ISCTE Business School
Instituto Universitário de Lisboa

INFORMATION TRANSMISSION EFFICIENCY BETWEEN HOUSING MARKET AND LAND MARKET: AN EMPIRICAL STUDY IN CHINA

LAN Zhengqiu

Thesis submitted as partial requirement for the conferral of the degree of

Doctor of Management

Supervisor:
Professor Rui Alpalhão, Professor, ISCTE University Institute of Lisbon

Co-supervisor:
Professor MA Yongkai, Professor, University of Electronic Science and Technology of China, School of Management and Economics

January 2016

- Spine –

INFORMATION TRANSMISSION EFFICIENCY BETWEEN HOUSING MARKET AND LAND MARKET: AN EMPIRICAL STUDY IN CHINA

LAN Zhengqiu

ISCTE Business School
Instituto Universitário de Lisboa

ISCTE Business School
Instituto Universitário de Lisboa

INFORMATION TRANSMISSION EFFICIENCY BETWEEN HOUSING MARKET AND LAND MARKET: AN EMPIRICAL STUDY IN CHINA

LAN Zhengqiu

Thesis submitted as partial requirement for the conferral of the degree of

Doctor of Management

Jury:

Doutor Mu Yinping, Professor Catedratico, University of Electronics and Science Technology of China, UESTC

Doutor Paulo Femando de Sousa Pereira Alves, Professor Adjunto Convidado do Instituto Superior de Contabilidade e Administração de Lisboa

Doutor Sun Ping, Professor Associado, University of Electronics and Science Technology of China, UESTC

Doutor Rui Manuel Meireies dos Anjos Alpalhção, Professor Associado Convidado do Departamento de Finanças ISCTE-IUL (Orientador)

January 2016

Declaration

I declare that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university and that to the best of my knowledge it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed  Date: 15, 01, 2016

Name: LAN Zhengqiu

作者申明

本人郑重申明：除了论文致谢中明确说明并致以谢意的部分外，所呈交的论文不包含任何他人或作者本人已用于获得任何教育机构的学位和证书而使用过的材料。同时尽我所知，除了文中特别加以标注引用的内容外，本论文不包含任何其他个人或集体已经发表或撰写的成果作品。

作者签名： 日期：2016, 01, 15

姓名(拼音) Lan Zhengqiu

Abstract

In recent years, Chinese central government has introduced several rounds of macro-control policies to stabilize the development of real estate market. However, the regulatory effect is not significant. Actually, the regulating effect of macro-policies depends on the market efficiency largely, especially the information transmission efficiency inner and between housing market and land market.

Firstly, this thesis studies the information transmission efficiency of Chinese real estate market. The results show that no matter for the mean information and volatility information, there is only unidirectional transmission from land market to housing market , so land market is the information center. The information of land market will be reflected in housing prices in the next period. Meanwhile, the housing market is much more informationally efficient, as it responds to new information faster.

Secondly, this thesis studies the effect of IAL system and HPR on the information transmission efficiency between Chinese housing market and land market. The results show that, for the mean and volatility information, both IAL system and HPR decrease the transmission efficiency. Firstly, the mean information transmission channel changes from one to zero after the implementation of IAL system. Secondly, after the implementation of the two policies, the bidirectional volatility transmission between the two markets changes to unidirectional transmission or no transmission. Thirdly, the inner information transmission efficiency of housing and land markets both decrease after the implementation of the two policies.

Keywords: mean information transmission, volatility information transmission, IAL system, HPR

JEL Classification: E61, R20

Resumo

Nos últimos anos o Governo Central Chinês introduziu várias medidas de política de macro-controle com vista a estabilizar o mercado imobiliário. No entanto, o impacto das medidas introduzidas não se revelou significativo. Na verdade, o efeito estabilizador das macro-políticas escolhidas revelou-se largamente dependente da eficiência do mercado, especialmente da eficiência da transmissão de informação dentro dos, e entre os, mercados de solos e residencial.

Em primeiro lugar, esta dissertação estuda a eficiência da transmissão de informação no mercado imobiliário Chinês. Os resultados evidenciam que há apenas transmissão unidireccional do mercado de solos para o mercado residencial, pelo que o centro da informação é o mercado de solos. A informação do mercado dos solos reflecte-se nos preços residenciais com um período de desfasamento. O mercado residencial é mais eficiente informacionalmente, dado que responde mais rapidamente a nova informação.

Em segundo lugar, esta dissertação estuda os efeitos dos sistemas IAL e HPR na eficiência da transmissão de informação entre os mercados Chineses de solos e residencial. Os resultados evidenciam que, relativamente a informação sobre média e volatilidade, ambos os sistemas diminuíram a eficiência da transmissão. Por um lado, o canal de transmissão de informação sobre a média passa de um a zero após a implementação do sistema IAL. Por outro lado, depois da implementação dos dois sistemas, a transmissão bidireccional da volatilidade entre os dois mercados muda para transmissão unidireccional ou ausência de transmissão. Finalmente, as eficiências internas de transmissão de informação dos mercados de solos e residencial baixam ambos com a implementação dos sistemas.

Palavras-chave: transmissão de informação, sistema IAL, sistema HPR

Classificação JEL: E61, R20

Acknowledgements

I would like to gratefully thank my advisors and mentors Prof. Rui Alpalhão and Prof. Ma Yongkai for their intellectual guidance and support, enormous patience and encouragement, and helpful comments and suggestions throughout the course of this thesis. I would like to thank the team members of Prof. Ma. They gave me great help in model establishment and estimation. Additionally, I would also like to thank my families for their unconditional love and support, driving me to tackle challenges head on.

Contents

List of Tables

List of Figures

List of Abbreviations/Glossary

BJ	Beijing
CQ	Chongqing
EGARCH	Exponential Generalized Autoregressive Conditional Heteroskedasticity
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
HP	Housing Prices
HPR	Housing Purchasing Restriction
IAL	Invitation to tender, Auction and Listing
LP	Land Prices
OLS	Ordinary Least Squres
PGARCH	Partial Generalized Autoregressive Conditional Heteroskedasticity
PVAR	Panel Vector Autoregression
SH	Shanghai
TGARCH	Threshold Generalized Autoregressive Conditional Heteroskedasticity
TJ	Tianjin
VAR	Vector Autoregression
VECM	Vector Error Correction Model

Chapter 1: Introduction

1.1 Research background

In 1949, the People's Republic of China was founded. Influenced by the socialist transformation theory of Marx and Engels, the new Chinese central government abolished the private ownership of land and housings, and implemented the socialistic public ownership. By 1978, 74.8% of China's urban housings were public owned. At this stage, houses were assigned by the government or stated-owned enterprises free or rented at a low price, which is called the welfare housing system. Because individual and other organizations could not own and acquire land, the housing construction mainly relied on the government and state-owned enterprise. From 1952 to 1978, the total housing investment only accounted for 7.5% of the capital construction investment of China, and only accounted for 0.7% of Chinese GDP, leading to a serious shortage of housings in the major cities of China. The urban residential area was 1.4 billion square meters by 1978, but the per capita living area decreased to 3.6 square meters, and 8.69 million families were homeless, accounting for 47.5% of the total urban households.

In this context, how to satisfy the increasing demand for housings became one of most important issues for central government. However, on the premise that individuals could not build houses, it was difficult to solve this problem. At the same time, the commodity attribute of housings was cognized by the theorists and practitioners gradually, and the viewpoint that there was no contradiction between the private owned house and the socialist public ownership began to be accepted by the authorities. In 1980, Deng Xiaoping proposed that “selling public houses, adjusting rent and promoting individuals to buy or build houses by themselves”, which marked the beginning of the reform of Chinese housing system. From 1980 to 1987, the welfare housing system was abolished gradually, but the effect was not significant. In the process of selling public owned houses to individuals and families, the local governments needed to provide high subsidies, which led to the overweight financial burden. Meanwhile, because of the low rent of public houses, the individuals and families were lack of willingness to buy. In 1980s, the housing subsidies provided by the governments at all levels accounted for 3.17% of Chinese GNP. Combined with the urban housing construction investment, the total accounted for 13.86% of GNP.

In 1991, the second housing system reform was started in China. In June, State Council officially issued“ Notice on continuing to promote the urban housing system reform actively and steadily”, and put forward that raising the rent step by step, paying the rental deposit, encouraging the cooperation in building houses and so on. The housing system reform at this stage promoted the sale of public houses mainly by increasing the rent. However, due to the overheating of Chinese economy from 1992, the real estate investment was excessive, and housing price rose sharply, which resulted in a serious shortage of governments’ housing subsidies. The housing system reform was difficult to promote. In 1993, that selling public housings at a low price prevailed all over the country. 3 million public housings were sold and the average price was only 130 RMB/m^2, which absolutely violated the expectations of central government. Therefore, State Council stopped the public housing selling in 1993, and the second housing system reform ended.

In 1998, Chinese housing system reform ushered in an important change. The State Council officially issued “Notice on further deepening the reform of urban housing system and speeding up the housing construction”, which claimed that the housing distribution in kind would be ended in the second half of 1998, and the monetary distribution system would be put into force. This reform truly hit the corn of urban housing system, which cut off the relationship between the employees and the enterprise, and created the conditions for the thorough bid farewell to the old welfare housing distribution system. Until then, Chinese real estate market entered in a fast growing period. With the development of more than ten years, the reform of Chinese housing system has made remarkable achievements. For example, the living level of urban citizens had been improved significantly, while real estate industry became a pillar industry of national economy. According to the statistics, the per capita housing area for Chinese urban residents was 31.6 square meters in 2010, 28 square meters more than that in 1978, and 13 square meters more than that in 1998. Over the past decade, real estate industry contributed 1/6 of total GDP and 3.5% of the nominal GDP growth. It also drove the development of building materials, steel, logistics and other related industries, and thus became a barometer reflecting the development of Chinese economy.

