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Formation of Financial Real Estate Risks and Spatial Interactions: Evidence from 35 Cities in China

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Abstract: The real estate prices in urban China have been soaring sharply since the commercialization reform of the housing market in 1998, but have suffered from downward pressure recently. In addition to the peculiarities of the state-owned land system, newly built houses dominate market across the vast territories of China, and this study of China will further the understanding of the financial real estate risks. Based on theoretical analyses, a spatial Durbin model is adopted to evaluate the financial real estate risks based on various sectors' participation in the real estate market, because it can overcome the biased results brought about by the omission of possible spatial dependence. The results show the following: (1) the four sectors' participation in the real estate market promotes the rise of real estate prices in the both local and other cities with spatial contagion effects, while the most important factors are different across regions; (2) the real estate price fluctuations, the local government's land revenue, the bank credit provided to the real estate industry, the demand in the local city, and the real estate developers' investments in other cities increase the local financial real estate risks, and there are strong spatial diffusion effects among the cities. This study sheds light on the roles of the various sectors' participation in promoting the financial real estate risk as well as their spatial interactions from both theoretical and empirical aspects. Particularly, the different roles of local governments and real estate developers in China should be highlighted. The rules on the sector and spatial levels suggest that government policy should take the different features of various sectors and regions and spatial connections into account.

Keywords: real estate price; financial risk; regional difference; spatial diffusion; China

JEL Classification: R31; P34

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1. Introduction

Many scholars attribute financial risks to asset price fluctuations, especially real estate price fluctuations (Kiyotaki and Moore 2002; Daníelsson and Zigrand 2008). The outbreak of the subprime mortgage crisis in 2007 and the subsequent evolution into the global financial crisis are good evidence of this. Therefore, real estate price fluctuations are closely related to financial risks. The real estate prices in China have been soaring since the commercialization reform of the housing market in 1999, causing the public concerns about financial risks. In particular, the real estate prices in large cities have increased significantly. For example, the average commercial real estate price in Beijing rose from 5647 RMB/sq. m. in 1999 to 32,140 RMB/sq. m. in 2017, increasing by nearly six times. Differing from the stock real estate markets in Western countries, the real estate markets in China are dominated by newly built houses, bringing strong market power to real estate developers. Due to the state-owned land system in China, local governments also play an important role in the real estate markets. In addition to China's vast territory and the significant regional features of the real estate markets, the spatial interactions of real estate

markets may aggravate the financial risks. Therefore, we ask what impacts do the activities of these sectors have on the real estate price fluctuations, and subsequently on financial real estate risks in the large and medium-sized cities of China, and how? What kinds of spatial interactions and regional features among large and medium-sized cities in China are involved in the process? These problems need to be solved, and are very important for China to avoid a financial real estate crisis. The existing literature contains analyses of the factors of real estate price fluctuations and the spatial contagion effect of real estate prices. Liu et al. (2018, 2019) discussed the real estate development mode and the roles of different sectors on real estate price increases from a spatial economic perspective in China. However, it is still necessary to further study how financial real estate risks form in the context of the participation of various sectors based on the peculiarities of the real estate markets in China and the regional features and spatial interactions in the process, particularly the characteristics of large and medium-sized cities. Thus, this paper conducts research on the following aspects: (1) we take 35 large and medium-sized cities in China as the research objects, according to the interest network of various sectors based on the real estate markets, and the panel spatial models are built to analyze the influence of various sectors on the real estate prices and their spatial interaction characteristics; (2) we analyze the financial real estate risks caused by real estate price fluctuations in the context of the participation of various sectors, and construct an aspatial Durbin model to empirically test the effects of real estate price fluctuations and various sectors' participation on the financial real estate risks in the local city, as well as their spatial interactions among the 35 large and medium-sized cities; (3) according to the geographical positions, the 35 large and medium-sized cities are divided into the eastern, middle, and western regions, and spatial panel models are built for each region to empirically test the influences and spatial interactions of various sectors on real estate price fluctuations, and subsequently financial real estate risks, and then similarities and differences among the three regions are obtained via a comparative analysis.

Since the relevant literature only relates to the promotion effect of the local government or banking sector or individual speculation on real estate prices, and as the roles of each sector's participation in the financial real estate risk have not been revealed, the main contributions of this paper can be summarized as follows: (1) we introduce the various sectors' participation into the theoretical and empirical analysis to evaluate the financial real estate risks; (2) we establish empirical models to reveal the contribution of the participation of each sector to the financial real estate risk; (3) the spatial interactions of the effects of each sector's participation on the financial real estate risks among large and medium-sized cities are studied.

The existing literature shows that financial institutions over-participate in the real estate industry, which magnifies the financial real estate risks. Mishkin (1999) suggests that, with the real estate as the collateral, the adverse selection and moral hazard of enterprises are low when the real estate price remains stable or continues to rise; however, once the real estate prices drop sharply, the information asymmetry in the financial market will worsen, the market will not be able to perform the function of financing, and the financial system will be unstable. Pavlov and Wachter (2004) point out that information asymmetry and incomplete information have always existed in the market, which lead banks to price the overall risk as low and provide excessive liquidity. The provision of excessive bank credit to the real estate industry promotes a rise in real estate prices (Huang et al. 2015; Cerutti et al. 2017), creating a real estate bubble. Krugman (1999) found that a large proportion of bank financing is the common point of all bubbles in the real estate market. Zhao et al. (2017) points out that a close connection between the financial system and the real estate industry is likely to lead to a financial crisis, and the situation in China is risky. Accordingly, the existing literature confirms the important role of banks' excessive lending to the real estate industry in real estate price fluctuations and the formation of financial real estate risks.

The speculation of investors and consumers in the market may also give rise to financial real estate risks. Goetzmann (1993) found that investors tend to invest a large proportion in real estate when they choose an optimal asset portfolio, which increases the risk appetite coefficient. Brueckner (1997) asserts that real estate comprises both investment and consump-

tion goods, leading to excessive investment in real estate. Roehner (1999) found that the contradiction between speculative behavior and inelastic supply is the main reason leading to the formation of a real estate bubble. The expectations of buyers (Garino and Sarno 2004) and the crazy buying and herding effect (Wong 2001) are considered by many scholars to be the main factors in real estate bubbles. There is a high vacancy rate of commercial housing in China, causing serious speculation in the real estate market (Zhang et al. 2016). The speculative purchasing increases the housing vacancy rate in China, leading to the increase in the non-performing loan ratio of banks (Wan 2018). Yang et al. (2017) found that speculation in China's real estate market has interactive influences among cities. Therefore, the speculation of buyers is one of the main factors in house price fluctuations and financial real estate risks. The speculation in Chinese real estate markets has attracted attention from some researchers; however, its spatial interactions and impacts on financial risks still need further exploration. This is also one of the issues that this paper aims to analyze.

Government policy may promote the accumulation of financial real estate risks. Allen and Gale (2004) point out that the financial liberalization policy implemented by government leads to asset bubbles and real estate risks. Tao et al. (2010) and Liu et al. (2016) suggest that local governments' "land revenue" and "land finance" in China are important factors of the rise of real estate prices. Liu et al. (2018, 2019) found that land transfer fees of local governments in China promote the rise of real estate prices in local cities/provinces and their neighbor cities/provinces. Accordingly, governments' policies, especially the excessive participation of local governments in the real estate market, have attracted the attention of some scholars in recent years. However, the impacts of local governments' land-use-right transaction behavior on financial real estate risks and their spatial interactions among the 35 large and medium-sized cities are still unclear. This paper will explore the impacts and the spatial interactions.

