Housing Prices and Corporate Innovation in China

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Abstract： Based on the data of 35 major cities in China, this paper examines the impact of the rising housing prices on the innovation activities of Chinese A-share listed companies. We find that the increase in housing prices significantly inhibit the number of patent applications and the proportion of R&D expenditure of listed corporations. In addition, we further consider the ownership structure, and find that the impact of housing price on corporate innovation is more pronounced in state-owned enterprises. This paper reveals the negative impact of a booming real estate market on the real economy from the perspective of innovation in China.

Keywords: Real Estate Markets, Innovation, Crowding Out Effect

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I. Introduction

The impact of rising housing prices on the company and the economy has been a topic of concern to policy makers and scholars. Especially in China, the relationship between real estate and China's overall macro economy is extremely close. The investment in real estate industry accounts for more than 25% of China's fixed asset investment. In addition, real estate accounts for 74.7% of the total wealth of the people in China, which means up to 3/4 of the wealth of residents is directly linked to real estate, while real estate accounts for only 27.9% of its residents' wealth in the United States. China's housing prices have remained almost unilaterally rising, especially in first-tier cities, where housing price bubbles have been really dangerous.

Although the prosperity of real estate industry can promote economic development in the short-term, the real estate bubble may prompt the transfer of the corporate investment focus, transferring more resources to the higher-profit real estate industry and ignoring the long-term R&D expenditures on the major business, which will have a negative impact on overall economic growth in the long run (Shi et al, 2016). Samuelson (1958) proposed a market-based hypothesis under the framework of exogenous growth theory. He thought that there would be problems of excessive capital accumulation in equilibrium, and asset bubbles can improve economic operation efficiency by extruding investment. However, in the framework of the endogenous economic theory, Grossman and Yanagawa (1993) proposed that the speculative behavior induced by asset bubbles squeezed out investment and lowered the speed of capital accumulation and finally restrained economic growth. Miao and Wang (2012) established a two-sector endogenous economic growth model and found that when the company's mortgage assets generate asset bubbles, the company has the incentive to mortgage more assets to get more loans to invest, which can finally drive the overall economic growth. But if the company is attracted by a sectoral bubble and invests limited capital in industries that have no externalities (such as real estate), the flow of capital to the sector will have a negative impact on the economy. Exploring the relationship between housing price volatility and economic growth has become a hot issue in the present academic research.

In empirical research, Gan (2007) firstly used firm-level data to examine the impact of

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housing price changes on corporate lending and investment. The study found that when the Japanese land market bubble burst in the early 1990s, as companies obtained large amounts of loans mostly through mortgaging real estate, the decline in housing prices caused the company's bank lending and investment to drop significantly. At the same time, a large number of recent literature pointed out that the high return rate of the real estate industry has attracted a large number of companies to invest in real estate projects (Lu, 2016). Since the R&D investment as an innovation activity has a significant positive correlation with the company's market value (Richard Blundell, Rachel Griffith, John Van Reenen, 1999), the company's neglect of technological innovation and reduction of innovation investment are harmful to the company's long-term development. In China, Wang et al. (2014) empirically analyzed the inhibitory impact of rising house prices on new product development and R&D investment. The study pointed out that the faster the housing price rises, the lower the company's tendency to develop new products. Deng (2014) studied the impact of industrial companies' investing in real estate on their innovative capabilities, and proved that the rise in real estate prices has a negative impact both in the long run and in the short term, refuting the opinion that the rise in housing prices has a "compensatory effect" on industrial companies in the long run.[3]

Combined with the above-mentioned literature, this paper studies the impact of rising house prices on the innovation activities of A-share listed companies based on the data of A-share listed companies in 35 large and medium-sized cities. The main conclusions are as follows: (1) An increase in housing price will lead to less innovation input and output; (2) The innovation activities of state-owned enterprises are more affected by the rising of housing prices. We use different innovation and housing price indicators, try different measurement models and subsample regressions to conduct robustness checks.

This paper has the following contributions. Firstly, the existing literature on the negative impact of rising house prices is mainly concentrated on the innovation of industrial companies, and there are few references to the impact of innovation activities in other industries. This paper further explores the impact of rising house prices on the innovation activities of all Chinese A-share listed companies. Secondly, the existing literature still has no unified view on the impact of housing price on state-owned enterprises and non-state-owned enterprise innovation activities. This paper uses micro-company data from various regions to circumvent the aggregate bias and the endogenous problem due to macro data, and further explores the influence of housing price fluctuations on the innovation activities of state-owned enterprise. Thirdly, in terms of innovation, this paper uses the number of patent applications of the company while most existing researches choose R&D expenditures as a proxy variable for innovation. However, as Gao et al. (2004) proposed, R&D expenditure is only an input variable of innovation, and it cannot accurately capture the true innovation ability of the company. In addition, by adopting patent indicators, we can more accurately characterize the company's ability to innovate.

The structure of the rest of the paper is as follows: the second part is literature review and theoretical mechanism, the third part is data description and model specification, the fourth part is the estimation of the effect of housing price fluctuation on the company's innovation, and the fifth part is conclusions and suggestions.

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[3] That means when the profit of the main business is relatively low, the company will invest part of the funds to the profitable real estate industry, and then use the real estate industry operating income to support its R&D and other innovation activities.

