therefore,
this paper uses the practices of Cui Yanjuan and Sun Gang as reference, and takes the ratio of total deposits and loans at the end of each year to GDP as a measure of financial support.

2.4. Data description and description statistics

This paper selects the data of 285 prefecture level cities in China from 2007 to 2016 for empirical analysis. The data are from China Urban Statistics Yearbook. MATLAB is used for analysis, and the sorting is as shown in Table 1:

| Variable symbol | Variable name                        | Observations | mean  | standard deviation | minimum value | Maximum |
|-----------------|-------------------------------------|--------------|-------|--------------------|---------------|---------|
| RIS             | rational structure of production    | 2850         | 0.2660| 0.2188             | 0.0001        | 3.5172  |
| LS              | Advanced industrial structure       | 2850         | 0.8423| 0.4883             | 0.0063        | 12.0440 |
| CHP             | Housing price (10000 yuan / m²)     | 2850         | 0.3981| 0.2757             | 0.0845        | 4.5498  |
| PGDP            | Per capita GDP (RMB ten thousand)   | 2850         | 3.9698| 3.02878            | 0.0099        | 46.7749 |
| FD              | Fiscal freedom                      | 2850         | 0.8241| 0.0991             | -0.4852       | 0.9618  |
| IFA             | Investment in fixed assets          | 2850         | 0.7176| 0.2735             | 0.0872        | 2.1969  |
| ECO             | Financial support                   | 2850         | 0.8985| 1.5420             | 0.0193        | 48.5452 |

3. Empirical analysis

Global spatial auto correlation is a description of the spatial characteristics of attribute values in the whole region. In the current spatial econometrics, the Moran index I index and Geary index are usually used to measure the spatial auto correlation \(^2\). In this paper, Moran index I, which is widely used, is used for correlation analysis. The formula of Moran index I is as follows:

\[
I = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij} (Y_i - \bar{Y})(Y_j - \bar{Y})}{\frac{1}{n} \sum_{i=1}^{n} (Y_i - \bar{Y})^2 \sum_{j=1}^{n} \sum_{j=1}^{n} W_{ij}}
\]

Where, \(\bar{Y} = \frac{1}{n} \sum_{i=1}^{n} Y_i\), \(Y_i\) is the value of the first city, \(W_{ij}\) is the spatial weight matrix. The value of Moran index I is: the greater the absolute value of I, the stronger the correlation. When Moran index I>0, there is a positive correlation between regions. When the Moran index I<0, there is a negative correlation between regions. When Moran index I=0, there is no correlation between regions. The Moran index of rationalization and advancement of industrial structure and urban housing price calculated by MATLAB is shown in Table 2. It can be seen that no matter which spatial weight matrix is used, the Moran index obtained is significantly positive at the level of 1%. From the Moran index trend chart of the weight matrix, it can be seen that the trend of the Moran index under the 3 weight matrix is basically the same, indicating that the industrial structure and housing prices have a high degree of spatial correlation.
Spatial correlation refers to the potential mutual dependence of some variables among the observation data in the same distribution area. The study of spatial auto correlation needs to be analyzed from the perspectives of global spatial auto correlation and local auto correlation.

3.1. Spatial auto correlation analysis
Spatial correlation refers to the potential mutual dependence of some variables among the observation data in the same distribution area. The study of spatial auto correlation needs to be analyzed from the perspectives of global spatial auto correlation and local auto correlation.