There is some research investigating the impacts of real estate developers on real estate prices and financial risks. A few scholars tentatively discuss the spatial aggregation of real estate development capital, such as Hoesli et al. (1997), Meyer (2007), Byrne and Lee (2009) and Atack and Margo (1998). Froot et al. (1992) point out that the homogeneity of investors and the similarity of market information would prompt institutional investors to make similar responses to the same external information, and they would exhibit herd behavior. DeCoster and Strange (2012) confirmed the herd effect of real estate developers' investment behavior, and further explained the problem of urban real estate developers' overbuilding with the herd effect. Then, what impacts do real estate developers' investments have on the real estate prices and financial real estate risks in China, and what are the spatial interactions among the 35 large and medium-sized cities? These problems remain to be explored, which is also one of the innovations of the paper.

The regional features of real estate price fluctuations have been confirmed by many studies. Wang and Zhang (2014) and Zhang et al. (2015) found that the responses of real estate price and its determinants in inland areas and coastal cities are not consistent. Furthermore, many scholars found spatial diffusion effects of real estate price bubbles, such as Roehner (1999), Costello et al. (2011), Riddel (2011), Nneji et al. (2015) and Hui et al. (2016). Yang et al. (2018) point out that the urban real estate prices in China have obvious spillover effects, and the spillover effects of real estate prices in first-tier cities and eastern cities are stronger. Shih et al. (2014) found that there is a provincial spillover effect in the real estate bubble in China. Accordingly, real estate price fluctuations as the direct reasons for financial real estate risks, the regional features of real estate price fluctuations and the spatial contagion of a real estate price bubble have been confirmed by many scholars. However, the regional features and spatial interactions of financial real estate risks caused by real estate price fluctuations still need to be studied. Therefore, this paper uses a spatial Durbin model to study the spatial interactions of financial real estate risks among the 35 large and medium-sized cities in China, and divides these cities into the eastern, middle and western regions for comparative analysis to find out the regional features of financial real estate risks caused by real estate price fluctuations. This is also an innovation of this paper.

The remainder of this paper is as following: Section 2 analyzes the interest network of various sectors based on the real estate market and subsequent financial risks. Section 3 deduces the theoretical foundation for financial risk caused by real estate price fluctuations. Section 4 constructs panel spatial econometric models to analyze the spatial interactions of the influences of various sectors on real estate prices and the impacts of house price fluctuations and various sectors on the financial real estate risks, as well as the comparison among different regions, based on the panel data of the 35 large and medium-sized cities. Section 5 presents discussion and Section 6 concludes.

2. The Formation Mechanism of Real Estate Risks Involving Various Sectors

As suggested by Liu et al. (2018, 2019), four sectors—local governments, real estate development enterprises, banks, and individuals and households—participate in the financial ties of real estate markets in China, breeding financial real estate risks.

(1) Local Governments

Local governments increase fiscal revenue by raising commercial and residential land-use-right transactions (referred to as "land revenue"), while the high land costs are transferred to the high real estate prices, driving up the real estate prices (Wu et al. 2016). In addition, local governments indirectly obtain a large amount of bank loans (referred to as "land finance") by mortgaging land use rights through their affiliated financing platform companies to conduct large-scale infrastructure constructions (Tao et al. 2010), such as economic development zones and industrial parks, with a view to capitalizing the investment into land-use-right transaction fees.

Local governments are motivated to borrow heavily to obtain economic and political benefits through the "land revenue" and "land finance" (Tao et al. 2010). However, the decline of housing prices will lead to the decline of land prices, and the local governments' "land revenue" will be greatly reduced, which will make them unable to repay their loans from banks and possibly lead to a debt crisis.

(2) Real Estate Development Enterprises

Accompanying urbanization and soaring real estate prices, real estate developers gain strong market power and rent-seeking abilities. They not only transfer the high land prices to the high real estate prices, but also use property hoarding, price conspiracy, price discrimination and other ways to increase the real estate prices to obtain high profits, exacerbating the further rise of real estate prices (Zhou et al. 2021). Moreover, the sources and structure of real estate development funds also breed heavy financial risks (Pellegrini et al. 2022). Real estate developers not only obtain funds from banks and other financial institutions through both direct credit and indirect means such as the advance payment of buyers with mortgage loans, but also obtain funds through shadow banking, private financing and even illegal fundraising channels. Once the market is depressed, risks will be exposed and transmitted to financial institutions.

(3) Banks

Banks share the benefits of soaring prices by providing a large number of loans to local governments' affiliated financing platform companies, real estate developers and speculators. The excessive credit support from banks to the real estate industry further drives up real estate prices and increases the risk of real estate price fluctuation. Furthermore, the commercial banking system with excessive deposit balances generally regards the real estate industry as an ideal loan project (Wang et al. 2020). Kader et al. (2022) found that mortgage credit volume is influenced by real housing prices. To some extent, commercial banks themselves have evolved into supply speculators. Even if the banks knew the real estate market was overheating, there was an incentive to extend credit to the sector. The banks ignored the real estate loan risk, which led to a large amount of capital flooding into the real estate market, further accelerating the rise of the real estate prices. Subsequently, the financial real estate risk began to form and continue to intensify.

(4) Speculators

The rapid growth of real estate prices attracts a large number of speculators to buy many houses and then sell them after real estate prices increase. In addition, due to the limited direct investment channels in China, urban high-income families, even state-owned enterprises and non-real estate enterprises conduct large-scale real estate investment or speculation (Beladi et al. 2021), leading to the growth of real estate price bubbles. Once real estate prices fall, investors and speculators who have not exited the market will face huge losses, causing financial risks.

Accordingly, local governments, real estate developers, banks and speculators take various strategies to promote the sharp growth of real estate prices together, and thus to share the benefits brought by the rising real estate prices, as shown in Figure 1. However, once the real estate price falls sharply, each sector will suffer significant losses which conduct through the capital network among these sectors, and the financial real estate risks involving each sector eventually form, as shown in Figure 2.

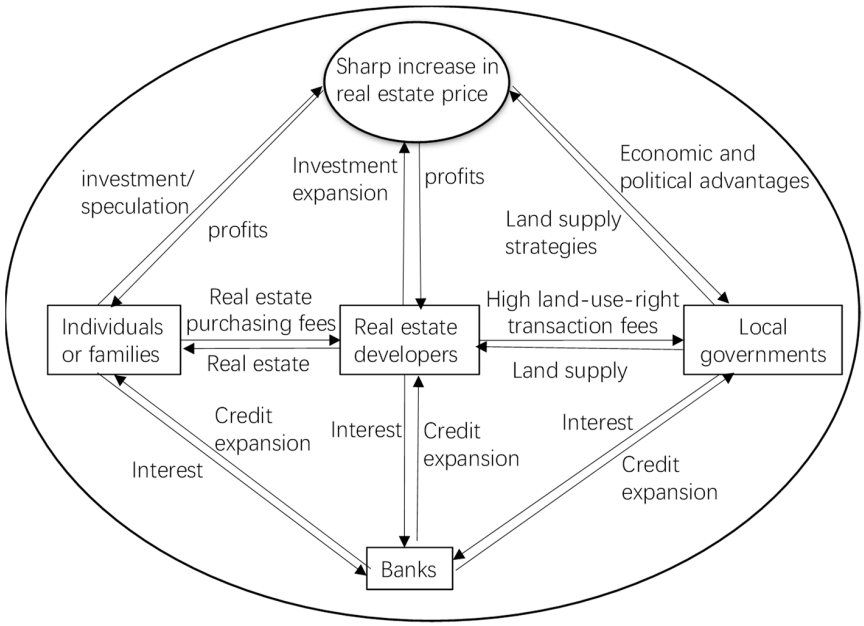

Figure 1. How various sectors promote the increase in real estate price. Source: Liu et al. (2018).