II. Literature Review and Theoretical Mechanism

1、Literature Review

The bubble in the real estate market has attracted the attention of many scholars and policy makers because of its enormous impact on social and economic development. In 2013, real estate investment accounted for 15% of China's total GDP; by comparison, this figure was only about 4% in 1998(Nie and Cao, 2014). Given that China has become the world's second largest economy, China's real estate investment may even have a global impact. Real estate can “squeeze out” investment or “crowd in” investment, thus both mitigating distortions in the economy and possibly exacerbating distortions in the economy (Wang et al., 2016).

This paper mainly combines three types of research directions. The first category of literature focuses on the possibility of housing price increases serving to the company's innovation activities. Since Schumpeter (1942) proposed the innovation theory, more and more economists have emphasized the role of innovation in promoting economic growth (Romer, 1990; Grossman and Helpman, 1994). The corporate innovation activities face many financial constraints. According to the theory of Hall (2002)'s innovation activities with high financing costs, the output of innovation activities is highly uncertain and the innovation process has high regulatory costs, making it difficult for external investors to evaluate the company. The strengths and weaknesses of innovative projects require a high risk premium, which in turn increases the cost of innovative external financing. The rapid development of the real estate industry may have a positive impact on innovation. The booming real estate market will lead to continued appreciation of the company's real estate, and improve the mortgage value and loan capacity of the company's real estate, thus reducing the company's financing constraints, “crowding into” investments in research and development, companies can further leverage loans to increase investment in R&D innovation (Kiyotaki and Moore, 1997). According to a study by Chaney et al. (2012), for every $1 increase in real estate mortgage value between 2003 and 2010, US non-real estate company fixed asset investment increased by 2.7 cents, which shows that the real estate bubble relaxes the company's finance constraints, alleviates the financial impact of the company and ensures the continuity of the company's innovative investment.

The second category of literature focuses on the “crowding out effect” of rising housing prices on corporate innovation activities. “Extrusion effect” means that when corporate managers pursue short-term benefits, the high return on investment in the real estate industry may attract managers to move investment from company R&D and innovation to the real estate industry (Narayanan, 1985; Stein, 1989; Kaplan & Porter, 1992; Aghion et al, 2013). Under the influence of the “crowding out effect”, the real estate bubble will attract a large number of companies to invest a large amount of money in the already over-prosperous real estate market, thereby reducing innovation investment, resulting in inefficient resource allocation and drop down of long-term economic growth rate. Wu (2012) finds that the rise of real estate prices has led to the “hollowing” of these private industries. Wang (2014) use the data system of industrial enterprises above designated size in 35 large and medium-sized cities in China from 1999 to 2007 to study the inhibitory effect of housing price increase on industrial company innovation, and empirically analyzed the impact of increases in housing prices and industrial enterprises' new product output and R&D investment. The study finds that the faster the rate of housing price increase, the weaker the tendency of industrial companies to develop new products, and such inhibitions are weaker in

smaller companies and foreign companies.

The third type of literature focuses on the factors that influence the company's innovation (the level of R&D expenditure, the size of the company, the shareholding structure etc.). Griliches (1986) finds that the company's R&D expenditure significantly promoted the company's productivity and improved the company's innovation ability based on the data of 1000 manufacturing companies in the United States from 1957 to 1976. David and Zoltan (1988) argue that the size of a company is positively correlated with industry innovations, and that larger companies have an advantage in corporate innovation. Audretsch. D. B and Acs.Z. J (1989) find that companies of different sizes have different innovation advantages in different industries, and the strength of the company's innovation. There is no obvious linear relationship with the size of the company. An empirical study by Zahra et al. (2000) on the innovation activities of medium-sized companies find that the shareholding ratio of company managers is significantly positively correlated with the company's technological innovation activities. In China, Xu and Zhang (2008) find that state-owned equity-oriented companies tend to innovate internally and will not actively seek cooperation from others; Feng and Wen (2008) find that the proportion of state-owned shares[4] has a negative correlation with the company's technological innovation.

This paper combines the above three directions to explore the inhibitory effect of rising house prices on the innovation activities of Chinese A-share listed companies, and further studies the difference in the inhibitory effect of house price increases on companies of different sizes and different ownership structures.

2、Theoretical Mechanism

Real estate is a capital-intensive industry, and real estate development requires a large amount of investment and a long investment cycle. Without strong financial resources, it is difficult for companies to enter the real estate market. As a developing country, for one thing, China’s financial market is still incomplete, what’s worse, the poor institutional environment magnifies the shortage of financial market, resulting in a lack of assets that can be used as collateral and hedging, and the real estate market thus acts as collateral assets. When the financial industry is relatively backward, many non-real estate companies have significant financing advantages in entering the real estate industry. They not only establish good credit relationships with banks through their daily business activities, but also have more fixed assets (especially factories and land) as loan collateral. In addition, many non-real estate companies have extensive management experience and have established close relationships with local governments because they can provide local governments with tax revenues and job creating opportunities. 37% of the 35 large and medium-sized cities in 2013 launched real estate business. In order to pursue high-return real estate industry, the companies are actively preparing for participation in real estate funds. Due to financing constraints, it is bound to reduce the original investment projects to meet the large-scale capital demand of real estate investment. R&D projects are more dependent on internal financing, have a large demand for capital and a long payback period, so they can be easily affected by the reduction of existing investment projects. It is foreseeable that rising house prices will have a major negative impact on innovative investments in major industries.