3.1.1. Global spatial auto correlation

| Year | Spatial adjacency weight matrix (W1) | Inverse distance square weight matrix (W2) | Economic distance weight matrix (W3) |
|------|-------------------------------------|------------------------------------------|------------------------------------|
|      | Rationalization (RIS) | Advanced (LS) | Housing price (CHP) | Rationalization (RIS) | Advanced (LS) | Housing price (CHP) | Rationalization (RIS) | Advanced (LS) | Housing price (CHP) |
| 2007 | 0.406*** | 0.113*** | 0.349*** | 0.244*** | 0.058*** | 0.252*** | 0.175*** | 0.026*** | 0.325*** |
|      | (10.238) | (2.947) | (9.013) | (13.401) | (3.384) | (14.142) | (9.638) | (1.633) | (18.113) |
| 2008 | 0.373*** | 0.117*** | 0.391*** | 0.225*** | 0.053*** | 0.265*** | 0.161*** | 0.018*** | 0.324*** |
|      | (9.447) | (3.039) | (10.047) | (12.46) | (3.111) | (14.809) | (8.946) | (1.185) | (18.016) |
| 2009 | 0.377*** | 0.209*** | 0.383*** | 0.223*** | 0.065*** | 0.259*** | 0.162*** | 0.036*** | 0.334*** |
|      | (9.547) | (5.375) | (9.861) | (12.346) | (3.789) | (14.506) | (8.954) | (2.145) | (18.568) |
| 2010 | 0.381*** | 0.21***  | 0.385*** | 0.23***  | 0.06***  | 0.249*** | 0.165*** | 0.036*** | 0.319*** |
|      | (9.637) | (5.441) | (9.907) | (12.724) | (3.483) | (13.937) | (9.148) | (2.17) | (17.775) |
| 2011 | 0.353*** | 0.226*** | 0.417*** | 0.209*** | 0.065*** | 0.288*** | 0.140*** | 0.047*** | 0.355*** |
|      | (9.009) | (5.843) | (10.729) | (11.626) | (3.768) | (16.124) | (8.294) | (2.779) | (19.736) |
| 2012 | 0.36***  | 0.208*** | 0.436*** | 0.212*** | 0.061*** | 0.294*** | 0.14***  | 0.049*** | 0.351*** |
|      | (9.112) | (5.4) | (11.147) | (11.714) | (3.545) | (16.373) | (7.757) | (2.873) | (19.399) |
| 2013 | 0.29***  | 0.233*** | 0.393*** | 0.18***  | 0.068*** | 0.275*** | 0.101*** | 0.055*** | 0.352*** |
|      | (7.324) | (6.035) | (10.136) | (9.934) | (3.924) | (15.43) | (5.638) | (3.229) | (19.6) |
| 2014 | 0.33***  | 0.295*** | 0.364*** | 0.197*** | 0.102*** | 0.25***  | 0.121*** | 0.075*** | 0.33*** |
|      | (8.063) | (7.614) | (9.421) | (10.834) | (5.854) | (14.105) | (6.691) | (4.323) | (18.443) |
| 2015 | 0.134*** | 0.077*** | 0.297*** | 0.083*** | 0.034*** | 0.215*** | 0.01***  | 0.02***  | 0.296*** |
|      | (3.873) | (2.632) | (7.939) | (5.288) | (2.691) | (12.5) | (0.8) | (1.657) | (17.038) |
| 2016 | 0.284*** | 0.275*** | 0.293*** | 0.162*** | 0.103*** | 0.214*** | 0.093*** | 0.059*** | 0.307*** |
|      | (7.172) | (7.077) | (8.05) | (8.965) | (5.842) | (12.841) | (5.191) | (3.446) | (18.184) |

(Note: Z value in brackets, *, **, *** respectively indicate 10%, 5%, 1% significance level)

3.1.2. Local spatial auto correlation
The global auto correlation statistics only provide a general description of the spatial auto correlation of the whole research space. The premise of its correct application is to require homogeneous spatial processes, and the conclusion is not reliable when the spatial processes are homogeneous. In order to identify the spatial variability correctly, local spatial auto correlation statistics are applied. At present, the commonly used statistics are local Moran index and Moran scattered point graph. The formula of local Moran index I is as follows:
The 4 quadrants of the Moran scatterer map correspond to 4 types of local spatial connection situations between a certain area and the adjacent area respectively: the first quarter represents the HH area, i.e. the high value area is surrounded by the same high value area; the second quarter indicates that the low value area is surrounded by the low value area (LH); the third quarter indicates LL, i.e. the low value area is surrounded by the low value area; the fourth quarter indicates that the high value region is surrounded by the low value region (HL).

Limited to space, here is a random selection of reference data for a certain year. The rationalization and upgrading of industrial structure and the Moran scattered point of housing prices in 2012 are based on the economic distance matrix. As can be seen from the figure, 2/3 of the cities are located in the first and third quarters, which indicates the rationalization and upgrading of industrial structure and the HH agglomeration and LL agglomeration of housing prices. Therefore, there is a positive spatial correlation between the rationalization and upgrading of industrial structure and housing prices.