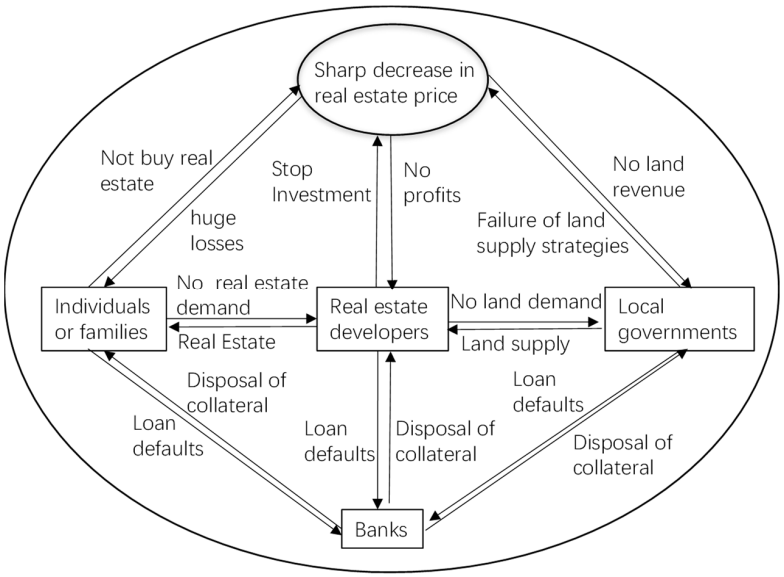

Figure 2. How financial real estate risks involving each sector form. Source: Arranged by the authors.

3. Research Method and Modelling

3.1. Research Method

As the beginning of spatial econometric models, the spatial correlation is defined by Anselin (1988). Then, Baltagi (2001) and Elhorst (2003) consider the spatial error lag and the spatial explained variable lag. Anselin et al. (2008) assert that the spatial lag model (SLM) considers the possible interactions among explained variables, while the spatial error model (SEM) considers the possible interactions among errors due to the missing explanatory variables. The spatial Durbin model (SDM), considering both the spatial explained variable lag and the spatial explanatory variable lag, is proposed by LeSage and Pace (2009) to overcome biased results brought by the omission of possible spatial dependence among explanatory variables.

(1) The Spatial lag model

According to Anselin et al. (2008), the general form of the SLM is as follows:

$$y_{it} = \alpha \sum_{j=1}^{N} W_{ij} y_{jt} + \beta + X_{it}\theta + u_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Here, y_{it} represents the observed value of the explained variable in area i at period t, $i = 1, \cdots, N; t = 1, \cdots, \mathrm{T}$. The spatial autoregressive coefficient is α, indicating the influence of the explained variable in other areas on the explained variable in the local area. The endogenous interaction—the spatial dependence among explained variables—is described by $\sum_{j=1}^{N} W_{ij} y_{jt}$, where W_{ij} is an $N \times N$ spatial weight matrix. The observed value vector of explanatory variables of $1 \times \mathrm{K}$ order is shown by X_{it}, while the unknown parameter vector of $\mathrm{K} \times 1$ order is represented by θ, and K is the number of explanatory variables. β is the constant term, u_i is the area fixed effect, and λ_t is the time fixed effects. The random error term is ε_{it}, obeying the standard normal distribution, with an expectation value of 0 and a variance of σ^2.

(2) The Spatial error model

According to Anselin et al. (2008), the general form of SEM is as follows:

$$y_{it} = \beta + X_{it}\theta + u_i + \lambda_t + \varnothing_{it} \quad (2)$$

$$\Psi_{it} = \sigma \sum_{j=1}^{N} W_{ij} \Psi_{it} + \varepsilon_{it} \quad (3)$$

Here, Ψ_{it} is the random error term vector. $\sum_{j=1}^{N} W_{ij} \Psi_{it}$ is on behalf of the interactive effect between the interference items of different areas, reflecting the spatial dependence. σ is the spatial autocorrelation coefficient, which describes the influencing direction and degree of the error shocks of the explained variable in adjacent areas to the explained variable in the local area.

(3) The Spatial Durbin model

According to LeSage and Pace (2009), the general form of SDM is as follows:

$$y_{it} = \alpha \sum_{j=1}^{N} W_{ij} y_{jt} + \beta + X_{it}\theta + \sum_{j=1}^{N} W_{ij} X_{jt}\delta + u_i + \lambda_t + \varepsilon_{it} \quad (4)$$

where $\sum_{j=1}^{N} W_{ij} X_{jt}$ indicates the exogenous interaction—the spatial dependence among explanatory variables. δ is an unknown parameter vector of $\mathrm{K} \times 1$ order, suggesting the influence of explanatory variables in other areas on explained variables in the local area.

(4) Direct and indirect effects

The direct and indirect effects of explanatory variables are proposed by LeSage and Pace (2009) to describe their spatial interaction. The influence of a certain explanatory variable of a certain area on the local explained variables is the direct effect of the explanatory variable, which equals the average value of the sum of the influences of the certain explanatory variable on the local explained variable in all areas. The influence of an explanatory variable of one area on the explained variables in other areas is the indirect

effect, referring to the average value of the sum of influences of the certain explanatory variable in all areas on the explained variables of other areas.

The sum of the direct effect and the indirect effect is the total effect (Elhorst 2010). The total effect refers to the average value of the sum of the impacts of the certain explanatory variable in all areas on the explained variable in both the local and other areas. The influence of the feedback between the local area and other areas is included in the direct effect, and thus the direct effect cannot be represented by θ in Equations (1) and (4).

3.2. Modelling

3.2.1. Data

Referring to previous studies (Liu et al. 2018, 2019), the following variables are adopted. The average price of commercial houses (P) is used to indicate the level of real estate price. The land-use-right transaction fees (TF) shows local governments' dependence on "land revenue". The real estate development investments of real estate development enterprises (RDI) represent the investment expansion, but are replaced by the real estate development enterprises' employment figure (EP) to avoid the endogeneity between real estate prices and real estate development investments in the models for real estate prices. Due to data unavailability for the loans of real estate industry from the financial institutions in the 35 large and medium-sized cities in China, the sum of domestic loans and other sources of funds of real estate development enterprises (BL) is employed as an indicator for the participation of the banking sector in the real estate market, considering that the main parts of domestic loans and other sources of funds are real estate enterprises' loans from banks and real estate buyers' real estate mortgage loans, respectively. Similarly, it is replaced by financial institutions' lending balance (LB) to avoid endogeneity in the models for real estate prices. The sold area of commercial houses (SA) represents the demand in the real estate market, but is replaced by the total population (TP) to overcome the endogeneity problem in the models for real estate prices. To measure the impacts of percentage change in the explanatory variables on the percentage change in the explained variable, and reduce collinearity and heteroscedasticity in statistics, the logarithm of each variable, that is, logp as the explained variable, and logtf, logep, loglb and logtp as the explanatory variables, are employed in the models.

According to the above interest network of the four sectors based on the real estate market, the four sectors have the incentive to expand their investment in the real estate market to promote the real estate prices, and the fluctuation of real estate prices also brings financial risks to the four sectors. Therefore, this paper considers the financial real estate risk from the four aspects. Considering that relative indicators in the form of ratios are more conducive to eliminating the impacts of different absolute sizes of different sectors and the construction of the overall financial real estate risk indicator, the following relative indicators for various sectors are adopted. The ratios of land-use-right transaction fees to the local general public financial revenue (TF/LR), the stock space of unsold commercial houses to the completed space of commercial houses in the last three years (SB/CS), the growth rate of financial institutions' loans to the real estate industry to the growth rate of the total lending balance of financial institutions (RBL/RLB), and the growth rate of commercial real estate sales to the growth rate of urban residents' average wage (RS/RW), represent the financial real estate risk levels of the local governments, real estate development enterprises, banks and individuals and families, respectively. The financial real estate risk value of each sector is standardized to eliminate the dimensional influences, and the sum of them—the total financial real estate risk of the four sectors—is obtained as the explained variable in the models for financial real estate risks (FR). The explanatory variables in the models for financial real estate risk include the over-growth in real estate prices—the ratio of the growth rate of the house price to the growth rate of the gross domestic product (PR/GDPR)—and the logarithms of the four sectors' variables of showing their participation in the real estate market: logtf, logrdi, logbl and logsa.