We expect that the negative impact on state-owned enterprises’ innovation is greater than that of non-SOEs. The reasons are as follows. Firstly, 65% of enterprises are state-owned enterprises in China's stock market. In terms of quantity, state-owned enterprises are more affected by external

[4] State-owned shares include state-owned shares and state-owned legal person shares

stimuli. Second, state-owned enterprise managers do not value innovation as much as these of non-state owned copanies, and they lack innovative incentives or capacity (Megginson and Netter, 2001). Finally, compared with non-state-owned enterprises, state-owned enterprises have relatively close relationships with local governments and state-owned banks, and it is relatively easier for them to enter the real estate market.

III. Data Source and Model Settings

The company data used in this paper is from the CSMAR database. Since the listed company began to disclose the relevant information about real estate investments in the notes of the financial statements since 2003, we choose 2003-2015 as our sample period. Companies are located in 35 large and medium cities. This article excludes companies in the "financial", "insurance", "real estate" and "construction" industries, as companies investing in these industries are not solely for the purpose of using real estate as mortgage. In addition, we excludes companies in "agriculture", "mining", "traffic industry", "warehouse" and "hydropower and gas" industries, because companies in these industries have large amounts of land and real estate outside the urban area. If urban housing prices are used, estimates tend to be biased in calculating their mortgage value.

1、Housing Price Data

The price data of 35 major cities used in this paper from 2003 to 2015 comes from the website of the National Bureau of Statistics. The average sales price data of commercial housing is standardized by setting the price of each district in 2002 to 1.

$$HPI = \frac{General\ Housing\ Price}{General\ Housing\ price\ (2002)} * 100 \qquad (1)$$

$$RPI = \frac{Residential\ House\ Price}{Residential\ House\ price\ (2002)} * 100 \qquad (2)$$

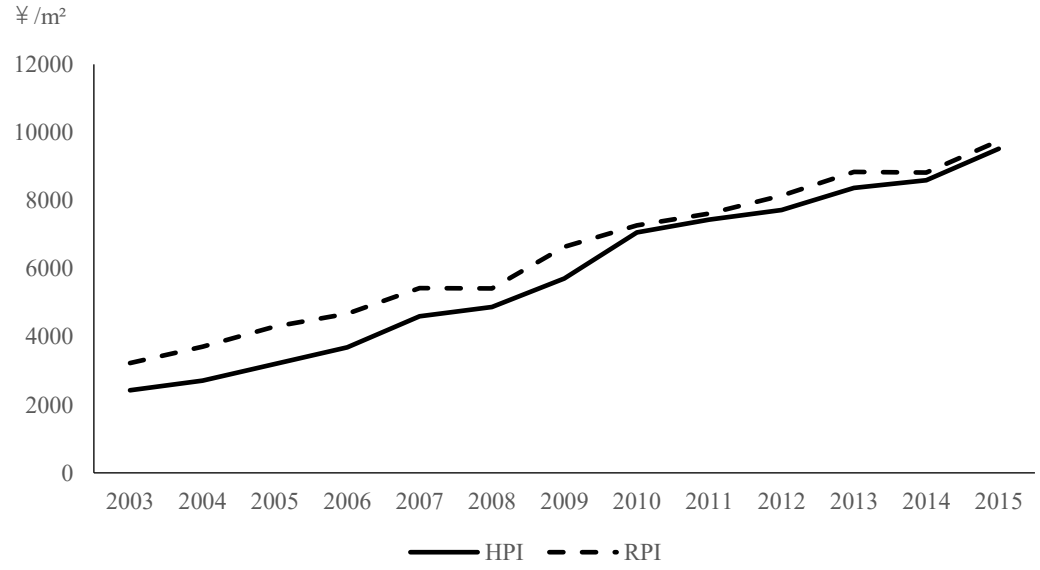

Figure 1 Commercial Housing Sales Price

Figure 1 shows the trend of housing prices in 35 large and medium-sized cities from 2003 to 2015. According to the picture, it can be seen that the average sales price of the 35 cities showed a

rapid growth trend in the past ten years. In 2002, the average housing price in the 35 large and medium-sized cities was 3041 yuan / square meter, while the average house price in the 35 large and medium-sized cities in 2015 rose to 9752 yuan / square meter, with an annual growth rate of 10%, far higher than 2.85% inflation growth rate.[5]

2、Patent Data Description

The explanatory variables in this paper are the company's innovations, but it is difficult to find a comprehensive indicator to measure the company's innovation activities. In the past, the research often used the amount of new products or R&D expenditures to measure the company's innovation activities, but both of these indicators have certain limitations. Firstly, R&D spending can only measure the company's innovation investment, while companies with more investment are not necessarily innovative; in addition, the company does not necessarily produce new products through R&D activities, and the innovative features of new products are difficult to measure with uniform standards. What's more, the company's patent stock does not accurately reflect the company's current R&D innovation investment status because the company's patents are affected by factors such as policies and systems of patents authorization. Referring to Shi et al. (2016), we used the company's patent applications for the current year to measure the company's innovation output that year. The patent is the result of independent innovation. The number of patents applied by the company directly reflects the company's ability to innovate.