The rapid growth of real estate industry also brought a series of problems, such as the regional and structural imbalance of housing supply and demand, the sharply growing of property investment, the fiercely expanding of credit, and especially the increasingly livelihood issues caused by the high housing prices, which attracted widespread attention of government and all sectors of the society.

Based on this background, the central government has started the real estate macro-control since 2003. The regulation lasting for more than ten years can be divided into three rounds. The first round began in the third quarter of 2003, and the regulation goal was to cool down the overheated investment in real estate, and control the rapidly rising housing prices. The second round began in the fourth quarter of 2008, and while the goal was to stimulate the real estate market and encourage property development and housing consumption, to pick the entire national economy out of low times. The third round began in early 2010, the goal of which was to curb the rapid rise of housing prices and promote the rational callback of real estate market. Overall, in recent ten years, the trend that “tightening-easing-secondary tightening” could be observed from the three rounds of real estate macro-controls of Chinese central government.

The first round lasts from 2003 to mid-2008.

Because of the housing system reform in 1998, a large number of pent-up housing demands were released, leading to the rapid development of real estate market and the fierce rise of housing prices in some regional markets. Chinese real estate investment increased from 361.4 billion in 1997 to 1015.4 billion in 2003, accounting for 18.27% of the total fixed assets investment, while the average housing price also increased from 1854 RMB/m^2 in 1997 to 2197 RMB/m^2 in 2003.

Under this circumstance, controlling the housing prices and meeting the housing demands of low-income families were the main targets of Chinese central governments. They used the credit policies and land policies to achieve these goals. For example, the credit policies included that Chinese central bank increased the benchmark deposit and loan rate for six times and modulated the statutory reserve rate for ten times in 2007. The land policies contained that in September, 2003, State Council promulgated “Notice on strengthening the land supply management to promote the sustainable development of real estate market”. It was the first notice on the land market, requiring the local government to strictly control the land supply and the land use right should be granted with invitation to tender, auction and listing, which is fully implemented in September, 2004.

The second round lasts from mid-2008 to 2009.

In August 2007, America sub-prime crisis broke out, which quickly evolved to global financial crisis and significantly affected Chinese economic development. In 2007, the growth of Chinese GDP was 11.4%, fall back to 9% in 2008, and further decreased to 8.7% in 2009. Meanwhile, as one of the three carriages driving Chinese economy, the export was also influenced by the international situation. The total volume of import and export dropped from $1428.5 billion in 2008 to $1201.7 billion. Because of the double shock of previous macro-control policies and global financial crisis, the signs of weakness were appeared in Chinese real estate market. The property investment decreased significantly, the housing sales was shrinking and housing prices continued to drop.

Under this background, Chinese central government began a new round of real estate macro-control, goal of which was to stimulate the development of property market and encourage the housing consumptions. For this purpose, the government mainly used a loose monetary policy and credit preferential policies, for instance, central bank reduced the benchmark deposit and loan rate for four times and lowered the statutory reserve rate of big deposit-taking institutions to 15.5% in 2008. In January, 2009, the Big Four Banks announced that the residential mortgage rate was 30% off.

The third round lasts from 2009 to now.

Because of the loose monetary policy, the proactive fiscal policy and the stimulation policies in the second round, Chinese economy revived rapidly. To be specific, the GDP was 39798.3 billion RMB in 2010, and its growth rate reached 10.3%. At the same time, after the rapid recovery, the real estate market entered into a rapid heating phase. The real estate investment in 2009 accounted for 17.35% of total fixed assets investment. The average housing price in 2009 was 23.25% higher than that in 2008, while the housing sale was 43.6% higher. In this stage, the real estate market was obviously overheated.

Against this backdrop, State Council promulgated "Notice on promoting the stable and healthy development of Chinese real estate market" in January, 2010, marked the beginning of a new round of macro-control. Again, it introduced "Notice on resolutely curbing the sharp rise of housing prices of partial cities", which proposed the housing purchasing restriction (HPR) for the first time, and adjusted the mortgage rate of the second and the third set of house. Its purpose was to suppress speculative demands and curb the rapid rise in housing prices.

By analyzing the macro-control practices of the past decade, we can find that, although the government used suppressing and stimulating means in different stages, from an overall viewpoint, "to promote the healthy, stable and sustainable development of Chinese real estate market” was always the target of the central government. The core is stability, which not only includes suppressing measures in the overheated period from 2003 to 2008 and from 2010 to now, but also contains the stimulating measures in the downturn period from 2008 to 2009. Therefore, in general, the goals of the above three rounds of macro-controls can be unified as “to promote the stability of Chinese real estate market”. If the target is described from a statistical point of view, it should include two aspects. One is to maintain the stability of mean value of real estate prices, preventing them from rising or decreasing in the average sense. The other one is to maintain the stability of volatility of housing and land prices, avoiding their fiercely fluctuations. In this sense, the changes of mean value and volatility of the two prices can reflect the effect of real estate macro-control policies.

Are the above goals achieved or not? According to incomplete statistics, the central government had introduced 43 macro-control policies directly related to real estate from 2003-2013, but the effect was not obvious, and the housing prices and land prices were still rising fast. It shows that, Chinese average house prices increased from 2051 RMB/m^2 in 1999 to 6237 RMB/m^2 in 2013, rising 204%, while the average land prices grew from 479.68 RMB/m^2 to 3478.54 RMB/m^2, and the growth rate was 625%. In some cities, the housing prices rose tenfold. In the first-tier cities such as Beijing and Shanghai, some poor people even lived in the sewer well. What are the causes of the failure of the ten years’ macro-control on Chinese real estate market? Why do the housing prices and land prices increase together?

1.2 Research problems

Chinese real estate market can be divided into two parts: housing market and land market, and there are four market players: central government, local government, property developer and household. Among them, central government is the regulator of the overall market, local government is the supplier in land market, property developer is the demander in land market and the supplier in housing market and household is the demander in housing market. In the property macro-control system, central government is the policy maker, while the other three are the policy acceptors.

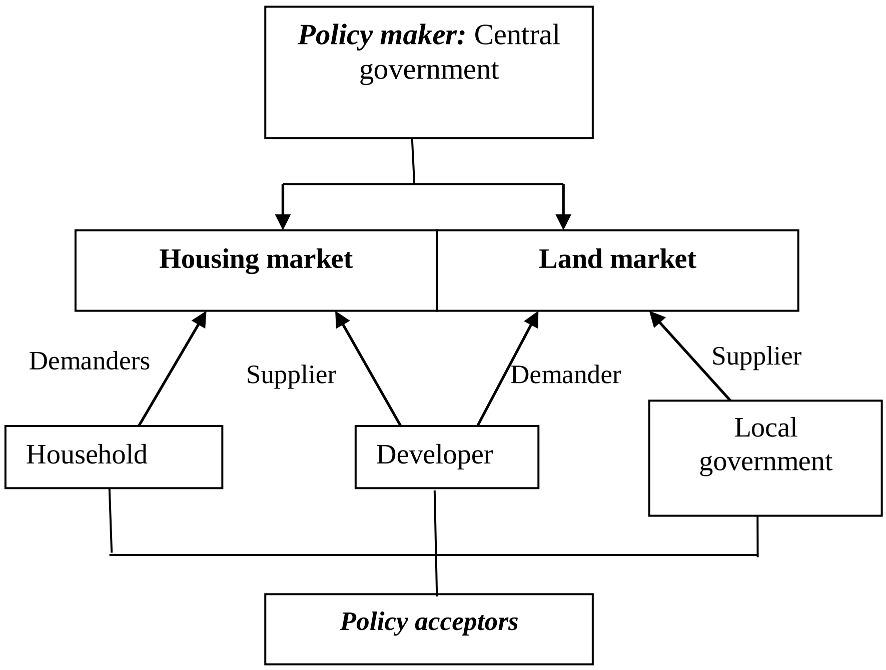


Figure 1- 1 Structure and players of Chinese real estate market
Source: analyzed by the author.

Although the Chinese local governments are the policy acceptors, they also have the right to formulate specific rules according to the policy guidance of central government. Moreover, in practice, they often do not follow the requirements of central government for their own interests, as they have a significant effect on land pricing. Since the new land use right granting system called IAL (invitation to tender, auction and listing system) was fully implemented on August 31, 2004, and the “Land Reserve Regulations” formally came into effect On November 19, 2007, Chinese local governments controlled the land market totally. The implementation of IAL system enabled them to monopolize the supply in the primary land market, and controlled the supply quantity and timing of land use rights. In addition, they could call back the land use rights allocated by non-market-oriented orders, bought back those granted in market-oriented ways, and replaced some left, thus the amount of land use rights traded in the secondary market were negligible.

While in Chinese housing market, the property developer has an important effect on housing pricing, which is decided by the particular features of houses and the actual situation of China. First, the demand of houses is rigid, since there is no substitute to meet people’s housing needs, which leads to that the price and income elasticity of houses are relatively low. Second, because of the location, there is no two houses are the same in the world. The exclusive use of land resources makes the differences of houses, resulting in a corresponding supply monopoly. Third, housing demand is regional specific, so that in some regions, the housing demand exceeds the supply in a long term. Forth, housing construction requires a certain period, which leads to the inelastic housing supply in the short run. Finally, because of information asymmetry, the developers may conceal their true amount of supply and make an illusion of supply shortage. Thus, based on the above reasons, the developers can largely price the houses. Moreover, the most important reason lies in the excessive speculative demand of Chinese housing market in recent decade, which makes the developer can affect housing prices by controlling the housing supply.