The definition and descriptive statistical analysis results of the above variables are shown in Tables 1 and 2, respectively. Eastern cities such as Beijing and Shanghai have the highest real estate price level, followed by middle cities, and western cities such as Yinchuan and Xining have the lowest real estate price level. The highest financial real estate risk level is in some eastern cities such as Dalian, Nanjing and Hangzhou, while the lowest one is in some western cities such as Xining and Urumqi. The annual panel data of the 35 large and medium-sized cities in China from 2004 to 2016 for the above variables in their logarithmic form except for PR/GDPR and FR are employed in the empirical analysis. This is the longest and latest data set available in public until we wrote this paper. All the data come from the "China Land and Resource Almanac", "China City Statistical Yearbook", "China Real Estate Statistical Yearbook" and "China Statistical Yearbook" of various years, and the CEIC database.

Table 1. The definition of variables.

Variable	Definition	Calculation Method	Unit	Source	Time Period
P	Real estate price	The average selling price of commercial houses	RMB/sq. m.	China Statistical Yearbook	2014–2016
TF	Land revenue	The land-use-right transaction fees	Million RMB	China Land & Resource Almanac	2014–2016
EP	Employment figure	Real estate development enterprises' employment figure	Person	China Real Estate Statistical Yearbook	2014–2016
LB	Lending balance	Financial institutions' lending balance	Billion RMB	CEIC database	2014–2016
TP	Total population	Total population of the city	Million person	China City Statistical Yearbook	2014–2016
PR/GDPR	Over-growth in house prices	The ratio of the growth rate of house price to the growth rate of the gross domestic product	/	China Statistical Yearbook	2014–2016
RDI	Investment expansion	The real estate development investments of real estate development enterprises	Billion RMB	China Real Estate Statistical Yearbook	2014–2016
BL	Banking sector in the real estate market	The sum of domestic loans and other sources of funds of real estate development enterprises	Billion RMB	CEIC database	2014–2016
SA	Sold area	The sold area of commercial houses	Million sq. m.	China Real Estate Statistical Yearbook	2014–2016
FR	Financial risks	The total financial real estate risk of the four sectors: the sum of the standardized financial real estate risk value of each sector	/	Calculated by the authors	2014–2016

Table 2. The descriptive statistical analysis results of variables.

	P	TF	EP	LB	TP	PR/GDPR	RDI	BL	SA	FR
Mean	6733.91	29,461.53	25,081.81	817.52	7.06	0.97	78.69	74.55	10.51	0.93
Median	5745.34	16,139.75	17,868.50	522.18	6.49	0.96	50.86	41.89	8.06	0.90
Max	45,146.00	205,977.68	99,612.00	5660.00	33.92	1.64	417.71	607.18	62.57	1.91
Min	1547.45	37.57	2861.00	40.14	1.38	0.61	2.29	0.11	0.73	0.47
Std. Dev.	4725.89	34,773.86	21,290.06	872.24	5.44	0.13	78.26	92.12	8.80	0.22
Obs	454	454	454	454	454	454	454	454	454	454

3.2.2. Modelling

Spatial econometric models are widely used in the study of real estate prices (Osland 2010; Efthymiou and Antoniou 2013). Some scholars found that the SDM has higher accuracy of estimation results than ordinary linear regression models (Macfarlane et al. 2015; Zhong and Li 2016; Duan et al. 2019). Therefore, based on Hao et al. (2016), the following testes are conducted. First of all, Moran I tests (Moran 1950), as the most popular test for the spatial correlation, are conducted for the model of real estate prices with logp as the explained variable and logtf, logep, logbl and logtp as the explanatory variables,

and the model of financial real estate risks with fr as the explained variable and logtf, logrdi, logbl and logsa as explanatory variables, at 3.80 and 1.41 with a 1% significance level, respectively. The results indicate the existence of spatial correlations. Thus, the paper adopts spatial econometric models rather than ordinary linear regression models.

The Wald and LR tests for the two models are carried out based on the SDM. The spatial lag model (SLM) should be adopted if the Wald-lag and LR-lag test results are significant and the Wald-error and LR-error test results are not. If the results of Wald-lag and LR-lag tests are insignificant and the results of Wald-error and LR-error tests are significant, the spatial error model (SEM) should be adopted. If the Wald-lag and LR-lag test results are significant and the Wald-error and LR-error test results are also significant, the spatial Durbin model (SDM) should be adopted. The test results are shown in Table 3. For the model of real estate prices, both Wald test and LR test suggest the construction of the SLM rather than the SEM. For the model of financial real estate risks, Wald tests and LR tests have an opposite indication, and here SDM is more appropriate as a general form of the SLM and the SEM. Therefore, the SLM and SDM are adopted for the model of real estate prices and the model of financial real estate risks, respectively, as shown by Equations (5) and (6).

Table 3. Wald and LR test results.

Test	Model of Real Estate Prices		Model of Financial Real Estate Risks	
	Statistics	**Prob.**	**Statistics**	**Prob.**
Wald_spatial_lag	53.50	6.71×10 **	52.59	4.08×10 ***
LR_spatial_lag	20.03	4.92×10 **	53.73	2.38×10 ***
Wald_spatial_error	5.13	0.27	37.74	4.26×10 **
LR_spatial_error	−2.03	1	44.33	1.99×10 **

Note: "***" and "**" represent a 1% and 5% level of significance, respectively.

To empirically analyze the influence of the four sectors on real estate prices, the explained variable logp and explanatory variables logtf, logep, logbl and logtp are adopted to construct SLM (Elhorst 2003; Hao et al. 2016), as shown by Equation (5).

$$\log p_{it} = \delta \sum_{j=1}^{N} W_{ij} \log p_{jt} + \alpha + [\log tf_{it}, \log ep_{it}, \log lb_{it}, \log tp_{it}]\beta + u_i + \lambda_t + \varepsilon_{it} \quad (5)$$

The explained variable *fr* and explanatory variables pr/gdpr, logtf, logrdi, loglb and logsa are introduced to construct the SDM (LeSage and Pace 2009), as shown by Equation (6), to empirically test the impacts of real estate price fluctuations and the four sectors' participation in the real estate market on financial real estate risks.

$$\begin{aligned} fr_{it} = {} & \delta \sum_{j=1}^{N} W_{ij} fr_{jt} + \alpha + [(pr/gdpr)_{it}, \log tf_{it}, \log ep_{it}, \log lb_{it}, \log tp_{it}]\beta \\ & + \sum_{j=1}^{N} W_{ij}[(pr/gdpr)_{it}, \log tf_{it}, \log ep_{it}, \log lb_{it}, \log tp_{it}]\theta + u_i + \lambda_t + \varepsilon_{it} \end{aligned} \quad (6)$$

The panel spatial econometric models are established for the 35 large and medium-sized cities in China, where $t = 1, \ldots, 13$, $i = 1, \ldots, 35$. Based on the geographical position, the 35 cities are divided into the eastern, middle and western regions to compare the different geographic features among different regions. The eastern region includes Beijing, Tianjin, Shijiazhuang, Shenyang, Dalian, Shanghai, Nanjing, Hangzhou, Ningbo, Fuzhou, Xiamen, Jinan, Qingdao, Guangzhou, Shenzhen and Haikou. The middle region consists of Taiyuan, Hohhot, Changchun, Harbin, Hefei, Nanchang, Zhengzhou, Wuhan and Changsha. The western region contains Nanning, Chongqing, Chengdu, Guiyang, Kunming, Xi'an, Lanzhou, Xining, Yinchuan and Urumqi. Then, the panel spatial econometric models for the three regions are constructed, where $i = 1, \ldots, 16$, $i = 1, \ldots, 9$, $i = 1, \ldots, 10$ for the eastern, middle and western regions, respectively.

Based on the latitude and longitude of each city, W is produced by Matlab to test the influence of geographical location. W is in 35×35, 16×16, 9×9 and 10×10 order for the 35 large and medium-sized cities, the eastern, middle and western regions, respectively.