The patent data in this paper is from the patent and R&D innovation database of CSMAR. We can get the number of patent applications of a company in a given year. The State Intellectual Property Office granted three kinds of patents: invention patents, utility model patents and design patents. The definition of an invention patent is "a new technical solution proposed for a product, a method or a modification thereof", and a utility model patent is defined as "a new technology suitable for practical use of the shape, structure or combination of the product. The definition of a design patent is "a new design that is aesthetically pleasing to the shape, pattern or combination of the product and the combination of color and shape and pattern, and is suitable for industrial applications." It takes more than two years before a patent is granted, and the use of patent grants will result in truncation bias. Therefore, the logarithm of the number of patent applications is used as an indicator to measure the company's research and development results. The technical quantities of the three patents are different, and the technical content of the invention patents is the highest (Zhuo, 2012). Therefore, we use the total number of patent applications and invention patent applications as our dependent variables.

3、Control Variables

We control a range of variables at the company level that may affect innovation. Book to market ratio refers to the total value of assets compared to the listed value. Leverage refers to the ratio of total debt to total assets. In order to control the size of the company, we controlled the logarithm of the company's sales. In addition, because financing factors are of great significance to the company's innovation, we also control the company's cash assets ratio in the return, which is defined as the company's cash compared to the total assets of the year. In addition, in order to control some unobservable factors at the city level and the company level that do not change with time, we control the city fixed effect and the company fixed effect. Finally, we also control the annual fixed effects to absorb the effects of some macro factors.

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[5] The inflation growth rate is calculated from the Urban Residents Consumer Price Index of the National Bureau of Statistics website.

4、Descriptive Statistics

Table 1 gives descriptive statistics for the key variables in this paper. In order to reduce the impact of outliers, all continuous variables are winsorized at the 1% level. In Table 1, we report the logarithm of the company's patent applications and the logarithm of the number of invention patent applications. It can be seen that the distribution of all patents is extremely right-biased. The table also reports general housing price (HPI) and residential housing price (RPI). The general housing price index is standardized according to the local housing price in 2002. In terms of HPI, the fastest-rising city is Shenzhen, and the slowest region is Yinchuan. The table also reports the company's micro-level control variables, including leverage, book-to-market ratio, sales and cash to asset ratio.

Table 1 Descriptive Statistics

Variable	Number of Observations	Median	Std. Deviation	Min	Max
Number of patent applications	9,375	1.30	1.56	0.00	5.92
Number of invention patent applications	9,375	0.88	1.28	0.00	5.07
General housing price	9,375	2.96	1.15	0.85	5.85
Residential housing price	9,375	3.10	1.28	0.91	7.29
Leverage	9,375	0.44	0.21	0.05	1.00
Book to market ratio	9,375	0.82	0.71	0.08	3.77
Sales	9,375	21.06	1.45	17.94	25.10
Cash to asset ratio	9,375	0.23	0.17	0.01	0.78

Note: The number of patent applications, the number of invention applications, and sales are all in logarithmic form. The general housing price is standardized according to the 2002 data of each city.

5、Empirical Model

The basic empirical analysis model is as follows:

$$Y_{it}^{C} = \beta \cdot HPI_{t}^{C} + \gamma \cdot X_{it} + \alpha_i + \lambda_t + \varepsilon_{it} \qquad (3)$$

Among them, i, c, t represent company, city and year respectively. Y represents the explanatory variable, which is Ln (Patents+1); HPI represents the standardized housing price, which is the explanatory variable. Following the empirical literature of corporate innovation, we control some company-level variables, including the logarithm of sales, book-to-market ratio, cash-to-asset ratio, and leverage. The logarithm of sales is used to control the size of the company, the cash to asset ratio controls the company's investment capacity, and leverage controls the company's financing ability. Taking into account the unobserved heterogeneity at the company level, we control the company fixed effect; in order to explain the possible impact of domestic macroeconomic changes on investment, we also control the year fixed effect, expressed by λ; at the same time, this paper controls city fixed effect, using α to represent the various factors that influence the innovation at the city level and do not change with time, including urban incentives for innovation and urban residents' awareness of innovation. ε represents the residual and is a random error term.

Since all companies in the same city face the same rate of housing price increase in the same year, the “city-year” data in this paper is not relatively independent. We group the samples by

"city-year" and relax the assumption that the samples are independent of each other, instead we only assumes that different groups are independent from each other and accordingly cluster the residuals. Such clustering process can result in a more robust estimation variance.

IV. Regression Results

1 Baseline Regression Result

We firstly use the full sample to run the regression, and the results are shown in Table 1. The coefficient of the housing price index is significantly negative, indicating that the increase in the sales price of commercial housing has a significant negative impact on the number of patent applications, that is, the housing price increase has an extrusion effect on the company's innovation results, and the results are in line with the theoretical mechanism of this paper. And previous research findings (Wang, 2014; Shi et al, 2016). The coefficient of housing price index is negative and significant at 1% significance level, which means that if the house price rises by 50%, the company's patent applications are reduced by an average of 4.48%. Columns (3) and (4) are the results of the regression of the number of invention applications, which further supports the view that the inventions in the predecessor patents are more effective. The company's financial indicators may have a high correlation with the number of patent applications.