There are two kinds of housing demanders. One is housing buyer, and the other one is housing tenant. According to statistics, more than 80% of Chinese households have their own housings. Less than 20% of them are renters, which is far lower than the proportion of developed countries. The rent is remained at low levels for the long run, and the price to rent ratio is higher than 800 in some cities. Therefore, buyers are the main composition of housing demanders, and the effect of renters on the housing price is very small.

As the structure of Chinese real estate market is specified as above, there are three possible reasons causing the failure macro-control.

The first possible reason is that the goals are not set appropriately. Seen from the history of Chinese real estate macro-control, there were two kinds of policies. One was housing policy, and the other one was land policy. The two kind policies affected housing prices and land prices directly, and had effect on each other through the connection between the two markets. The introduced policies in the past decade mainly consisted of housing policies, such as tax, credit, financial tools these market-oriented measures, and purchasing restriction the non-market-oriented measure. While the land policies were relatively less. Nevertheless, if the land market was the information center of Chinese real estate market, which meant that the land policies not only affected land prices, but also had an influence on housing prices, the neglect of land policy might lead to the incompletion of control measures. Because the government only controlled the factors directly affecting housing prices, but not controlled the land prices, the rise of which would still push up the housing prices. Therefore, the macro-control was failed, and we observed that the housing and land prices both increased sharply.

The second possible reason is that the policy implementation is poor, which mainly depends on the local government and property developers, as they have great effect on the land pricing and housing pricing, respectively. Which one of them should be responsible for the rise of housing prices? For this question, there is a long-running dispute between the two parties, and both sides think the other side should be responsible for this.

The property developers believe that the local governments push up the land prices, and then increase the housing prices. They have three reasons at least. Firstly, the local governments have the ability to push up the land prices. It is decided by the special land property system and land granting system of China. As stated above, the land ownership belongs to the government and collectives, the individuals, enterprises and other organizations only can get the land use rights. The local governments can call back or buy back the land use rights, and grant them again through the IAL system according to the land supply plan. In this case, the local governments monopolize the supply in the primary land market, and totally control the supply quantity and timing of land use rights. Therefore, they can control the land prices by reducing the supply. Meanwhile, IAL land use rights granting system lowers the entry threshold of land market, resulting in a sharply increase of the quantity of property developers, including the domestic enterprises and those from foreign countries, which increases the land demands. At last, the evaluating method that “land use right goes to the highest price” also will lead to higher land prices. Therefore, because of the above reasons, the land prices are easily pushed up by the local governments. Secondly, the local governments are motivated to push up the land prices. There is a long-run disequilibrium between the fiscal income and expenditure for Chinese local governments. It means that they have more things to do but with less income channels. Therefore, to increase fiscal income, many local governments maintain the fiscal expenditure by granting land use rights, which is called “land fiancé” or “second finance”. In many areas, the revenue of land finance is more than the tax revenues. According to a research report of the development center of Chinese State Council, the direct taxes of land and the indirect taxes of urban land expansion account for 40% of the local budget revenue, and the land use rights granting revenues account for more than 60% of the government ex-budget revenues. Thus, in this case, to make achievements, the local governments must get more income from land granting. Therefore, they are motivated to push up the land prices and obtain monopoly profits by controlling the land supply, which is supported by the research of Yan & Ge (2014). Thirdly, there is theoretical basis that land prices will push up housing prices. According to neoclassical rent theory, the price of product is decided by its costs, while the land price is one of the important parts of the costs of houses. Therefore, if the information that the land price is rise is transmitted to housing market, the housing prices will increase.

The local governments believe that the developers pull up the housing prices, and cause the rise of land prices. Firstly, as the dominant player of the housing market, developers can control the supply of houses effectively. To obtain the extra profits, they can also reduce the supply quantity and pricing monopolistically. Because the house demand in China is very strong, the developers can get more profits by reducing supply, which will push up the housing prices. Secondly, according to the Ricardo rent theory, the rise of product price will increase the derived demand of raw materials, and make their prices rise. In the housing market, land is the material of houses, so the rise of housing prices will increase the land prices.

The third possible reason is that Chinese housing prices cannot be controlled. Although the goals are set appropriately, and these policies are well implemented, it still results in efficiency loss. If the housing prices and land prices are independent, and there is no connection between Chinese housing market and land market, this may be the real reason for the failure of macro-control policies, because the rising of land prices will not push up the housing prices anymore.

Which one above is the real reason of the failed Chinese real estate control? The answer of this question lies in the relationship between housing and land prices. If the land prices can affect housing prices, it indicates that the land market is the information center and the neglect of land policy is the reason of the failure of macro-control indeed, and the local government should be responsible for this too. If it is the housing prices that affect land prices, it shows that the developers should be responsible for this failure. If the housing prices and land prices are independent, it shows that Chinese housing prices cannot be controlled. Thus, what is the relationship between Chinese housing prices and land prices?

1.3 Research questions

This thesis attempts to research two questions.

First, this thesis will study the relationship between Chinese housing prices and land prices to clarify the real reason for the failure of real estate macro-control.

The relationship between housing and land prices, in essence, reflects the information transmission between housing market and land market. From the perspective of economics, housing and land prices are decided by the supply and demand of houses and land, respectively. While further analysis shows that, the supply and demand behaviors of market players are affected by the new information. As Fig. 1-2 shows, when new information arrives at housing market, for example, a new housing macro-policy is enacted, the developers and households will analyze this information and adjust their supply and demand plan, and then the equilibrium of housing price will change. Moreover, this information will be transmitted to land market and affect the equilibrium land price. Therefore, the information changes will be reflected in price changes eventually, and then the efficiency of information transmission between the two markets can be revealed by the relationship between the two prices. Research on this relationship is studying the information transmission efficiency between the housing and land markets.

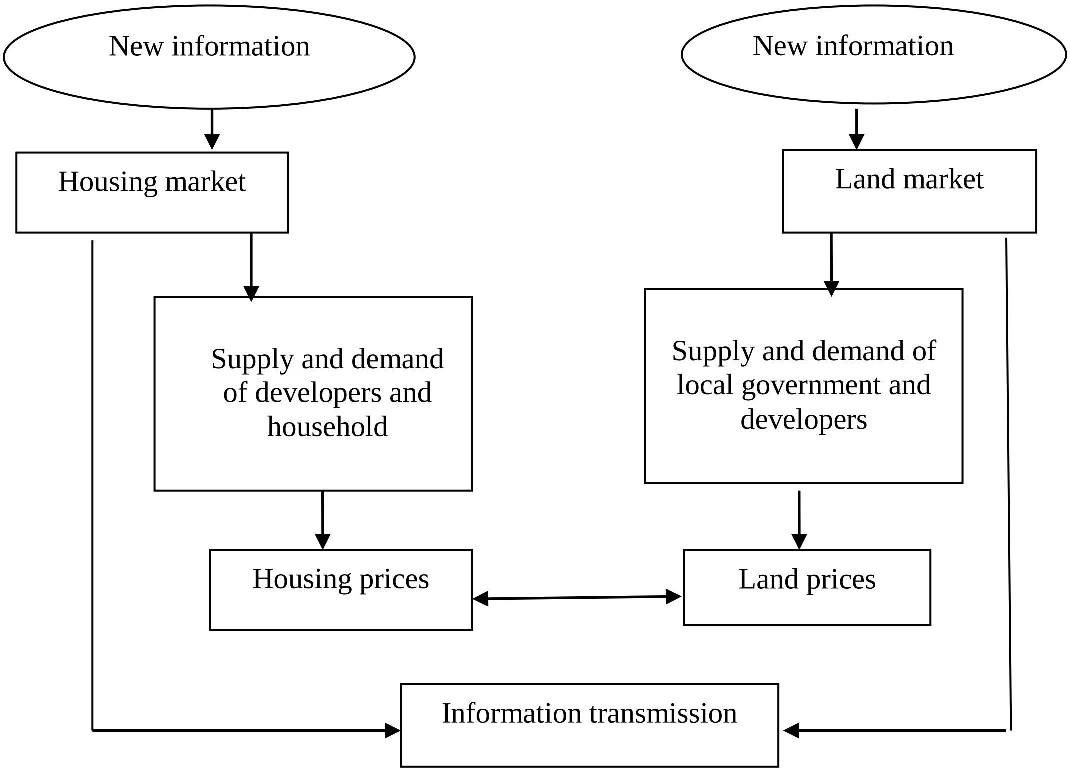


Figure 1- 2 Information transmission between housing market and land market

Source: analyzed by the author.

The housing prices and land prices may affect each other on two levels. One is the mean value level. It means that the trend changes of housing and land prices may affect each other, and is called price discovery between two markets. The other one is the volatility level, which means that the short-running volatility of the two prices may have an effect on each other. From the perspective of information transmission, the relationships between the two prices on the two levels represent the mean information and volatility information transmission, respectively. As the volatility of asset prices can measure its risk, the volatility transmission also refers to the risk transmission between the two markets.

This thesis will examine the direction and speed of the information transmission between housing and land markets. Analysis of the two aspects is important for the government to make macro-control policies. Firstly, the direction of information transmission will tell us regulating on which market is more efficient. While from the speed of information transmission, we can know how long the real estate market needs to completely absorbed a macro-policy, and then provide useful references for the government to determine when introducing new policy. Second, this thesis wills study the effect of administration policies on the information transmission efficiency between housing and land markets.