3.2. Direct and indirect effects

In the case of spatial correlation, the explanatory variables in a group of observation data of any region will not only directly affect the explanatory variables, but also affect the explanatory variables in the region with spatial correlation. LeSage and Pace (2009) refer to the former as direct effect and the latter as indirect effect. The above tests show that the SDM model has a good fitting effect, and the space panel model test also shows that SDM should be used. However, the estimation parameters of lag explanatory variables in SDM are not the magnitude of indirect effects (Elhorst, 2010). To this end, we first rewrite the SDM into a matrix form:

$$Y = (I - \rho W)^{-1}\alpha + (I - \rho W)^{-1}(X\beta + WX\theta) + (I - \rho W)^{-1}\varepsilon$$  \hspace{1cm} (8)

Where, \( I \) is the unit vector, \( I_N \) is the unit vector of \( N \times 1 \), \( \varepsilon \) is the specific effect in space and time. The partial differential matrix of Variable k is:

$$\begin{bmatrix} \frac{\partial Y}{\partial x_{k1}} & \cdots & \frac{\partial Y}{\partial x_{kn}} \end{bmatrix} = (I - \rho W)^{-1}[I\beta_k + W\theta_k]$$  \hspace{1cm} (9)

Where the mean value of the diagonal elements of the rightmost matrix represents a direct effect, and the mean value of the sum of the non-diagonal elements in each row or column represents an indirect effect. From the above formula, the direct and indirect effects of urban housing prices on industrial structure upgrading based on geographical proximity, geographical distance and economic distance can be obtained respectively.

3.3. Spatial model analysis

Due to the special cases of spatial Dupin model (SDM), i.e. spatial lag model (SLM) and spatial error model (SEM), it is necessary to conduct corresponding parameter test before directly adopting spatial Dupin model, so as to check whether SDM needs to be reduced to spatial error model or spatial lag model. There are 3 main methods of spatial Metrology: LM test, Wald test and LR test. Among them, the LM test only needs to carry out regression estimation on the ordinary linear model, and this paper uses the ordinary least square method to get it; Wald test and LR test are parameters estimation based on spatial regression model. Therefore, we can judge whether the original assumption is rejected according to the estimated results for the selection of SDM, SLM and SEM. In this paper, correlation tests are carried out based on 3 different spatial weight matrix, and the results are summarized as shown in Table 3. As shown in Table 3, no matter what kind of spatial weight matrix is used, the sum of residual square in the second column of the spatial fixed effect model and the fourth column of the double fixed effect model is about 0.06, which is the smallest, and the sum of regression square $R^2$ is
about 75%, which is the largest of the 4 fixed effects. In the same model, both of them have better logarithmic likelihood. From the perspective of LM test, LM test based on 3 kinds of spatial weight matrix can pass, but Robust LM test of some models cannot pass significantly. Whether fixed in space or fixed in both directions, both Wald test and LR test pass the test at the level of 1% significance, indicating that it will be more convincing to choose SDM model for empirical analysis. At the same time, there was no significant difference between the regression results under the effects of space fixation and double fixation. Therefore, this paper will discuss the direct and indirect effects of urban housing prices on the industrial structure based on the SDM model of spatial double fixed effect.

| Inspection 1 | Based on adjacent space weight matrix (W1) |
|--------------|------------------------------------------|
|              | No fixed (1) | Fixed space (2) | Fixed time (3) | Two way fixing (4) |
| LM test spatial lag | 189.0545*** (0.0000) | 184.3102*** (0.0000) | 140.1311*** (0.0000) | 34.0250*** (0.0000) |
| robust LM test spatial lag | 1.9677 (0.1610) | 27.3718*** (0.0000) | 1.5216 (0.2170) | 5.7897*** (0.0160) |
| LM test spatial error | 249.2553*** (0.0000) | 166.5526*** (0.0000) | 183.1190*** (0.0000) | 31.1914*** (0.0000) |
| robust LM test spatial error | 62.1685*** (0.0000) | 9.6142*** (0.0020) | 44.5095*** (0.0000) | 2.9561*** (0.0000) |
| Wald_spatial_lag | — (0.0000) | 45.7206*** (0.0000) | 41.6768*** (0.0000) | 16.2262*** (0.0062) |
| Wald_spatial_error | — (0.0000) | 53.7725*** (0.0124) | 14.5636*** (0.0124) | 18.0261*** (0.0065) |
| LR_spatial_lag | — (0.0000) | 49.8559*** (0.0000) | 43.2040*** (0.0000) | 16.1133*** (0.0029) |
| LR_spatial_error | — (0.0000) | 59.5673*** (0.0121) | 14.6156*** (0.0121) | 17.9516*** (0.0030) |
| sigma^2 | 0.18 | 0.0673 | 0.174 | 0.0604 |
| log-likelihood | -1496.5375 | -114.8598 | -1472.2476 | -20.3578 |
| R-squared | 0.3118 | 0.7381 | 0.3204 | 0.7514 |