4. Empirical Results

4.1. Results for the 35 Large and Medium-Sized Cities in China

The results of the SLM with spatial fixed effects for real estate prices in the 35 large and medium-sized cities in China are shown by Table 4. Logtp, logep, logtf and loglb have significantly positive coefficients, indicating that individual and household demand, real estate development enterprises' investment, local governments' land revenue, and bank credit have a positive impact on real estate prices in the 35 large and medium-sized cities in China. Logtp has the largest influence (0.22), followed by logep (0.19), logtf (0.18) and loglb (0.14). These are consistent with the analysis of Section 2 that the four sectors jointly drive up the real estate prices. It is interesting that, contrary to the supply and demand theory, real estate development enterprises' investment expansion has positive rather than negative influence on real estate prices. Relying on their strong market power in the context of urbanization and soaring real estate price, real estate development enterprises employ various strategies to promote real estate prices, such as price discrimination and property hoarding. Meanwhile, real estate development enterprises raise funds in various ways and expand their investment to seek more profit. As a result, there appears a cycle of "the higher real estate price, the more investment, the higher real estate price ...". These findings are consistent with Lai (2008) and Liu et al. (2017)'s viewpoints of investment driving growth.

Table 4. Results of the SLM with spatial fixed effects for the 35 large and medium-sized cities in China.

Variables	Coefficient	Direct Effect	Indirect Effect	Total Effect
W*logp	0.30 ***			
logtf	0.18 ***	0.18 ***	0.08 ***	0.26 ***
logep	0.19 ***	0.19 ***	0.08 ***	0.27 ***
loglb	0.14 ***	0.13 ***	0.06 ***	0.19 ***
logtp	0.22 ***	0.22 ***	0.09 ***	0.31 **
R^2	0.81			

Note: "***" and "**" represent a 1% and 5% level of significance, respectively.

The coefficient of W*logp is 0.30, indicating that the rise of real estate prices in neighbor large and medium-sized cities promotes the rise of real estate prices in this city (Hao et al. 2016). Therefore, real estate prices have strong spatial diffusion effects among the 35 large and medium-sized cities in China. In other words, the rise of real estate price in a city will bring the increase in real estate prices in other cities.

Logtp, logep, logtf and loglb have significantly positive direct effects, at 0.22, 0.19, 0.18, 0.13, respectively, suggesting that the promotion of the four sectors' participation in the real estate market drives up the local real estate prices. The indirect effects of the logtp, logep, logtf and loglb also have significantly positive indirect effects, at 0.09, 0.08, 0.08 and 0.06, respectively, indicating that market demand, investment expansion of real estate development enterprises, land revenue, and bank credit in one city elevate the real estate prices of other cities as well. The total effects of logtp, logep, logtf and loglb are 0.31, 0.27, 0.26, and 0.19, respectively, showing that the four sectors drive up the real estate prices in the 35 large and medium-sized cities in China.

The results of the SDM with spatial fixed effects for financial real estate risks in the 35 large and medium-sized cities in China are described in Table 5. The coefficients of logpr/gdpr, logtf, logsa, and logbl are significantly positive, suggesting that over-growth in real estate prices, local governments' land revenue, market demand and bank loans to the real estate industry promote the local financial real estate risks in the 35 large and medium-sized cities in China. The positive impact of over-growth in real estate prices on the local financial real estate risk is strongest (0.28), followed by local governments' land revenue (0.16), market demand (0.15) and bank loans (0.06). However, logrdi has a negative coefficient of −0.30, indicating that the increase in real estate development enterprises' investment brings about a decrease in the local financial real estate risks; it is the opposite,

on the contrary. Real estate developers usually increase their development investment when market demand is rising, thus providing more houses to meet the increasing demand, while reducing their development investment to decrease market supply and prevent the further collapse of real estate prices in the market downturn. Therefore, real estate developers' development investment has a negative impact on the local financial real estate risks.

Table 5. Results of the SDM with spatial fixed effects for the 35 large and medium-sized cities in China.

Variables	Coefficient	Direct Effect	Indirect Effect	Total Effect
W*fr	0.32 **			
pr/gdpr	0.28 ***	0.28 ***	−0.09	0.19
logtf	0.16 ***	0.16 ***	−0.07 **	0.09 ***
logrdi	−0.30 ***	−0.30 ***	0.30 ***	0.00
logbl	0.06 **	0.05 **	−0.13 ***	−0.08 **
logsa	0.15 ***	0.14 ***	−0.20 ***	−0.06
W* pr/gdpr	−0.15			
W*logtf	−0.10 ***			
W*logrdi	0.31 ***			
W*logbl	−0.11 ***			
W*logsa	−0.19 ***			
R^2	0.42			

Note: "***", "**" represent a 1% and 5% level of significance, respectively.

W*logrdi has a positive coefficient of 0.31, suggesting that the investment expansion of real estate development enterprises in other cities raises the financial real estate risks in the local cities. Real estate development investment usually accompanies soaring real estate prices, and the expansion of real estate development enterprises' investment in other cities means that the real estate price is rising rapidly, which will diffuse to the local city, and thus raise the financial real estate risks in the local city. W*logsa, W*logbl and W*logtf have negative coefficients of −0.19, −0.11 and −0.10, respectively, indicating that the increases in market demand, bank loans to the real estate industry and land revenue in other cities lower real estate prices in the local city. With limited resources, the rising demand, expansion of bank credit to the real estate industry and the increasing land transfer fees in other cities attract funds from the local city to other cities, and thus reduce the heat of the real estate market and financial real estate risks in the local city. The coefficient of W*fr is 0.32, indicating the strong spatial conduction effects of financial real estate risks among the 35 large and medium-sized cities in China. That is, the financial real estate risks in a city will diffuse to other cities, which is risky.

logpr/gdpr, has a strong direct effect of 0.28, indicating that the over-growth of real estate prices in a city will raise the local real estate prices and thus financial real estate risks. Similar to their coefficients, logtf, logsa, and logbl have strong positive direct effects, at 0.16, 0.14, 0.05, respectively; however, logrdi has a negative direct effect of −0.30, suggesting that the rising land revenue, market demand and bank credit to the real estate industry drive up the local financial real estate risks; however, increase in real estate development enterprises' investment has the opposite influence. logsa, logbl and logtf have negative indirect effects of −0.20, −0.13, −0.07, respectively; however, logrdi has a positive indirect effect of 0.30. That is, the increasing market demand, bank credit to the real estate industry and land revenue in a city decreases the financial real estate risks in other cities, contrary to the impact of real estate development enterprises' investment expansion. The total effects of logtf and logbl are 0.09 and −0.08, respectively, suggesting a positive impact of local governments' land revenue and a negative impact of bank credit to the real estate industry on financial real estate risks across the 35 large and medium-sized cities.

4.2. Results for the Cities in Different Regions in China

4.2.1. The Eastern Region

The results of the SLM with spatial fixed effects for real estate prices in the eastern region in China are shown by Table 6. The coefficients of logtp, loglb, logtf and logep are 0.21, 0.17, 0.15 and 0.11, respectively. That is, individuals and households' demand has the strongest positive impact on the local real estate price, followed by bank credit expansion, local governments' land revenue, and real estate enterprises' investment expansion in the large and medium-sized cities in the eastern region of China.

Table 6. Results of the SLM with spatial and time fixed effects for the eastern region in China.

Variables	Coefficient	Direct Effect	Indirect Effect	Total Effect
W*logp	0.28 ***			
logtf	0.15 ***	0.16 ***	0.06 **	0.22 ***
logep	0.11 ***	0.11 ***	0.04 **	0.16 ***
loglb	0.17 ***	0.18 ***	0.07 **	0.24 ***
logtp	0.21 ***	0.21 ***	0.08 ***	0.28 ***
R^2	0.75			

Note: "***", "**" represent the 1% and 5% and of significance, respectively.