Table 2 The inhibitory effect of rising house prices on company innovation

	(1)	(2)	(3)	(4)
Dependent variable	Number of patent applications	Number of patent applications	Number of invention patent applications	Number of invention patent applications
HPI	-0.0690***	-0.0896***	-0.0680***	-0.0767***
	(-2.68)	(-3.39)	(-3.00)	(-3.29)
Leverage		0.3295***		0.2701***
		(3.56)		(3.31)
M/B ratio		0.0268		0.0001
		(1.16)		(0.01)
Sales		0.1245***		0.1085***
		(6.84)		(6.76)
Cash		-0.3966***		-0.2977***
		(-4.60)		(-3.91)
Constant	0.9395***	-1.5995***	0.5224***	-1.6884***
	(19.62)	(-4.37)	(12.43)	(-5.23)
Firm fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Number of observations	9,375	9,375	9,375	9,375
R^2	0.0809	0.0969	0.0938	0.107

Note: The value of t is in parentheses. The error is a robust value. *** (**) (*) Significance at the 1% (5%)(10%) two-tailed level. The number of patent applications, the number of invention applications, and the income from the main business are all in logarithmic form. The average housing price index is standardized according to the 2002 data of each city.

2 Company Ownership Structure

In order to verify that the innovation activities of state-owned enterprises are more affected by the rise of housing prices, we divide all enterprises in the sample into groups of SOE and non-SOEs according to the ownership structure, and expect that the coefficient of housing prices in the state-owned enterprise sample is more significantly negative than that in the non-SOE sample. From the results in Table 3, it can be seen that the coefficient of HPI in state-owned enterprise sample is significantly negative at 1% significance level, but the coefficient in non-SOE sample is not significant. It shows that compared with non-state-owned enterprises, the innovation activities of state-owned enterprises are more affected by the rise in housing prices. When housing prices rise, due to the close relationship between state-owned enterprises and local governments and banks, it is easier for SOEs to enter the real estate industry to obtain high profits, which is at cost of the innovative research and development of the main business.

Table 3 Comparison of the inhibitory effects of rising house prices on state-owned enterprises and non-state-owned enterprises

	(1)	(2)	(3)	(4)
Dependent variable	Number of patent applications	Number of patent applications	Number of invention patent applications	Number of invention patent applications
	State-owned enterprises	Non-state enterprises	State-owned enterprises	Non-state enterprises
HPI	-0.1488***	-0.0476	-0.1211***	-0.0492
	(-3.76)	(-1.29)	(-3.42)	(-1.53)
Leverage	0.3174**	0.2912**	0.1850	0.3274***
	(2.46)	(2.08)	(1.60)	(2.69)
M/B ratio	0.0313	-0.0121	-0.0096	0.0069
	(1.16)	(-0.26)	(-0.40)	(0.17)
Sales	0.0806***	0.1723***	0.0909***	0.1235***
	(3.32)	(5.74)	(4.19)	(4.73)
Cash	-0.5772***	-0.2646**	-0.3199**	-0.2521**
	(-4.07)	(-2.25)	(-2.52)	(-2.46)
Constant	-0.8586*	-2.2391***	-1.3992***	-1.8702***
	(-1.72)	(-3.78)	(-3.14)	(-3.62)
Company fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Urban fixed effect	Yes	Yes	Yes	Yes
Number of observations	4,739	4,614	4,739	4,614
R^2	0.122	0.0708	0.133	0.0820

Note: The value of t is in parentheses. The error is a robust value. *** (**) (*) Significance at the 1% (5%)(10%) two-tailed level. The number of patent applications, the number of invention applications, and the income from the main business are all in logarithmic form. The average housing price index is standardized according to the 2002 data of each city.

3 Robustness checks

（1）Different Housing Price Indicators

In the previous regression, we use the general housing price index (HPI) to measure the price level. In order to test the robustness of the conclusion, we use another indicator of real estate price - the residential housing price index (RPI) to run the regression again. The results are shown in Table 4. The results are similar to the above. Specifically, if housing prices rise by 50%, the number of corporate patent applications will fall by an average of 3.7%. The rise in housing prices has curbed the innovation output of enterprises, and this inhibitory effect is more obvious after adding control variables.

Table 4 Residential housing price index

	(1)	(2)	(3)	(4)
Dependent variable	Number of patent applications	Number of patent applications	Number of invention patent applications	Number of invention patent applications
RPI	-0.0553**	-0.0741***	-0.0584***	-0.0657***
	(-2.46)	(-3.21)	(-2.96)	(-3.23)
Leverage		0.3316***		0.2717***
		(3.59)		(3.33)
M/B ratio		0.0276		0.0008
		(1.19)		(0.04)
Sales		0.1241***		0.1081***
		(6.82)		(6.74)
Cash		-0.3947***		-0.2965***
		(-4.58)		(-3.90)
Constant	0.9241***	-1.6097***	0.5118***	-1.6954***
	(20.22)	(-4.40)	(12.76)	(-5.25)
Company fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Urban fixed effect	Yes	Yes	Yes	Yes
Number of observations	9,375	9,375	9,375	9,375
R^2	0.0808	0.0968	0.0937	0.107

Note: The value of t is in parentheses. The error is a robust value. *** (**) (*) Significance at the 1% (5%)(10%) two-tailed level. The number of patent applications, the number of invention applications, and the income from the main business are all in logarithmic form. The average housing price index is standardized according to the 2002 data of each city.