| Inspection 2 | Based on spatial distance weight matrix (W2) |
|--------------|------------------------------------------|
|              | No fixed (1) | Fixed space (2) | Fixed time (3) | Two way fixing (4) |
| LM test spatial lag | 128.9665*** (0.0000) | 448.3351*** (0.0000) | 59.8580*** (0.0000) | 41.2534*** (0.0000) |
| robust LM test spatial lag | 23.7233*** (0.0000) | 25.8965*** (0.0000) | 29.3850*** (0.0000) | 5.8275** (0.0160) |
| LM test spatial error | 266.9983*** (0.0000) | 423.5424*** (0.0000) | 136.6054*** (0.0000) | 37.3554*** (0.0000) |
| robust LM test spatial error | 161.7557*** (0.0000) | 1.1038 | 106.1329*** (0.0000) | 1.9294 (0.1650) |
| Wald_spatial_lag | — (0.0000) | 42.6469*** (0.0000) | 115.5616*** (0.0000) | 28.1095*** (0.0000) |
| Wald_spatial_error | — (0.0000) | 46.2488*** (0.0000) | 62.0834*** (0.0000) | 17.9516*** (0.0030) |
| LR_spatial_lag | — (0.0000) | 45.1404*** (0.0000) | 115.4822*** (0.0000) | 26.9259*** (0.0000) |
| LR_spatial_error | — (0.0000) | 51.3414*** (0.0000) | 58.0814*** (0.0000) | 28.5970*** (0.0000) |
| sigma^2 | 0.18 | 0.0673 | 0.174 | 0.0604 |
| log-likelihood | -1496.5375 | -114.8598 | -1472.2476 | -20.3578 |
| R-squared | 0.3118 | 0.7381 | 0.3204 | 0.7514 |

| Inspection 3 | Based on spatial economic distance weight matrix (W3) |
|--------------|------------------------------------------|
|              | No fixed (1) | Fixed space (2) | Fixed time (3) | Two way fixing (4) |
| LM test spatial lag | 128.9665*** (0.0000) | 448.3351*** (0.0000) | 59.8580*** (0.0000) | 41.2534*** (0.0000) |
| robust LM test spatial lag | 23.7233*** (0.0000) | 25.8965*** (0.0000) | 29.3850*** (0.0000) | 5.8275** (0.0160) |
| LM test spatial error | 266.9983*** (0.0000) | 423.5424*** (0.0000) | 136.6054*** (0.0000) | 37.3554*** (0.0000) |
| robust LM test spatial error | 161.7557*** (0.0000) | 1.1038 | 106.1329*** (0.0000) | 1.9294 (0.1650) |
| Wald_spatial_lag | — (0.0000) | 42.6469*** (0.0000) | 115.5616*** (0.0000) | 28.1095*** (0.0000) |
| Wald_spatial_error | — (0.0000) | 46.2488*** (0.0000) | 62.0834*** (0.0000) | 17.9516*** (0.0030) |
| LR_spatial_lag | — (0.0000) | 45.1404*** (0.0000) | 115.4822*** (0.0000) | 26.9259*** (0.0000) |
| LR_spatial_error | — (0.0000) | 51.3414*** (0.0000) | 58.0814*** (0.0000) | 28.5970*** (0.0000) |
| sigma^2 | 0.18 | 0.0673 | 0.174 | 0.0604 |
| log-likelihood | -1496.5375 | -114.8598 | -1472.2476 | -20.3578 |
| R-squared | 0.3118 | 0.7381 | 0.3204 | 0.7514 |
3.4. Regression analysis

Under the big data environment, a large number of samples are selected in this paper, and Matlab software is used to estimate and test the SDM model constructed previously. Combined with table 3, the two-way fixed effect model in space and time is finally adopted. In this part, we will carry out SDM model regression on the overall level of the country and the level of geographical location differences based on the spatial weight matrix of geographical proximity, geographical distance and economic distance.