Since 2003, Chinese central government has introduced several rounds of macro-control policies, which contains the tax, credit, financial and other non-mandatory tools, and includes the compulsory tools such as government planning, administrative order and so on. Among them, because of its authority, coerciveness, directness and verticality, the administrative command becomes important supplementary means to regulate the property market. In the past ten years, Chinese central government produced a series of executive orders to control the real estate markets, which covers the way and structure of land supply, measures concerning protection of arable land, land inventory, the qualifications of housing purchase and so on. However, there are two types of administrative commands attracting widespread concerns from industry and academia, due to their persistence, universality and the fundamental impact on the market supply and demand structure. They are the IAL land use right granting system and the HPR policy. The IAL system was introduced in 2003 and fully implemented in 2004, while the HPR policy was introduced in 2010. They acted on the land and housing markets, respectively. The former lowered the entry threshold of land market, and while the latter increased the entry threshold of housing market. The two policies changed the formation mechanism of housing and land prices and might affect the information transmission mechanism between the two markets.

Therefore, this thesis will study whether the IAL system and HPR policy that western countries do not even have, change the information transmission efficiency of Chinese real estate market or not. Understanding this effect is very important for Chinese central government to make proper macro-control policies in different stages.

1.4 Research data, methods and structure

This thesis takes Beijing, Tianjin, Shanghai and Chongqing as the research objects, which are the only four municipalities under the direct administration of Chinese central government, and other cities are under the administration of provincial governments. Therefore, the effects of macro-policies on the real estate markets of the four cities should be more direct and significant. Beijing is the capital of China, which is the political, economic and cultural center. While Tianjin, Shanghai and Chongqing are located in the northern, southern and western parts of China, and are the center cities in their own regions respectively. The four cities all have large population and high developmental level of economy. Among them, the developmental levels of real estate markets of Beijing and Shanghai come out top of China. Therefore, taking the four cities as the research objects is of important practical significance.

Table 1- 1 Research methods and purposes

Research content	**Research methods**		**Research purposes**
Mean information transmission (the price data)	Stationary data	PVAR model	Construct the affecting system between housing and land prices
		Granger causality test	Examine whether the housing and land prices affect each other(the information transmission direction between the two markets)
		Impulse response function	Examine the persistence time and the change of the influences of information on the housing and land prices(the information transmission efficiency in and between the two markets)
	Not stationary data	Cointegration test	Examine the long-run relationship between housing and land prices
		VECM model	Construct the affecting system between housing and land prices(the information transmission direction between the two markets); when the two prices deviate from the long-run equilibrium, the correction speed of the two markets(the information transmission efficiency in the two markets)
Volatility Information transmission (the return data)	EGARCH model		Study on the volatility clustering and persistence of housing and land prices
	Asymmetry EGARCH model		Study on the volatility asymmetry of housing and land prices
	BEKK-GARCH model		Study on the volatility transmission between housing and land prices

Source: analyzed by the author.

This thesis mainly studies the relationship between housing and land prices. There are two types of data are common used in the current researches, which are the average data and the index data, respectively. In order to avoid the sampling error, this thesis chooses the monthly average data, as the index prices are calculated with sample data. The average housing prices and average land prices are calculated by dividing total house or land sales by total square meters sold. The data time spans from March 2002 to June 2014. The data is released by the National Development and Reform Commission, and derived from the Wind database. Meanwhile, the quarterly data is used to conduct the robustness check.

This thesis uses the below methods to study the mean and volatility information transmission between housing and land markets by learning from the researches studying on the information transmission of financial market.

The sectors of the thesis are specified as below.

The second chapter reviews the researches from four aspects: macro-control mechanism of Chinese real estate market, methods of studying the information transmission efficiency of financial market, information transmission efficiency of real estate market and effect of policies on the information transmission efficiency of real estate market.

The third chapter elaborates the research design of this thesis, which includes two parts: the research data and research methods and models. Firstly, this chapter describes the data sources and features, and secondly establishes the econometric models used in this thesis.

The forth chapter analyzes the accounting relationship between housing prices and land prices, and studies the mean information transmission and volatility information transmission between Chinese housing and land markets by using the methods such as stationary test, Granger causality relationship test, cointegration test, impulse response function, error correction model, univariate and bivariate GARCH model and so on. Both the information transmission direction and transmission speed are examined.

The fifth chapter divides the total sample into three sub-samples, and studies the effect of IAL system and HPR on the information transmission efficiency.

The last chapter summarizes the main findings and the innovations of this thesis, and provides some suggestions for Chinese central government to make macro-control policies according to the empirical results.

Chapter 2: Literature Review

This thesis attempts to research the efficiency of Chinese property macro-control policy and offer useful policy suggestions for central government, through studying the information transmission efficiency between housing and land markets. Houses are both consumer goods and investment goods. In recent years, the investment feature of houses becomes increasingly significant. This thesis can reference the methods used to study the information transmission of financial market. Therefore, we will review the researches from four aspects: macro-control mechanism of Chinese real estate market, methods of studying the information transmission efficiency of financial market, information transmission efficiency of real estate market and effect of policies on the information transmission efficiency of real estate market.

2.1 Macro-control mechanism of Chinese real estate market

There are abundant researches studying the Chinese real estate macro-control, but most of them are qualitative analysis, such as how to regulate the market with economic, law and administrative means reasonably. Fewer previous researches are quantitative researches, which mainly discuss how to establish the macro-control model, such as Ding & Li (2002), Deng (1995), and Chen (2006) and so on.

Deng (1995) uses the five steps modeling method of grey system theory to establish the property macro-control model, which not only combines the qualitative and quantitative analysis, but also optimizes and controls the system with the mathematic model of modern control theory. Ding & Li (2002) establishes a real estate fluctuation cycle and early warning model, and argues that there is an obvious cycle in real estate market. To avoid the great swings of property market, we should forecast the volatility and smooth it, by mastering the information and rules of the real estate fluctuation cycle. This paper also explores the technology of the early-warning system, including its design point, demand analysis, system structure design, function design and process design, and it proposes other three models such as the early-warning system based on the theory of business fluctuation cycle. Chen (2006) divides the real estate industry into three sub-systems. They are land supply, house supply and land demand sub-systems, respectively. He also presents that there are five feedback loops in these three sub-systems. There is only one negative feedback loop in the land supply sub-system, the left all are positive feedback loops. The real estate macro-control of government mainly aims to structurally adjustment the unreasonable conducts of the system. Song (2000) puts forward a real estate macro-control model that mainly using legal means, supplemented by economic, administrative measures and public opinion guiding. She thinks that Chinese government should use legal measures to regulate forcibly, use economics means to control, use administrative measures to manage, and use public opinion to guide, so that the real estate industry can play a role in expanding domestic demand and improving the development of economy.

In theory, the above quantitative models have good prospects, and are useful for Chinese government to make and implement real estate macro-control policy, and analyze the effect of macro policies. Those qualitative real estate macro-control models all are broad and large, and their macro-control means encompass all aspects of the national economy.

There are fewer researches studying the effect mechanism of real estate macro-control policy. For example, Jin & Wang (2008) studies the operation mechanism of Chinese property macro-control. They sum up it into four categories, including the driving mechanism, restraint mechanism, decision-making mechanism and regulation mechanism, and describe each type of mechanism specifically. Xue (2012) finds that Chinese housing price is not only affected by the basic economic factors such as liquidity and household’s income and so on, but also influenced by public expectations. He takes the expectation as a mediating variable, analyzes the conducting process of the policies through the establishment of quasi-rational expectations model. He also evaluates the effectiveness of regulation and reasons. Most of the previous researches take the conducting process of policies as a black box, but Xue (2012) has made some effective progress in this regard.

To sum up, most of the existing researches on the Chinese real estate macro-control are qualitative analysis, while quantitative researches are fewer. The quantitative researches mainly discuss how to build the real estate market macro-control model from the points of reaction cycle theory, dynamics theory and so on. Only small bodies of researches study the effect mechanism of macro-control policies. There is only one paper, Xue (2012), researching on the conducting process of property policy from the aspect of market expectation. Thus, previous studies have never studied the impact mechanism of the policy from the perspective of information transmission. Nevertheless, it is the internal mechanism through which the macro-policy acts on the real estate market. Understanding it is very important for government to make and evaluate the policies.

2.2 Methods of studying the information transmission efficiency of financial market

Information transmission mostly appears in the financial markets, and is also found in the general organizational structure. Among them, the former information transmission refers to asset price reactions to market information (Fama, 1970), while the latter refers to the information passes between different organizations, and between different levels within an organization. In common sense, information transmission refers to the former one. Information efficiency of financial market is defined as whether the asset price changes immediately and correctly when accepting new information. Fama (1970) divides the information efficiency of capital market into three kinds. The first one is weak efficient, which means that the current asset price has reflected all the history information, such as the history price and volume. The second one is semi-strong efficient, which means that the current price has reflected all the public information, including the history information, the financial information of the firm and so on. The last one is strong efficient, which means that the current asset price has reflected all information, including the history, public information, and even the private information.

Information transmission efficiency is different from information efficiency. The latter just exists in one market, while the former exists between two or more markets, such as the spot and futures market(Fama,1970, Ryoo *et al.*,2004), stock, bond and foreign exchange market(Torben *et al.*,2007), domestic and international market(Liu & An, 2011), one regional market and another(Rutledge *et al.*, 2013, Yin & Han,2013), real estate market and capital market(Payne & Sahu, 2004) and so on. Most researches consider that the information transmission efficiency can be described by the mean value (the first moment) and volatility (the second moment) relationship between the prices of different markets. The methods to study these relationships have changed with the development of econometric theory.