（2）Different Innovation Measures

In the main regression, we use the number of patent applications and the number of invention patent applications to measure the level of innovation. In order to test the robustness of the conclusions, here we use the R&D expenditures to measure the corporate innovation and the results are shown in Table 5. We can see from table 5 that our results remain robust, and when housing prices rise, the companies' R&D investment will decrease.

Table 5 R&D expenditure

	(1)	(2)	(3)	(4)
Dependent variable	R&D expenditure	R&D expenditure	R&D expenditure	R&D expenditure
HPI	-0.5128***	-0.4330***		
	(-3.18)	(-2.61)		
RPI			-0.4635***	-0.3679**
			(-3.21)	(-2.46)
Leverage		-1.4032*		-1.4049*
		(-1.73)		(-1.73)
M/B ratio		0.1543		0.1584
		(0.71)		(0.73)
Sales		-2.4247***		-2.4237***
		(-13.38)		(-13.37)
Cash		-1.3683**		-1.3652**
		(-2.35)		(-2.34)
Constant	4.0063***	54.1845***	3.9544***	54.0671***
	(8.06)	(14.81)	(8.16)	(14.78)
Company fixed effect	No	Yes	No	Yes
Year fixed effect	No	Yes	No	Yes
Urban fixed effect	No	Yes	No	Yes
Number of observations	4,800	4,553	4,800	4,553
R^2	0.0522	0.106	0.0523	0.106

Note: The value of t is in parentheses. The error is a robust value. *** (**) (*) Significance at the 1% (5%)(10%) two-tailed level. The number of patent applications, the number of invention applications, and the income from the main business are all in logarithmic form. The average housing price index is standardized according to the 2002 data of each city.

（3）Replace the Estimation Model

In this paper, the least squares (OLS) regression model is used in the previous regression. The explanatory variable in this paper is the patent number, which is a non-negative discrete random variable, and has a large number of observations at zero (many companies have not obtained patents in a certain year), showing typical biased distribution characteristics. Therefore, we then use the Poisson model to run the regression again. After changing to the Poisson regression model, the regression coefficient was significantly improved, proving that the price increase significantly inhibited the company's innovation activities. Besides, we also use negative binomial regression model to do the robust check too, and the regression results are shown in Table 6. The results are still robust.

Table 6 Poisson and Negative Binomial regression model

	(1)	(2)	(3)	(4)
Model	Poisson Regression		Negative Binomial Regression	
Dependent variable	Number of patent	Number of	Number of patent	Number of

	applications	invention applications	applications	invention applications
HPI	-0.4499***	-0.7565***	-0.1554***	-0.0664**
	(-59.37)	(-67.25)	(-3.93)	(-2.05)
Leverage	-1.1076***	-1.5590***	-0.1846	-0.0911
	(-33.08)	(-30.18)	(-1.35)	(-0.80)
M/B ratio	-0.1059***	-0.2664***	-0.0709**	-0.0055
	(-20.64)	(-35.98)	(-2.06)	(-0.19)
Sales	0.7773***	0.8742***	0.1010***	0.0916***
	(104.48)	(79.54)	(5.08)	(5.49)
Cash	0.3276***	-0.0248	0.0084	0.1105
	(10.79)	(-0.53)	(1.34)	(1.10)
Constant			-2.2040***	-1.5907***
			(-5.14)	(-4.48)
Company fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Urban fixed effect	Yes	Yes	Yes	Yes
Number of observations	4,698	4,652	4,784	4,784

Note: The value of t is in parentheses. The error is a robust value. *** (**) (*) Significance at the 1% (5%)(10%) two-tailed level. The number of patent applications, the number of invention applications, and the income from the main business are all in logarithmic form. The average housing price index is standardized according to the 2002 data of each city.

4 Endogeneity Problem

All the previous regressions are based on the fact that the company's innovation activities cannot affect local housing prices. In theory, there is the possibility that large-scale companies will put more efforts to innovation activities so as to increase the scale of the company through efficiency improvement. Such companies will provide a large number of jobs, attract a large number of people, which will affect the housing prices of the local city.

（1）Focus on the smaller companies

In order to address the endogeneity problems, we divide the companies into large companies and small companies according to whether the sales amount is greater than the median and whether the total assets are greater than the median. And then we focus on the group with smaller size, which can cause less impact on the local housing price. The regression results are shown in Table 7. The housing price coefficient of small companies is still significantly negative at the 1% level, indicating that the endogeneity problem in the regression model is not very serious.