W*logp has a significantly positive coefficient of 0.28, suggesting the strong spatial diffusion effects of real estate prices among the large and medium-sized cities in the eastern region of China.

logtp, loglb, logtf and logep have direct effects of 0.21, 0.18, 0.16 and 0.11, and indirect effects of 0.08, 0.07, 0.06 and 0.04, respectively, suggesting the positive impacts of individuals and households' demand, bank credit, local governments' land revenue, and real estate enterprises' investment on the local real estate prices, as well as real estate prices in other cities. The total effects of logtp, loglb, logtf and logep are 0.28, 0.24, 0.22 and 0.16, respectively, indicating that they drive up the whole real estate prices in the large and medium-sized cities in the eastern region of China.

The results of the SDM with spatial fixed effects for financial real estate risks in the large and medium-sized cities in the eastern region of China are shown in Table 7. logpr/gdpr, logtf and logbl have significantly positive coefficients of 0.36, 0.11 and 0.05, respectively, suggesting that over-growth in real estate prices has the strongest positive influence on the local financial real estate risks in the large and medium-sized cities in the eastern region of China, followed by local governments' land revenue and bank loans to the real estate industry. However, the coefficient of logrdi is −0.18, indicating that real estate development enterprises' investment has a negative impact on the local financial real estate risks.

Table 7. Results of the SDM with spatial fixed effects for the eastern region in China.

Variables	Coefficient	Direct Effect	Indirect Effect	Total Effect
W*fr	0.19 *			
pr/gdpr	0.36 ***	0.36 ***	−0.06	0.30
logtf	0.11 ***	0.11 ***	0.02	0.12 ***
logrdi	−0.18 ***	−0.18 ***	0.25 **	0.08
logbl	0.05 **	0.05	−0.15 ***	−0.11 **
logsa	0.06	0.05	−0.22 **	−0.17 **
W* pr/gdpr	−0.14			
W*logtf	−0.01			
W*logrdi	0.25 ***			
W*logbl	−0.13 ***			
W*logsa	−0.19 ***			
R^2	0.40			

Note: "***", "**", "*" represent the 1%, 5% and 10% level of significance, respectively.

W*logrdi has the coefficient of 0.25, indicating the positive impacts of real estate development enterprises' investment in other cities on the financial real estate risks in the local city in the eastern region of China. W*logsa and W*logbl have negative coefficients of −0.19 and −0.13, respectively. That is, the market demand and bank credit to the real estate industry in other cities lowers the financial real estate risks in the local city, because investors and speculators are attracted from the local city to other cities with hot real estate markets. W*fr has the coefficient of 0.19, suggesting that the financial real estate risks in a city can diffuse to other cities in the eastern region of China.

The direct effects of pr/gdpr, logtf and logrdi are 0.36, 0.11 and −0.18, respectively, suggesting the positive impacts of over-growth of real estate prices and local governments' land revenue on the local financial real estate risks, while real estate enterprises' investment has a negative influence. logrdi, logsa and logbl have indirect effects of 0.25, −0.22 and −0.15, indicating that real estate enterprises' investment expansion in local city elevates the financial real estate risks in other cities; however, the market demand and bank credit to the real estate industry have the opposite impacts. The total effects of logtf, logsa and logbl are 0.12, −0.17 and −0.11, respectively, showing the positive influence of local governments' land revenue and the negative impacts of market demand and bank credit to the real estate industry on the whole financial real estate risks in the large and medium-sized cities in the eastern region of China.

4.2.2. The Middle Region

The results of the SLM with spatial fixed effects for real estate prices in the middle region of China are shown by Table 8. loglb, logtf and logtp have the coefficients of 0.23, 0.22 and 0.16, respectively, suggesting the strongest positive influence of bank credit expansion on the local real estate prices in the large and medium-sized cities in the middle region of China. The coefficient of W*logp is 0.49, suggesting that the rise of real estate prices in other cities elevates the real estate prices in the local city.

Table 8. Results of the SLM with spatial fixed effects for the middle region in China.

Variables	Coefficient	Direct Effect	Indirect Effect	Total Effect
W*logp	0.49 ***			
logtf	0.22 ***	0.24 ***	0.20 ***	0.44 ***
logep	0.04	0.04	0.03	0.08
loglb	0.23 ***	0.25 ***	0.21 **	0.46 ***
logtp	0.16 **	0.17 *	0.14 *	0.31 *
R^2	0.88			

Note: "***", "**", "*" represent the 1%, 5% and 10% level of significance, respectively.

The direct effects of loglb, logtf and logtp are 0.25, 0.24 and 0.17, while indirect effects are 0.21, 0.20 and 0.14, respectively. That is, the rises in bank credit, local governments' land revenue and individuals and households' demand elevate the real estate prices in both the local city and other cities. loglb, logtf and logtp have the total effects of 0.46, 0.44 and 0.31, respectively, showing the positive impacts of bank credit, local governments' land revenue, and individuals and households' demand on the whole real estate prices in the large and medium-sized cities in the middle region of China.

The results of the SDM with spatial fixed effects for financial real estate risks in the large and medium-sized cities in the middle region of China are shown by Table 9. The coefficients of logtf, logtp, and logbl are significantly positive, at 0.25, 0.21 and 0.07, respectively. That is, local governments' land revenue has the strongest positive impact on the local financial real estate risks in the large and medium-sized cities in the middle region of China, followed by individuals and households' demand and bank loans to the real estate industry. The coefficient of logrdi is −0.45, indicating that real estate development enterprises' investment has a negative impact on the local financial real estate risks.

Table 9. Results of the SDM with spatial fixed effects for the middle region in China.

Variables	Coefficient	Direct Effect	Indirect Effect	Total Effect
W*fr	0.35 ***			
pr/gdpr	0.24	0.23	−0.04	0.19
logtf	0.25 ***	0.25 ***	0.07	0.33 ***
logrdi	−0.45 ***	−0.44 ***	0.24 *	−0.20 *
logbl	0.07 **	0.06	−0.22 ***	−0.17 **
logsa	0.21 ***	0.21 **	−0.07	0.13
W* pr/gdpr	−0.09			
W*logtf	−0.04			
W*logrdi	0.32 ***			
W*logbl	−0.17 ***			
W*logsa	−0.13			
R^2	0.50			

Note: "***", "**", "*" represent the 1%, 5% and 10% level of significance, respectively.

W*logrdi has the coefficient of 0.32, indicating that real estate development enterprises' investment expansion in other cities elevates the financial real estate risks in the local city in the middle region of China. W*logbl has a negative coefficient of −0.17, suggesting the negative impacts of bank credit to the real estate industry in other cities on the financial real estate risks in the local city, because the investors and speculators in the local city are attracted to other cities with more bank credit, and thus reduce the financial real estate risks in the local city. The coefficient of W*fr is 0.35, indicating the strong spatial diffusion effects of financial real estate risks among the large and medium-sized cities, which is the most influential factor for the rise in the local financial real estate risks in the middle region of China.

logtf, logsa and logrdi have the direct effects of 0.25, 0.21 and −0.44, respectively. That is, local governments' land revenue and market demand increase the local financial real estate risks; however, real estate enterprises' investment lowers the local financial real estate risks. Logrdi and logbl have the indirect effects of 0.24 and −0.22, indicating the positive impacts of real estate enterprises' investment expansion in the local city on the financial real estate risks in other cities, while bank credit to the real estate industry has the opposite influence. Logtf, logrdi and logbl have the total effects of 0.33, −0.20 and −0.17, respectively. That is, the local governments' land revenue has a strong positive effect, while the real estate enterprises' investment and bank credit have negative influences on the whole financial real estate risks in the large and medium-sized cities in the middle region of China.