The first kind of researches focuses on the mean value relationship between two markets, which is also called price discovery or the lead-lag relationship between two prices. For the relationship between spot market and futures market, the earliest study is Fama (1970). He studies the relationship between spot price and futures price with a simple regression model, which is widely used in this period. While as the non-stationary problem of financial data is discovered, Shen & Wang (1990) studies the relationship between spot and futures prices by using cointegration theory and E-G two steps methods in the first place. Lai & Lai (1991) researches this relationship to be further by using Johansen test base on the vector error correction model. And after that, Johansen test and Granger causality test become the most popular methods to examine the first moment relationship between spot and futures prices. For example, Lihara *et al.* (1996) studies the lead-lag relationship between spot and futures prices of Nikkei 225 index in Japan capital market. They find that the change of futures price of Nikkei 225 index leads that of spot price for up to 20 minutes, while the change of the yield of spot stock index just leads that of futures stock index for 5 minutes at most. The empirical study of Jong *&* Nijman (1997) also demonstrates that futures price of stock index leads the spot price for 10 minutes at least, but on the contrast, the spot stock price leads the futures stock price for only 2 minutes. Tse (1999) uses the DJIA (Dow Jones Industrial Average) index to study the price discovery between spot and futures prices, and finds that futures market is the leader. Booth *et al.* (1999) uses the DAX index to study this relationship, finding that the spot and futures markets both can discover each other, and there was no lead-lag relationship between them, and while the option price cannot discovery spot price and futures price. Brooks *et al.* (1999) thinks that the futures stock index indeed leads the spot index, but the lead is very short. Ryoo *et al.* (2004) studies the relationship in the Korea market, and finds that the spot and futures prices of KOSPI200 index affect each other. There is bidirectional Granger causality relationship between them. However, the futures price has a more significant lead effect.

The second kind of researches focuses on the volatility spillover of two markets. As Ross (1989) proposes that the volatility of price contains more information than its mean value, and the price volatility is related to the speed of the new information access closely. Therefore, studying the relationship between the volatility of two markets is essential to understand the information transmission between two markets. Based on cointegration test, Hasbrouck (1995) decomposes the total variance of price, and calculates the contribution of single factor to the total variance, to determine the contribution of every market to the price discovery.

In addition to the impulse response and variance decomposition methods, more and more scholars use multi-GARCH(Generalized Autoregressive Conditional Heteroskedasticity) models to study the volatility spillovers between different markets, such as the BEKK-GARCH model proposed by Engle and Kroner (1995) , CCC model (constant correlation model) proposed by Bollerslev and Wooldridge (1992), DCC model (time-varying correlation model) proposed by Engle (2002).

For the relationship between futures and spot prices, Tse (1999) examines the relationship between spot and futures prices of DJIA transaction by using the error correction model and binary EGARCH model, demonstrating that the volatility of futures market is stronger than spot market, and there is asymmetry. Bhar (2001) introduces the error correction term into mean equation and expands the binary EGARCH model as an explaining variable, to study the spot and futures market in Australian index. He finds that the error correction term and the conditional heteroskedastic term can significantly explain the spot and futures price indexes, while there is bidirectional volatility spillover between the two markets. Change *et al.* (1999) finds that the transaction of futures index will increase the volatility of portfolio of spot index, but there is no volatility spillover effect for stocks without futures transaction. They points out that the futures transaction will increase the uncertainty of market.

In China, the scholars examines the relationship between spot and futures markets mainly using cointegration test, Granger causality test, VAR (vector auto-regression) model and multi-GARCH model. For example, Hua (2005) researches on the relationship between spot and futures prices of copper, aluminum, rubber and other commodities. Some other researches examine the price discovery between spot and futures prices using multi-GARCH model. For example, Han & Zheng (2008) uses the asymmetric GARCH model to study the relationship between the mean value, volatility and volume of London and Shanghai copper futures markets. Liu *et al.*(2008) researches on the volatility spillover effect between the metal futures markets of LME and SHFE with the binary EGARCH model, and Yan *et al.*(2009) studies the effect of spot and futures prices of CSI-300 index on each other with the VECM model and multi-GARCH model.

The previous researches show that the information transmission in financial market contains two aspects: mean transmission and volatility spillover. Meanwhile, there are two aspects to measure the efficiency of information transmission. One is the transmission direction. If we just observe a unidirectional transmission and even no transmission, it indicates that the information transmission efficiency is relatively low. The other one is the transmission speed. In an ideal state, the market is perfect. When new information is announced, it will be obtained by all the market players immediately. However, in reality, there is no perfect market. Therefore, if the information is transmitted fast, it means that the market needs a long time to absorb the information, and also means that the information transmission efficiency is low. Moreover, we find that the existing researches usually use cointegration test, VECM, VAR, Granger causality test to study the mean value transmission, use multivariate GARCH to study the volatility spillover and use impulse response function to measure the transmission speed. This thesis can study the information transmission efficiency between Chinese housing market and land market by learning from the methods used in the financial market.

2.3 Information transmission efficiency of real estate market

For information transmission in real estate market, the previous researches can be divided into the following categories: information transmission between different regional property markets, information transmission between spot and futures property markets, information transmission between different levels of property markets, such as the information transmission between housing and land markets, and between housing and rental markets. This thesis will summarize and review the relevant researches from above aspects.

2.3.1 Information transmission between different regional property markets

The relationship between prices in different regions is known as “ripple effect”, describing the spatial relationship between the mean value and volatility of prices of different markets. The ripple effect is originally proposed by the British scholars. Giussani & Hadjimatheou (1991) deems that the British real estate market should be divided into north area and south area. They use Granger causality test and cointegration test to confirm that the housing prices of southern area increase first, followed by other regions. Since then, many scholars empirically confirm these kinds of phenomena in UK real estate market, such as MacDonald & Taylor (1993), Alexander & Barrow (1994), Cook & Thomas (2003) and so on. Meen (1999) proposes that the spatial dependence and coefficient heterogeneity will result in ripple effect. Ripple effect in researches outside UK is often called price diffusion. For example, Stevenson (2004) uses the quarterly data of Ireland housing price from 1978-2002 with the error correction model, and finds a significant diffusion effect, especially from Dublin to other cities. Oikarinen (2004) assumes that there is a lead-lag relationship between the central city and the surrounding cities. This paper uses the data of Finland from 1987-2004, and finds that the housing price of Helsinki metropolitan area changes first, and then spreads to central cities in other regions, and finally spreads to other surrounding cities. However, in the Helsinki metropolitan area, the change is spread from the suburbs to the city center. Luo *et al.* (2007) uses the data of 8 cities in Australia from the fourth quarter of 1989 to the second quarter of 2005 with the error correction model and cointegration test, and gets the results that there is a clear price diffusion effect in Australian real estate market. Shi *et al.* (2009) takes the data of 10 urban areas of New Zealand from 1994 to 2004, finding that the change of housing price of center cities leads that of other cities in an urban area, but there is no evidence to demonstrate that there is a ripple effect between the centre cities in different urban areas. Lee & Chien (2011) uses the quarterly data of five cities of Chinese Taiwan from 1993 to 2009, and gets the results that there is a ripple effect between adjacent cities, while this effect does not exist between the non-adjacent cities. Guirguis *et al.* (2007) takes the Coslada and Madrid in Spain as the representatives of big and small cities, to test whether there are price and volatility spillovers between the real estate markets with different size. They use a binary GARCH model and find a very significant price spillover from big cities to small cities, which represents that changes of housing price of big cities lead that of small cities. However, they do not find any volatility spillover between two cities. Ho *et al.* (2008) finds that ripple effect not only exists between the cities, but also appears in one city. Their studies shows that there is a ripple effect between houses with different quality in Chinese Hong Kong, and the policies may affect the price of houses with low quality and then transfer to that of houses with high quality.

For the ripple effect among different regional real estate markets in China, there are many researches. For example, Hong et al. (2007) uses the data of 35 Chinese cities from 2000 to 2005 to study the housing price bubble, finding that the bubble diffuses across cities. Wang *et al.* (2008) uses the data of 26 cities from 5 areas, and exhibits that the housing prices of Beijing and Shanghai can significantly forecast housing prices of other cities. Xu & Li (2008) studies the ripple effect with the annual data of 7 provinces and cities from 1994 to 2006. The results show that there is a 3-2-2 price diffusion mode among the 7 provinces and cities. Huang *et al.* (2009) finds that there is significant ripple effect among 4 municipalities and 15 sub-provincial cities with the quarterly housing prices data from 1991 to 2008.

2.3.2 Information transmission between spot and forward housing markets

Existing researches study the relationship between forward and spot housing markets by learning from the financial market. Chau *et al.* (2003) uses the repeated transaction price of Hong Kong, and finds that presale-housing price can discover the spot price. Yiu *et al.* (2005) divides the overall sample into two sub-samples according to the ratio that trading volume of forward house / trading volume of spot house, and examines the lead-lag relationship between Hong Kong forward and spot housing markets by using Granger causality test. The empirical results show that when this ratio is high, spot and forward housing prices can discover each other, while when the ratio is low, there is only unidirectional discovery between the two prices. Wong *et al.* (2006) uses the GARCH (1, 1) model to test whether the forward housing market is helpful to stabilize the spot housing market. They add a dummy variable that reflects the change of policy, and find that the forward market can reduce the volatility of spot market. Wong *et al.* (2007) expands the univariate GARCH model of Wong *et al.* (2006), uses Granger causality test, GARCH (1, 1) and BEKK-GARCH model to test the relationship between spot and presale prices of Hong Kong. They finds that spot housing price is the Granger cause of forward housing price, and there is volatility clustering in both spot and presale prices, volatility of forward housing market is more sensitive to new information, and there is a unidirectional volatility spillover from forward housing market to spot housing market. Therefore, they consider that, the information transmission between forward and spot housing markets is bidirectional. More specifically, information in mean value of housing price is transmitted from spot market to forward market, while information in volatility of housing price is transmitted from forward market to spot market. Shi & Xu (2013) studies the transmission of mean value, volatility and covariance between spot and forward housing markets, finding that, for the EPRA/NAREIT Europe index, spot market leads the forward market in a long term.