Table 7 Endogenous Problem Test

	(1)	(2)	(3)	(4)
Dependent variable	Number of patent applications		Number of patent applications	
Criteria for the classification	Sales		Assets	

	Small company		Small company	
HPI	-0.1124***		-0.0686*	
	(-3.03)		(-1.81)	
RPI		-0.0994***		-0.0648*
		(-3.02)		(-1.95)
Leverage	0.2273*	0.2341*	0.4846***	0.4883***
	(1.88)	(1.95)	(4.64)	(4.70)
M/B ratio	0.0762	0.0755	0.0371	0.0365
	(1.61)	(1.61)	(1.19)	(1.18)
Sales	0.1259***	0.1234***	0.1532***	0.1522***
	(4.14)	(4.12)	(6.98)	(6.99)
Cash	-0.3864***	-0.3881***	-0.4227***	-0.4246***
	(-3.63)	(-3.67)	(-4.32)	(-4.36)
Constant	-1.4456**	-1.4194**	-2.2495***	-2.2371***
	(-2.43)	(-2.42)	(-5.12)	(-5.13)
Company fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Urban fixed effect	Yes	Yes	Yes	Yes
Number of Observations	4,867	4,868	4,867	4,868
R^2	0.073	0.068	0.070	0.076

Note: The value of t is in parentheses. The error is a robust value. *** (**) (*) Significance at the 1% (5%)(10%) two-tailed level. The number of patent applications, the number of invention applications, and the income from the main business are all in logarithmic form. The average housing price index is standardized according to the 2002 data of each city.

（2）IV Regression

In order to further address the endogeneity problem, we use the product of housing supply elasticity and long-term interest rate as the instrumental variable of housing price to perform IV regressions. In theory, housing demand will increase when long-term interest rates fall. If the supply of land is flexible at this time, the decline in interest rates will promote the real estate companies to construct more houses; if the supply of land is not flexible at this time, the increase in housing demand will lead to a sharp rise in housing prices.

The regression results are shown in Table 8. The first and second columns use general housing price as the dependent variable, and the third and fourth columns are results using residential housing price index. The regression results show that the product coefficient of housing supply elasticity and long-term loan interest rate is significantly positive, and the second stage regression result shows that our results from the above main regression are still robust.

Table 8 Instrument Variable Method Test

	(1)	(2)	(3)	(4)
Dependent variable	The first stage	second stage	The first stage	second stage

Housing supply elasticity				
*long-term loan interest rate	14.0549***		14.1545***	
	(8.73)		(7.66)	
HPI		-0.0896***		
		(-3.39)		
RPI				-0.0741***
				(-3.21)
Leverage		0.3295***		0.3316***
		(3.56)		(3.59)
M/B ratio		0.0268		0.0276
		(1.16)		(1.19)
Sales		0.1245***		0.1241***
		(6.84)		(6.82)
Cash		-0.3966***		-0.3947***
		(-4.60)		(-4.58)
Constant	-0.0356	-1.5995***	-0.0349	-1.6097***
	(-0.26)	(-4.37)	(-0.22)	(-4.40)
Company fixed effect	No	Yes	No	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Urban fixed effect	Yes	No	Yes	No
Number of Observations	420	9,375	420	9,375
R^2	0.888	0.097	0.875	0.097

Note: The value of t is in parentheses. The error is a robust value. *** (**) (*) Significance at the 1% (5%)(10%) two-tailed level. The number of patent applications, the number of invention applications, and the income from the main business are all in logarithmic form. The average housing price index is standardized according to the 2002 data of each city.

（3）Diff-in-Diff Analysis

In order to combat housing investment and speculative demand, many governments have introduced a housing purchase restriction policy to curb the excessive rise in housing prices. This provides us an opportunity to perform the Diff-in-Diff analysis. We select the city that implements the purchase restriction policy as the experimental group, and the city that does not adopt the purchase restriction policy as the control group, and further compare whether the urban technological innovation level of the experimental group is higher. In order to study this problem, we use the urban innovation index as the dependent variable. It is defined as the number of patent applications in that city per person every year. The patent data comes from the CNKI patent database. We also control a series of city-level control variables such as GDP, FDI and industrial structure. FDI is defined as the industrial sales of FDI firms to the total industrial sales in that city. Industrial structure is defined as the ratio of the GDP of the second industry to the total GDP of the city. The city-level data comes from the China Regional Economic Statistical Yearbook. The regression results are shown in Table 9. The results show that the coefficient of the interaction term between purchase restriction city and restriction period is significantly positive, indicating that the purchase restriction policy has a significantly positive impact on the level of innovation of

the city.

Table 9 The Role of Purchase Restriction Policy

Dependent variable	(1) Urban innovation index	(2) Urban innovation index	(3) Urban innovation index	(4) Urban innovation index
Purchase restriction city*Purse restriction time	2.3245***	2.2630***	2.1925***	2.2585***
	(9.79)	(9.46)	(9.13)	(9.10)
GDP per capita		-0.0476**	-0.0483**	-0.0501**
		(-2.04)	(-2.08)	(-2.15)
Amount of foreign investment			-0.3581***	-0.3604***
			(-2.77)	(-2.79)
Industrial structure				0.0136
				(1.05)
Constant	0.0683	0.4102	0.4252	-0.1470
	(0.10)	(0.61)	(0.63)	(-0.17)
Year fixed effect	Yes	Yes	Yes	Yes
City fixed effect	Yes	Yes	Yes	Yes
Number of observations	2,286	2,286	2,286	2,286
R^2	0.352	0.353	0.356	0.356

Note: The value of t is in parentheses. The error is a robust value. *** (**) (*) Significance at the 1% (5%)(10%) two-tailed level.

v. Conclusion

This paper takes the listed companies in 35 large and medium-sized cities in China from 2003 to 2015 as the research samples, and empirically tests the relationship between the rise in housing prices and the company's innovation activities. The research results show that the increase in housing prices significantly inhibited the number of patent applications and R&D expenditures of listed companies, and verify the significant crowding out effect of the house price increase on the company's innovation activities. This shows that the rise in housing prices has attracted non-real estate companies to invest large amounts of money in the real estate industry, pursuing short-term profit growth, neglecting innovation activities that are conducive to the company's long-term development, and inhibiting the corporate innovation.