4.2.3. The Western Region

The results of the SLM with spatial fixed effects for real estate prices in the western region of China are described in Table 10. The coefficients of logep, logtf and loglb are 0.51, 0.17 and 0.14, respectively. That is, real estate development enterprises' investment expansion is the most influential factor for the rise of local real estate prices in the large and medium-sized cities in the western region of China, followed by local governments' land revenue and bank credit. W*logp has the positive coefficient of 0.24, suggesting the strong spatial diffusion among real estate prices in the large and medium-sized cities in the western region of China.

logep, logtf and loglb have the direct effects of 0.52, 0.17 and 0.14, and the indirect effects of 0.16, 0.05 and 0.04, respectively. Thus, the real estate development enterprises' investment expansion has the most positive influence on real estate prices in both the local city and other cities in the western region of China, followed by local governments' land revenue and bank credit. The total effects of logep, logtf and loglb are 0.68, 0.23 and 0.19, respectively, suggesting the positive impacts of real estate development enterprises' investment, local governments' land revenue and bank credit on the real estate prices in the large and medium-sized cities in the western region of China.

Table 10. Results of the SLM with spatial fixed effects for the western region in China.

Variables	Coefficient	Direct Effect	Indirect Effect	Total Effect
W*logp	0.24 ***			
logtf	0.17 ***	0.17 ***	0.05 **	0.23 ***
logep	0.51 ***	0.52 ***	0.16 ***	0.68 ***
loglb	0.14 **	0.14 **	0.04 *	0.19 *
logtp	−0.03	−0.04	−0.01	−0.05
R^2	0.91			

Note: "***", "**", "*" represent the 1%, 5% and 10% level of significance, respectively.

The results of the SDM with spatial fixed effects for financial real estate risks in the large and medium-sized cities in the western region of China are shown in Table 11. The pr/gdpr, logtf, and logbl have the positive coefficients of 0.32, 0.19 and 0.17, respectively, indicating the strongest influence of over-growth in real estate prices on the local financial real estate risks, followed by the local governments' land revenue and bank credit in the large and medium-sized cities in the western region of China. logrdi has a coefficient of −0.45, suggesting that increase in real estate development enterprises' investment lowers the local financial real estate risks.

Table 11. Results of the SDM with spatial fixed effects for the western region in China.

Variables	Coefficient	Direct Effect	Indirect Effect	Total Effect
W*fr	0.19			
pr/gdpr	0.32 ***	0.33 *	0.49	0.82
logtf	0.19 ***	0.19 ***	−0.04	0.15 **
logrdi	−0.45 ***	−0.44 ***	0.53 ***	0.09
logbl	0.17 ***	0.15 ***	−0.43 ***	−0.28 ***
logsa	0.08	0.08	−0.03	0.05
W* pr/gdpr	0.34			
W*logtf	−0.07			
W*logrdi	0.52 ***			
W*logbl	−0.39 ***			
W*logsa	−0.04			
R^2	0.58			

Note: "***", "**", "*" represent the 1%, 5% and 10% level of significance, respectively.

The coefficients of W*logrdi and W*logbl are 0.52 and −0.39, respectively, indicating that real estate development enterprises' investment expansion in other cities elevates the financial real estate risks in the local city in the middle region of China, while bank credit has the opposite effect.

Similar to their coefficients, pr/gdpr, logtf, logbl and logrdi have a direct effect of 0.33, 0.19 and 0.15 and −0.44, respectively, indicating that the over-growth in real estate prices, local governments' land revenue and bank credit to the real estate industry elevates the local financial real estate risks, and real estate development enterprises' investment has the opposite influence. The indirect effects of logrdi and logbl are 0.53 and −0.43, respectively. That is, real estate development enterprises' investment in the local city increases the financial real estate risks in other cities, while the bank credit to the real estate industry is to the contrary. logtf and logbl have the total effects of 0.15 and −0.28, respectively, showing that the local governments' land revenue increases the whole financial real estate risks in the large and medium-sized cities in the western region of China, while the bank credit to the real estate industry has the opposite influence.

5. Discussion

Comparing the empirical results of the SDM for all 35 large and medium-sized cities in China and the eastern, middle and western regions of China, some similarities and differences are found.

Local governments' land revenue, real estate developers' investment, bank credit and individuals and households' demand drive up the local real estate prices in the 35 large and medium-sized cities in China, which proves the four sectors' interest net based on real estate markets in Section 2. Different from the research on real estate markets in Western countries, the study found the driving roles of local governments and real estate developers in China's real estate prices. Of course, the positive effects of "land financing" and "land finance" of local governments on China's real estate prices is also supported by Liu et al. (2018, 2019).

Individuals and households' demand, bank credit, and real estate developers' investment are the most influential factors for the rise in local real estate prices in the eastern, middle and western regions of China, respectively, while the influences of real estate developers' investment in the middle region and individuals and households' demand in the western region are not significant. Liu et al. (2019) also supports that the most influential role is of bank credit and real estate developers in the middle and western regions of China, respectively. These findings also coincide with the reality that the much higher real estate prices in the large cities in the eastern region attract many speculators, while the much lower real estate prices in the western region have no attraction to speculators.

Local governments' land revenue, real estate developers' investment, bank credit and individuals and households' demand have strong direct and indirect effects in the 35 large and medium-sized cities in China. The participation of the four sectors elevates real estate prices in both the local city and other cities, suggesting the spatial interactions of the four sectors among cities. Although many scholars have found the driving roles of local government (Liu et al. 2018, 2019), banking sector (Huang et al. 2015; Cerutti et al. 2017) and individual and household' speculative demand (Zhang et al. 2016) on real estate prices, this study further proves the spatial interactions between different sectors in promoting real estate prices by SDM models.

Similar to their coefficients, the direct, indirect and total effects of real estate developers' investment in the middle region and individuals and households' demand in the western region are not significant. Moreover, real estate prices have strong spatial diffusion effects in the 35 large and medium-sized cities in China, and the eastern, middle and western regions of China.

Over-growth in real estate prices, local governments' land revenue, bank credit to the real estate industry, and market demand increase the local financial real estate risks in the 35 large and medium-sized cities in China. This is consistent with the existing research findings that the close connection between the financial sector and the real estate industry is an easy way to cause financial crisis (Zhao et al. 2017), and speculative purchasing by individuals increases the non-performing loan ratio of banks (Wan 2018). However, this paper further proved the positive effect of local governments' "land revenue" on financial real estate risk theoretically and empirically.

Over-growth in real estate prices in the eastern and western regions, and local governments' land revenue in the middle region, are the strongest contributors to the local financial real estate risks. These are consistent with the phenomenon of the sky-high real estate prices in the eastern region, and real estate prices exceed the economic development level in the western region due to the spatial diffusion effects. Local governments in the middle region obtain less tax revenue than those in the eastern region due to less economic development level in the former; however, they can obtain more land revenue than those in the western regions due to the higher real estate prices and economic development level in the former. As a result, local governments in the middle region rely on land revenue the most, and become the strongest contributor for the local financial real estate risks.

Real estate developers' investment in other cities elevates the financial risks in the local city; however, local governments' land revenue, bank credit to the real estate industry and market demand have the opposite influences in the 35 large and medium-sized cities in China. Since real estate development enterprises usually expand their investment to accompany increasing real estate prices, the expansion of investment for real estate devel-

opment in other cities shows the increasingly soaring real estate prices, which diffuse to the local city and increase the local financial real estate risks. The rise in local governments' land revenue, bank credit to the real estate industry and market demand in other cities suggest the fund and resource inflow from the local city, which decreases the heat of real estate markets and thus financial real estate risks in the local city.

Although some scholars have found that speculation in China's real estate market has interactive effects between cities (Yang et al. 2017), or that real estate prices have significant spillover effects between cities (Yang et al. 2018), this paper further found the spatial interactions of the influences of various sectors (real estate developers' investment, local governments' "land revenue", bank credit to real estate industry and the speculative demand of individuals) on the financial real estate risk.