3.4.1. Regression analysis of the whole China

It can be seen from the above that both the upgrading of industrial structure and urban housing prices have significant spatial dependence. If the role of spatial factors is ignored, it is difficult to comprehensively analyze the mechanism and spatial effect of urban housing prices on the upgrading of industrial structure. Table 4 is the empirical results of the impact of housing prices on the upgrading of industrial structure on the national level based on the SDM model. From the statistics of R square, log-likelihood and sigma^2, it can be seen that the fitting effect of the model in 3 kinds of spatial weight matrix is better, and the overall regression reliability is higher, indicating that the results are stable.

From the perspective of explanatory variables, whether it is the rationalization of industrial structure or the advancement of industrial structure, on the one hand, based on the direct effect, the direct effect coefficient of urban housing price is significantly positive. Taking the economic distance weight matrix as an example, the direct effect coefficient of housing price on the rationalization of industrial structure is 0.0558, which is significant at the level of 5% significance. It is clear that each percentage point increase in the local residential price will lead to an average increase of about 0.0558 percentage points in the rationalization index of industrial structure in the region. The direct effect coefficient of housing price on the upgrading of industrial structure is 0.3317, which is significant at the level of 1% significance, indicating that each percentage point increase in the local housing price will lead to an average increase of about 0.3317 percentage points in the rationalization index of industrial structure in the region. This shows that the rise of urban housing prices has a significant positive impact on the upgrading of the industrial structure in the region. The continuous rise of urban
housing prices will lead to the outflow of ordinary labor, change the supply structure of labor within the city, and improve the balanced wage level while forming a new employment cluster. Low efficiency labor intensive and some capital intensive enterprises are forced to move out due to the pressure of rising house prices, land rents and labor costs. However, technology intensive enterprises tend to cluster in cities due to their relatively insensitive to factors such as house prices and labor costs, and in order to make full use of the advantages of technology spillover of urban centers, thus promoting the upgrading of industrial structure within cities. On the other hand, the residential price has no significant impact on the rationalization of industrial structure in the adjacent areas based on the indirect effect. However, from the perspective of advanced industrial structure, the increase of 1 percentage point in local house prices will reduce the advanced industrial structure indicators of adjacent areas by 0.1806 percentage points. This may be due to the increase in consumption level and cost of living driven by colleagues with rising housing prices in the region, which will lead to the loss of labor force of some companies with lower wage level to the adjacent areas, and the relatively balanced state of industrial structure in the adjacent areas will be broken. Among them, the regression coefficient of the impact of housing prices on the upgrading of industrial structure is significantly larger than the regression coefficient of the rationalization of industrial structure. Therefore, from the national overall level, the impact of housing prices on the upgrading of industrial structure mainly affects the development of the upgrading of industrial structure.

From the perspective of control variables, only fixed asset investment has a negative impact on the local area, and other variables are not significant. In terms of the housing price for the industrial structure advanced regression, the control variable fixed asset investment has a negative impact on the local area and the adjacent areas, the government intervention has a positive role in promoting the local area, has a positive but not significant role in promoting the adjacent areas, and the financial support has a promoting role in the local area and the adjacent areas. GDP per capita has no significant impact on the region and its neighboring regions.