2.3.3 Information transmission between different levels of property markets

Real estate market can be divided into land market, housing market and rental market. Among them, the land market is the upstream of housing market, while housing market is the upstream of rental market. There is information transmission between the adjacent markets. Therefore, the previous researches consist of two parts. One is the information transmission between housing and land markets, and the other one is the information transmission between housing and rental markets. This thesis will review these researches from the two aspects.

2.3.3.1 Information transmission between housing and land markets

Regarding to the information transmission between housing and land markets, the existing researches mainly focus on studying the mean value of price discovery between two markets. There are three different conclusions.

The first is that housing price is the Granger cause of land price, such as Ahmed & Tsoukis (1998)，Kim, Park, Shilling & Cho(2008), Peter & Kupke (2012). Among them, Peter

& Kupke (2012) constructs a Site Adjusted Land Price Index and equivalent Quality Adjusted Housing Price Index with 121833 vacant land transactions from 1991 to 2010 and 404549 housing transactions from 1985 to 2010 of Australian. Then, they use Granger causality method to test the Ricaridan theory, and find that housing price is the Granger cause of land price, while the reverse does not hold.

For China, Xu (2006) argues that, in the land market, local government is the supplier, while property developer is the demander. As there is information asymmetry between the both sides on incentive mechanism, decision-making speed, bidding process, the attitude to the price rise and so on, it is housing price that decides land price, but not land price decides housing price. That some developers attribute the soaring housing price to the rise of land price is wrong. Zhu & Dong (2006) deems that the land demand is derived from the housing demand, and the land price change is the result of housing price change, but not the cause. It will exhibit a same trend in land price when housing price changes. “The dynamic monitoring report on land prices of Chinese key areas and important cities in 2004”issued by Ministry of Land and Resources points out that, the housing demand in China is very strong, while the supply is less, so that the housing price increases will lead to more land demands and pull up land prices. Zhang (2004), Cai *et al.*(2006), Xie(2006) and Wen & Goodman(2013) use the data from the third quarter of 1998 to the second quarter of 2002, Shanghai housing sale price index and land transaction price index from 2001 to 2004, Shanghai housing sale price index and land transaction price index from the first quarter of 2000 to the first quarter of 2005, and the data of 21 Chinese provincial capital cites from 2000 to 2005, respectively, to study the relationship between housing and land markets. They all find that housing price has significant effect on land price, while the reverse does not hold.

The second is that land price is the Granger cause of housing price. Ozanne & Thibodeau (1983), Manning (1988), Bostic, Longhofer & Redfearn (2007) all find that the land price and its lag terms can significantly explain the change of housing price. Kuang (2005) tests this relationship in China. He discusses the relationship between housing price and land price under the Cournot spatial competition and regulation situation respectively, by constructing a linear housing market and land market model. The results show that the housing and land prices both are higher under regulation than no regulation. We can observe a negative linear relationship between housing price and land price when supply is excessive, while this relationship is positive when demand is excessive. The results of Granger causality test show that, in the short term, housing and land prices affect each other, while in the long term, land price is the Granger cause of housing price.

The third is that there are bidirectional influences between housing and land prices. Some scholars believe that the land price and housing price affect each other. For example, Peng & Wheaton (1994) studies the relationship between land supply and housing price with the data of Hong Kong. They find that the reducing of land supply expectation will not reduce the housing supply in short run, but it will push up the housing price, and then increase the property investment in the long run. They also propose that there are many factors affecting housing price, and land price is just a part of the developing cost. There are many empirical studies on Chinese market supporting this conclusion. For instance, Gao (2001) presents that the correlation coefficient between the housing price and land price per floor area in Tianjin is 0.989, so she believes that land price is the base of housing price, while housing price is the expression of land price, and there is retroaction of housing price on land price. Liu & Liu (2003) points out that, there are several viewpoints to interpret the causal relationship between housing price and land price, such as demand, supply, and market operation and so on. From the view of demand, it is the rise of housing price pulls up the land price. To be specifically, applying the “the paradox of corn law” to the urban real estate market, we can know that the high housing price will stimulate land demand. While because the land supply in short run is inelastic, the land price will grow up. Therefore, the regional difference of land price lies in the regional difference of housing price. In detail, land price is a kind of derived demand price. Therefore, high land price is the result of high housing price, but not the cause. On the other hand, from the view of supply, the rise of land price is one of the factors pushing up the housing price. However, this positive effect is not immediate. The rise of current land price will be reflected in the housing price after a cycle of real estate development. As the signal of market supply and demand, the relationship between housing price and land price indicates the relationship between the demand and supply of housing and land markets, while the effect of housing and land prices on each other expresses the interaction of housing and land markets. Gao & Mao (2003) uses the quarterly data of land price index and housing price index from 1992 to 2002, adopts the Granger causality test, and finds that the trend of housing price is the support of land price in the long run. While in the short run, the two prices affect each other. Zeng & Zhang (2006) uses the quarterly data of Wuhan from 2002 to 2005 to test the relationship between housing price and land price. They points out that in the short term, the housing price and land price are the Granger cause of each other, but this relationship does not hold in the long run.

2.3.3.2 Information transmission between housing and rental markets

The researches always study the relationship between housing price and rent to reveal the information transmission between housing market and rental market. Case, Quigley and Shiller (2005) and Clayton (1996) proposes that the relationship between housing price and rent is similar to the relationship between stock price and dividend in stock market. They use the discount model to examine the relationship between the two, and believe that housing price should equal to the sum of the discounted value of all the expected rents. However, Himmelberger, Mayer and Sinai (2005) does not find a significant relationship between housing price and rent, and the ratio of housing price to rent cannot be used to measure the investment value of houses.

Regarding to Chinese real estate market, Xie (2004) discusses the reasonable range of the ratio of housing price to rent from the viewpoint of the potential investment, analyzes the internal mechanism of rational bubble and non-rationality of economy affecting this ratio. Moreover, he analyzes the current situation of Beijing, Shanghai and so on, but does not find that housing price and rent are correlated. While from the aspect of economic analysis, Zhou (2005) comes up with that, Chinese housing market and rental market are compartmented as a monopolistic competition market and a complete competition market. Therefore, the two markets are independent and there is no significant relationship between housing price and rent. Cui (2006) utilizes the housing price and rent of Shanghai in 1998 and 2004 to test their Granger causality relationship, finding that the two prices are independent. Du & Ma (2009) takes use of Chinese housing price index and rental price index from the first quarter of 1998 to the third quarter of 2006, and studies the relationship between the two indexes. By using the unit root test, cointegration test and Granger causality test, they find that, for the overall China, housing price and rent are independent in the short term, while housing price is the cause of rent in the long run.

In summary, there are abundant researches studying on the information transmission in real estate market. Firstly, for the information transmission between different regional property markets, most researches pay attention to the price discovery, and less studies consider the volatility spillover, such as Guirguis *et al.* (2007). Secondly, for the information transmission between spot and forward housing markets, the previous researches examine both the price and volatility spillovers, and get many meaningful results. Thirdly, for the information transmission between housing market and land market, the previous researches mainly test the mean value transmission. The purpose of their researches is to interpret and forecast the change of housing price and land price, but not to study the macro-control mechanism from the perspective of information transmission. It is supported by Geltner *et al.* (2003). More importantly, there is no paper studying the volatility transmission, which is of great concern to the macro-control, as understanding it can help the government to make sure whether a new housing policy can stabilize the land market or not. Fourthly, for the information transmission between housing and rental markets, there are fewer researches, and they mainly study the price discovery between housing price and rent, and do not pay attention to the volatility spillover.

2.4 Effect of macro-policies on the information transmission of real estate market

2.4.1 Macro-control policies of different countries

Policy tools are the means and ways that government used to solve a social problem or to achieve a policy target under certain policy environment. It’s a bridge to connect the policy target and policy implementation. Dahl and Lindblom (1953) divides the policy tool into two kinds: mandatory tool and non-mandatory tool. Mandatory tool refers to the ways that the government uses to directly guide and control organizations and individuals, relying on its authority resources and coercive force of the state. It contains the authority policy tool, such as national plan etc., direct supply (the direct fiscal expenditure and transfer payment etc.), public enterprises and administrative mandatory measures (regulations, setting up and withdrawing of government agency, prohibition order etc.).

Through the comprehensive analysis of the property macro-control means of United States, Britain, Japan, Germany, Russia and other countries, we can find that policies of these countries are mostly market-oriented based, such as interest and tax measures. Among them, only few countries have used the administrative means to regulate real estate market. For instance, to curbing the continuous rising of housing price of big cities such as Moscow and St. Petersburg, Russian government has instructed the General Prosecutor's Office of the Russian Federation to investigate the property developers who manipulate the market price, and caution other construction departments and the city planning departments’ official for their sluggish action. Policies of other countries are more market-oriented (Xiao *et al.*, 2006; Zhou, 2007).

It can be seen that market economy countries always use market-oriented means to regulate the behaviors of market players, and then control the real estate price. Due to the special situation of Chinese market, there are not only market-oriented means introduced, but also non-market-oriented measures implemented. While these non-market policies bypasses market mechanism, change market participants' behavior through coercive means, and then have an impact on market prices.