Financial real estate risks have strong spatial diffusion effects among the 35 large and medium-sized cities, and these cities in the eastern and middle regions of China. That is, financial real estate risks in a city can directly diffuse to other cities in the eastern and middle region of China, due to the hotter real estate markets and higher financial real estate risks in the eastern and middle regions of China. However, the spatial diffusion effects are not significant due to cooler real estate markets and lower financial real estate risks in the western region of China. As shown by Figure 3, the average real estate price of the large and medium-sized cities in the eastern region is highest, at 15,858.25 RMB/sq. m. in 2016, followed by the middle region (7726.33 RMB/sq. m. in 2016), and finally the western region (6308 RMB/sq. m. in 2016). Thus, the much higher real estate prices and hotter real estate markets in the eastern and middle regions bring much stronger spatial diffusion effects of financial real estate risks among cities.

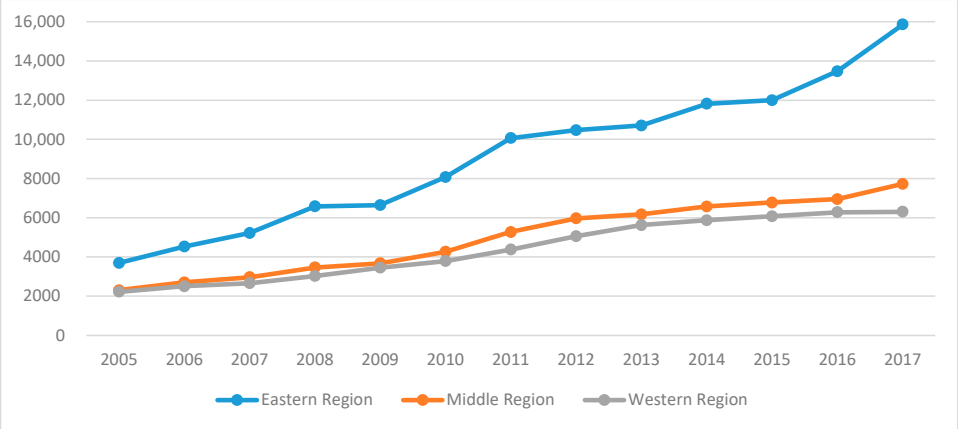

Figure 3. The average real estate price of the large and medium-sized cities in the eastern, middle and western regions of China (Unit: RMB/sq. m.). Source: arranged by the authors.

Accordingly, the originality of this paper is mainly in the following aspects: firstly, different from the real estate markets in the Western countries, the roles of local governments and real estate developers in promoting the Chinese real estate prices have been proved. Secondly, the spatial interactions of different sectors on real estate prices are proved based on SDM models. Thirdly, the positive effects of local governments' "land revenue" on the financial real estate risks are proved through theoretical and empirical analysis, in Sections 2 and 4, respectively. Fourthly, the spatial interactions of various sectors (real estate developers' investment, local governments' "land revenue", bank credit to real estate industry and the speculative demand of individuals) on the financial real estate risks are proved.

6. Conclusions

In conclusion, the main originality of this paper is in introducing various sectors' participation into the theoretical and empirical analysis to evaluate the financial real estate

risks and clarify their spatial interactions. The paper provides a new perspective from various participating sectors to study the financial real estate risks. The results on the roles of various sectors' participation in promoting the financial real estate risks, as well as their spatial interactions, enrich the research in this field. Particularly, the different roles of local governments and real estate developers in China compared to the Western countries should be highlighted. The rules on the sector and spatial levels suggest that government should take various policy measures for different sectors and regions to regulate financial real estate risks, and those policies considering spatial connections will be more effective. The main conclusions are as follows:

Firstly, local governments' land revenue, bank credit, real estate developers' investment expansion and individuals and households' real estate demand drive up real estate prices in both the local city and other cities, suggesting the spatial spillover effects of the four sectors on real estate prices among the 35 large and medium-sized cities in China. Moreover, real estate prices have strong spatial diffusion effects among the 35 large and medium-sized cities, as well as in the three regions. Individuals and households' demand, bank credit and real estate developers' investment have the strongest positive influences on real estate prices in the eastern, middle and western regions of China, respectively; however, real estate developers' investment in the middle region and individuals and households' demand in the western region have no significant influence on real estate prices.

Secondly, real estate price fluctuations, local governments' land revenue, bank credit to the real estate industry and market demand elevate the local financial real estate risks in the 35 large and medium-sized cities in China; however, real estate development enterprises' investment has the opposite influences. Sharp growth in real estate prices contributes most to the local financial real estate risks in the eastern and western regions, while local governments' land revenue is the most significant contributor for the local financial real estate risks in the middle region.

Thirdly, the impacts of the four sectors on the financial real estate risks have significant spatial interactions among the 35 large and medium-sized cities in China. That is, real estate development enterprises' investment in a city elevates the financial real estate risks in other cities due to the diffusion effects of soring real estate prices; however, local governments' land revenue, bank credit to the real estate industry and market demand have the opposite influences due to the substitution effects of funds and sources among cities. The substitution effects of market demand are much stronger in the eastern region than in the middle and western regions.

Fourthly, financial real estate risks have strong spatial diffusion effects among the 35 large and medium-sized cities, and these cities in the eastern and middle regions of China, due to much hotter real estate markets having higher financial real estate risks than in the western region.

Based on the above conclusions, the following suggestions are proposed for the regulation of real estate prices and financial real estate risks.

Firstly, housing prices and financial real estate risks are supposed to be regulated from the perspective of the four sectors. For the local governments, it is suggested that they reduce their dependence on land transfer fees, standardize the debt management of their underlying financing platform companies, and promote the development of the local economy by introducing high-tech enterprises and talents. With respect to banks, their risk management should be strengthened, and the lending to the real estate industry should be replaced by high-tech industries. As for real estate development enterprises, their various strategies to elevate real estate prices should be limited, the development of affordable housing to meet rigid demand should be encouraged, and the management of the debt ratio of real estate development enterprises should be strengthened. For the individuals and households, the down payment ratio and loan restrictions for non-rigid self-occupied houses should be promoted, and the possession of multiple properties should be taxed.

Secondly, regulatory policies with different emphases should be adopted for different regions and cities to keep in line with their different features. Eastern cities should pay

more attention to restricting individuals and households' speculation; middle cities should restrict more heavily banks' excessive lending to the real estate industry; western cities should be more wary of real estate development enterprises' speculation. In addition, the middle and western cities should avoid financial risks caused by sharp fluctuations in real estate prices, while middle cities should be more alert to local governments' financial risks. All three regions should be alert to the concentration of credit funds and land transfer fees in central cities, while the eastern region should pay more attention on the concentration of speculative demand in central cities. Furthermore, the eastern and middle regions may reduce financial real estate risks in the central cities and thus lower those in other cities.

Thirdly, spatial interaction features of real estate prices should be taken into account in regulation policies. Restraining land transaction fees, the expansion of credit scale, the investment expansion of real estate development enterprises and market demand in the central cities could lower the local real estate prices and bring about the decrease in the real estate prices in other cities. Reducing the investment expansion of real estate development enterprises in the central cities could drive the cooling of real estate markets and thus financial real estate risks in other cities. Other cities should take various measures to attract capital and resources to promote local economic development, avoiding excessive capital and resource inflows to real estate markets in the central cities to reduce the agglomeration of financial real estate risks in the central cities.

Of course, there are still some deficiencies in this study. For example, many factors, such as the Chinese government's recent financial real estate risk regulation policies, the outbreak of COVID-19, and flood risk (Jung and Yoon 2018; Hsieh 2021), have important influences on the real estate prices and financial risks, but only the participation of the four sectors are studied in this paper. Since this paper focuses on the financial real estate risks from the perspective of the participating sectors in the real estate market, other factors are not included in the research framework. This is one of the deficiencies of this paper. In the future study, we will try to specifically and deeply analyze the influences of these external factors on financial real estate risks.

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