This paper further considers the influence of ownership structure, and finds that the inhibitory effect of housing price increase on the company's innovation mainly appears in state-owned enterprises in that SOEs tend to have close relationship with local governments and banks so that they can enter the real estate industry more easily.

From the results, we can see that the company's management short-sightedness leads non-real estate companies to pursue short-term interests through reducing innovation investment, which hinders the long-term development of the main business. The high return in the real estate industry is unlikely to continue to rise. Once a housing bubble burst like Japan is broken, the company will not only suffer from losses from these real estate investment but also lose its competitive

advantage in the long run. The company should look at the company's development from a long-term perspective, actively invest in innovation activities, and focus on technology research and development.

Therefore, for the healthy development of the non-real estate industry, this paper suggests that the government actively control the speculators in the market through policy control and curb the irrational prosperity of the real estate industry. At the same time, due to the large gap in economic development in various regions of China, it is recommended that the government formulate differentiated housing price control policies based on actual conditions in different regions to accurately target real estate market speculators in various regions. Finally, the government should actively guide the company to establish a correct sense of innovation by creating a good external environment, promoting the innovation and development of all walks of life, and guiding the companies to return to their main business from real estate industry.

References

[1] Deng Bowen. The Impact of Industrial Enterprise Real Estate Investment on Enterprise Innovation——An Empirical Study Based on Data of Chinese Listed Companies [J]. Research on Economics and Management, 2014(10):113-120.

[2] Gao Jian, Wang Jianfei, Wei Ping. Performance Indicators of Enterprise Technology Innovation: Current Situation, Problems and New Conceptual Models[J]. Research Management, 2004 (z1): 14-22.

[3] Li Yizhong: Developing the real economy to prevent industrial hollowing out [J]. Machinery Industry Standardization and Quality, 2013, (12): 4.

[4] Lu Lingzhi. The impact of industrial enterprises investing in real estate on the production efficiency of enterprises--taking China's listed companies as an example [D]. Southwestern University of Finance and Economics, 2016.

[5] Niu Wenxin. “Industrial Hollowization” is the Essential Cause of House Price Bubbles [J]. China Economic Weekly, 2014, (18): 15.

[6] Wang Yongqin, Gao Xin, Yuan Zhigang, Du Juzhen. Financial Development, Asset Bubble and Real Economy: A Literature Review [J]. Financial Research, 2016, (05): 191-206.

[7] Wang Wenchun. Regional housing price difference and industrial enterprise innovation behavior [D]. Southwestern University of Finance and Economics, 2014.

[8]Xu Erming, Zhang Wei. The Impact of State-owned Equity of Chinese Listed Companies on Technological Innovation Modes[J]. Economic Management, 2008, 30(15): 42-46.

[9] Acs Z J, Audretsch D B. Patents as a Measure of Innovative Activity [J]. Kyklos, 1989, 42(2):171-180.

[10] Aghion P, Van Reenen J, Zingales L. Innovation and Institutional Ownership [J]. The American Economic Review, 2013, 103(1): 277-304.

[11] Blundell R, Griffith R, Van Reenen J. Market Share, Market Value and Innovation in a Panel of British Manufacturing Firms [J]. The Review of Economic Studies, 1999, 66(3): 529-554.

[12] Gan J. Collateral, Debt Capacity, and Corporate Investment: Evidence from a Natural Experiment [J]. Journal of Financial Economics, 2007, 85(3): 709-734.

[13] Grieder T, Khan H. The Collateral Channel: How Real Estate Shocks Affect Corporate

Investment: Comment[R]. Carleton University, Department of Economics, 2017.
[14] Griliches Z. Patent Statistics as Economic Indicators: a Survey[R]. National Bureau of Economic Research, 1990.
[15] Grossman G M, Yanagawa N. Asset Bubbles and Endogenous Growth [J]. Journal of Monetary Economics, 1993, 31(1): 3-19.
[16] Hall B H, Griliches Z, Hausman J A. Patents and R and D: Is there a lag? [J]. International economic review, 1986: 265-283.
[17] Kiyotaki N, Moore J. Credit cycles [J]. Journal of Political economy, 1997, 105(2): 211-248.
[18] Miao J, Wang P. Sectoral Bubbles and Endogenous Growth [J]. 2012.
[19] Nie J, Cao G. China's slowing housing market and GDP growth [J]. Macro Bulletin. Kansas City: Federal Reserve Bank.
[20] Olivier, J., 2000, "Growth-enhancing bubbles", International Economic Review, 41(1), pp.133-151.
[21] Pakes A, Griliches Z. Patents and R&D at the firm level: A first report [J]. Economics letters, 1980, 5(4): 377-381.
[22] Samuelson P A. An exact consumption-loan model of interest with or without the social contrivance of money [J]. Journal of political economy, 1958, 66(6): 467-482.
[23] Zahra S A, Neubaum D O, Huse M. Entrepreneurship in medium-size companies: exploring the effects of ownership and governance systems [J]. Journal of Management: Official Journal of the Southern Management Association, 2000, 26(5):947-976.