2.4.2 Effect of macro-policies on the information transmission efficiency

Implementation of policy will lead to changes in the behavior of market players, thereby affect the market price formation mechanism, and thus may affect the efficiency of the market. Government should be aware of these changes, and adjust the future policy.

Previous researches mainly study the impact of macro-control policy on the real estate prices. There is a large class of researches focus on the impact of implementation of land policy on housing and land prices. The land policy includes land supply plans, programs, and granting system and so on. Hannah, Kim and Mills (1993) finds that, the high housing price of Korea in 1980s is caused by the insufficient allocation of residential land, which is decided by the government's planning. However, Peng & Wheaton (1994) has different viewpoints. They find that, the land supply limitation in Hong Kong from 1965 to 1990 does not decrease the housing prices.

Monkkonen & Ronconi (2013) finds that more and more empirical studies pay attention to the effect of strict land use regulation on the urban housing and land prices. Meanwhile, they discover that most researches focus on the countries that the related laws are enforced. If the regulations are not mandatory, the effect of regulations on housing and land prices will be not clear. They study the relationship among land use regulation, degree of abidance by law and land price of three major cities of Argentina. The empirical results exhibit that in cities with a high degree of regulation, the degree of abidance by the real estate laws is relatively low and the land price is low too. Huang & Tang(2013) uses the data of more than 300 American cities from January, 2000 to July, 2009, and finds that strict residential land use regulation and geographic land restriction are associated with the sharply boom-and-bust. Zhang *et al.* (2013) establishes a simple three-section model, including houses, agriculture and so on. This paper estimates the effect of land use control on Chinese housing price, and finds that maintaining the minimum cultivated area is the cause of high housing prices.

The above studies show the regulation role of land policy on a country's real estate market, but do not examine the impact of land policy on market information transmission efficiency. In the previous researches, only two papers have conducted empirical tests. Both of them study the effect of IAL system on Chinese real estate market efficiency. One is Du *et al.* (2011). They find that after the implement of IAL system, the efficiency of housing market and land market both decrease, by using the average housing price and average land price. When the housing price and land price deviate from the long-run equilibrium, the speed they callback is lower than that before the implement of IAL system. Peng & Thibodeau (2012) collects the land and house transaction data of 7 cities of China from 2001Q1 to 2005Q5, and gets the similar results.

To sum up, the previous researches have studied the effect of macro-control tool, especially land policy on the housing price and land price. These researches cover America, Britain and China and so on. However, fewer studies pay attention to the effect of macro policy on the information transmission efficiency, which is important for government to make new policies.

Chapter 3: Research Data and Methods

3.1 Data source and description

3.1.1 Data source

This thesis takes Beijing, Tianjin, Shanghai and Chongqing as the research objects, which are the only four municipalities under the direct administration of Chinese central government, while other cities are under the administration of provincial governments. Therefore, the effect of macro-policy on the four cites should be more direct and significant. Beijing is the capital of China, which is also the political, economic and cultural center. While Tianjin, Shanghai and Chongqing are located in the northern, southern and western parts of China, and are the center cities in their own regions, respectively. The four cities all have large population and high developmental level of economy. Among them, the development levels of the real estate markets of Beijing and Shanghai come out top of China. Therefore, taking the four cities as the research objects is of important practical significance. This thesis mainly studies the relationship between housing and land prices. There are two types of data are common used in the current researches, which are the average data and the index data, respectively.

In order to avoid the sampling error, this thesis uses the monthly average data, as the indexes are calculated with the sample data. The average housing prices and average land prices are calculated by dividing total house or land sales by total square meters sold, named HP and LP respectively. The sample period spans from March, 2002 to June, 2014. The data is released by the National Development and Reform Commission, and derived from the Wind database. As the data of January of each year is missing, 544 observations from 4 cities and across 136 months are obtained finally.

In fact, the quarterly data is more stable and reasonable than the monthly data. The reason lies in that the monthly average data is calculated by dividing the total house or land sales on the total meters sold in one month. However, the size, location and other features of houses and land sold in every month differ greatly. For example, the land sold in this month mainly locates near the urban centre, while the land sold in last month mostly locates in outskirts, which will lead to that the average land price of this month is significantly higher than that of last month. That is because the land used to calculate the monthly prices are not the same, which is referred to as "sampling bias". If the bias is too large, the estimation results of models will be affected. While the quarterly data can reduce this bias to a certain extent, as the quantity of houses and land sold in a quarter is more than that in a month. Therefore, the differences of houses and land may be smaller, and the quarterly data may be more stable. However, there is a disadvantage of quarterly data, which is that the data size is too small to support some econometric models used in the thesis. Therefore, this thesis still gives priority to the monthly data, and the quarterly data is used for the robustness check, to ensure the stability of the results. Finally, 232 quarterly observations from 4 cities and 58 quarters spanning from 2000 Q1 to 2014Q2 are got.

In addition, BJ, TJ, SH and CQ refers to Beijing, Tianjin, Shanghai and Chongqing in this thesis.

3.1.2 Data description

Figure 3-1 shows the trends of averaging housing and land prices for Beijing from 2000 to the second quarter to 2014. It can be seen from the diagram that both housing and land prices show a rising trend, while the rise of housing prices is greater than that of land prices. Especially in 2010, housing prices hit the record highs, while after 2012, housing prices had a slight decline, but also rose to an all-time high in 2014. The land prices of Beijing had no significant change before 2004, because the land granting system was unchanged. Since the implementation of IAL (invitations to tender, auctions, or listings) system in 2004, we can observe an obvious rising trend in land prices, and it reached an all-time high in 2014.

Figure 3-2 shows the trends of average housing and land prices for Tianjin from 2000 to the second quarter of 2014. It can be found that the change trend is almost unanimous with Beijing. The housing price had a slight decrease in 2012, but stabilized and picked up again in 2013, while the land prices rose obviously in 2008.

Figure 3-3 shows the trends of averaging housing and land prices for Shanghai from 2000 to the second quarter of 2014. It can be seen from the figure that the trend of housing prices is slightly different from that of Beijing and Tianjin. Overall, the housing and land prices tend to rise. To be specific, house prices showed a sharp rise in 2008, stabilized in 2010, slightly reduced in 2012, and hereafter started to increase again. While land prices increased obviously from 2007, and were even higher than the housing prices in the second quarter of

2014, reaching 17000 RMB/m^2.

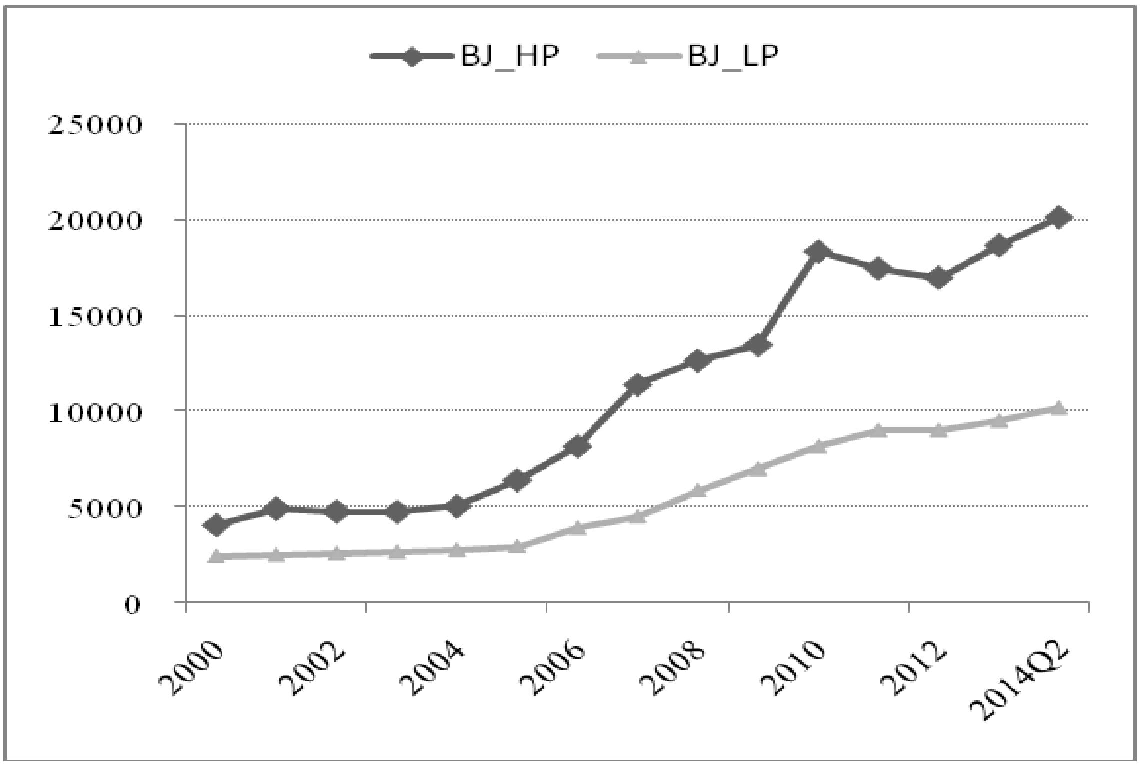


Figure 3- 1 Trends of annual average housing and land prices for Beijing

Source: Wind database.