Table 4. Regression results of direct and indirect effects at the national level.

| variable | Direct effect | Indirect effect | Direct effect | Indirect effect | Direct effect | Indirect effect |
|----------|---------------|----------------|---------------|----------------|---------------|----------------|
| **CHP**  | 0.0648***     | 0.009344       | 0.0655***     | 0.007487       | 0.0558**      | 0.0501         |
|          | (0.0080)      | (0.8489)       | (0.0079)      | (0.9204)       | (0.0220)      | (0.1737)       |
| **IFA**  | -0.0668***    | 0.023130       | -0.0665***    | 0.028661       | -0.0599***    | 0.03976        |
|          | (0.0000)      | (0.3517)       | (0.0000)      | (0.4969)       | (0.0000)      | (0.4705)       |
| **MD**   | 0.0770        | -0.067032      | 0.0688        | -0.003536      | 0.0703        | -0.2272        |
|          | (0.1403)      | (0.5430)       | (0.1860)      | (0.9880)       | (0.1730)      | (0.5053)       |
| **ECO**  | 0.0006        | 0.011791       | 0.0009        | 0.029197       | 0.00137       | 0.0453         |
|          | (0.8670)      | (0.1858)       | (0.7837)      | (0.1161)       | (0.7020)      | (0.0890)       |
| **PGDP** | -0.0032       | 0.011***       | -0.0042*      | 0.0206***      | -0.0003       | 0.0032         |
|          | (0.1427)      | (0.0020)       | (0.0676)      | (0.0000)       | (0.8707)      | (0.2149)       |

R-squared | 0.7896 | 0.7895 | 0.7882
### Direct and indirect effects of housing prices on the upgrading of industrial structure

| Variable | Two way fixing (W1) | | | 
| --- | --- | --- | --- | 
|  | Direct effect | Indirect effect | Direct effect | Indirect effect | Direct effect | Indirect effect |
| CHP | 0.2946*** (0.0000) | 0.0020 (0.9860) | 0.3485*** (0.0000) | -0.3883* (0.0609) | 0.3317*** (0.0000) | -0.1806* (0.0660) |
| IFA | -0.1384*** (0.0000) | 0.1059* (0.0822) | -0.1017*** (0.0070) | -0.3952*** (0.0000) | -0.112*** (0.0000) | -0.3982*** (0.0000) |
| MD | 0.2408* (0.0589) | -0.298 (0.2876) | -0.19349 (0.1114) | 0.7967 (0.2130) | 0.2126* (0.0963) | 1.310 (0.0000) |
| ECO | 0.0210** (0.0159) | 0.066*** (0.0000) | 0.0202** (0.0230) | 0.1606*** (0.0000) | 0.0212** (0.0170) | 0.237*** (0.0020) |
| PGDP | -0.0124** (0.0254) | 0.020** (0.0280) | -0.0112** (0.0397) | 0.032** (0.0390) | 0.0076 (0.1108) | 0.01149 (0.1195) |
| R-squared | 0.7514 | 0.7536 | 0.7515 |
| sigma^2 | 0.0101 | 0.0101 | 0.0101 |
| log-likelihood | 2506.4 | 2506.4 | 2499.5 |

(Note: the values in brackets are p values, and *, ** and *** indicate 10%, 5% and 1% significance levels respectively)

### 4. Conclusions

Based on the big data, this paper selects a large number of samples, through theoretical analysis and empirical regression, we can obtain that there is a significant spatial correlation between housing prices and the upgrading of industrial structure; the growth of housing prices will not only affect the changes in local industrial structure (direct effect), but also affect the development of industrial structure in relevant regions (indirect effect). Nationwide, housing prices have a significant positive direct effect on the upgrading of industrial structure, whether it is rationalization or upgrading; while for the development of industrial structure in surrounding areas, it has a significant negative indirect effect, and the effect of rationalization is not significant.

In this regard, we conclude that: First, the rise of housing prices has certain spillover effect, which not only affects the local industrial structure, but also affects the industrial structure of other regions. The rainbow effect of rising housing prices intensifies the unbalanced development of regional
industrial structure. Second, there is a tendency of deindustrialization in the process of housing price rising. The prosperity of land finance and real estate industry brought by the rising housing prices will attract the resources that should be invested in the industrial manufacturing industry, especially will aggravate and worsen the financing environment of enterprises. In this way, the development of the secondary industry is limited, so that the peak value will arrive in advance, and the land finance will have the effect of deindustrialization. On the surface, land finance promotes economic growth by attracting investment and developing real estate industry. However, due to the early deindustrialization, it has damaged the accumulation of human capital in middle schools, damaged the spontaneous matching and agglomeration effect of the market, shortened the stage of full development of producer services, and also made the supply and demand structure change in advance. Although there was a relatively high economic growth in the early stage, it has damaged the economic growth potential in the long run.

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