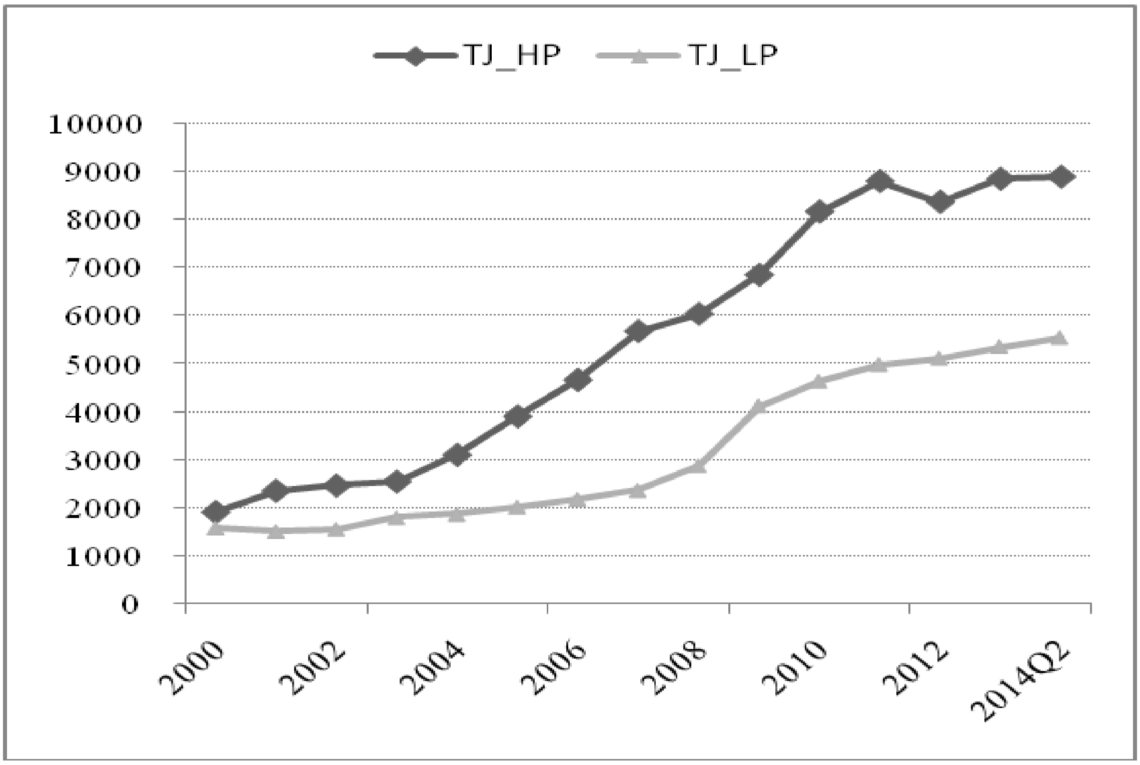


Figure 3- 2 Trends of annual average housing and land prices for Tianjin

Source: Wind database.

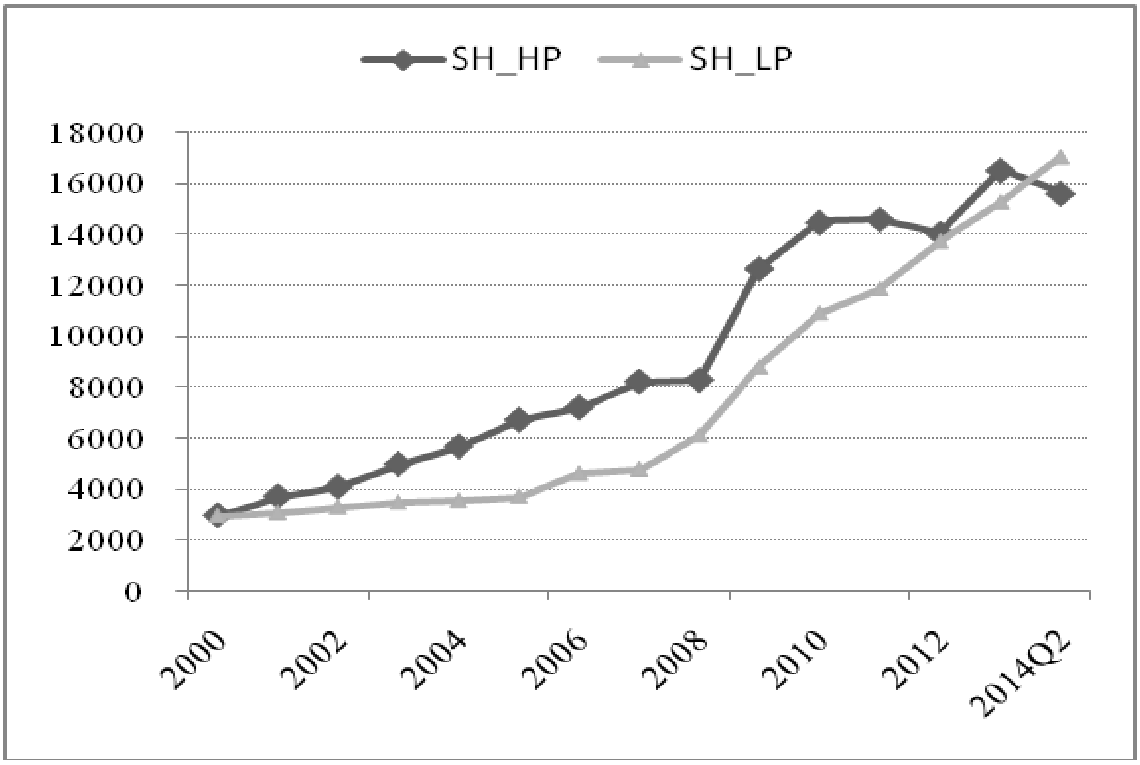


Figure 3- 3 Trends of annual average housing and land prices for Shanghai

Source: Wind database.

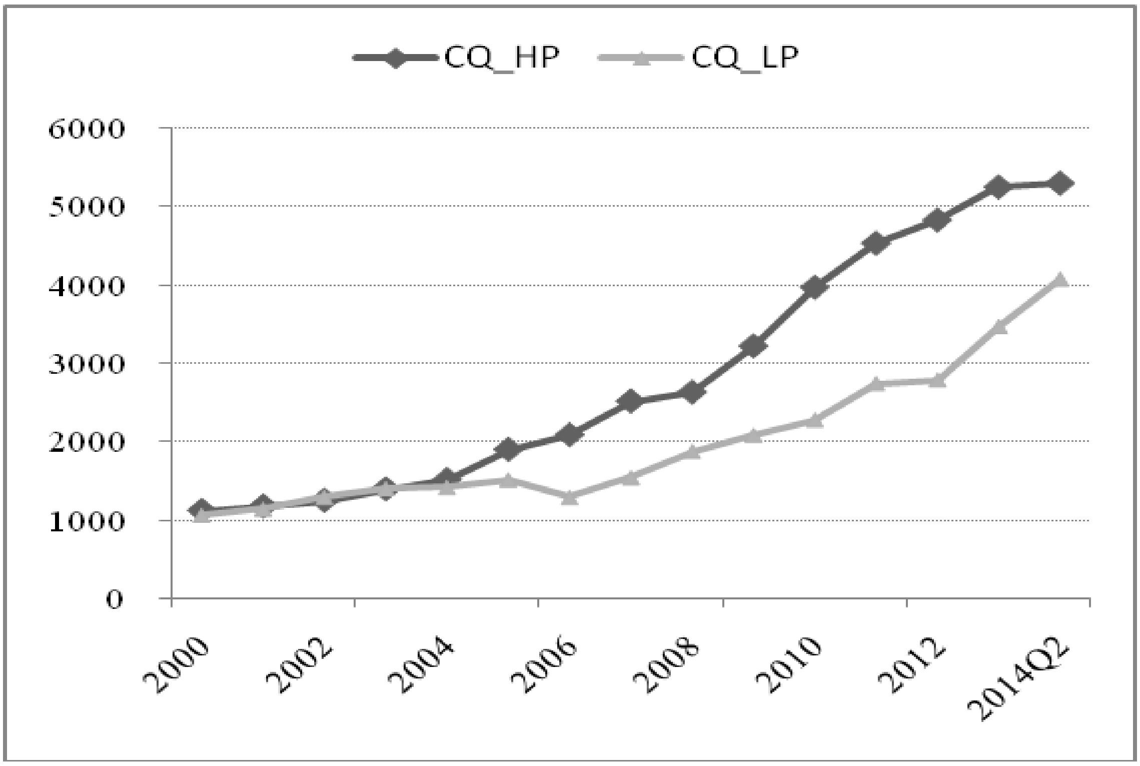


Figure 3- 4 Trends of annual average housing and land prices for Chongqing

Source: Wind database.

Figure 3-4 shows the trends of averaging housing and land prices for Chongqing from 2000 to the second quarter of 2014. The two prices were very close from 2000 to 2004, and appeared differentiation after that. House prices rose faster, and it was different from the other three cities that the housing prices of Chongqing showed a continuous rise trend after 2010, instead of a cut trend.

Table 3- 1 Description of housing and land prices for the overall sample

Statistic	HP (RMB/m^2)	LP (RMB/m^2)
Mean	7010	4393
Median	5223	2792
Maximum	21580	17233
Minimum	1046	1050
Std. Dev.	5107	3591

Source: calculated by the author.

Table 3-1 exhibits the description statistics for the overall sample including all the observations for four cities. It can be found that the mean value of housing prices and land prices are 7010 RMB/m^2 and 4393 RMB/m^2, respectively. The maximum of housing prices is 21580 RMB/m^2, while that of land prices is 17233 RMB/m^2. The standard deviations of housing prices and land prices are 5107 RMB/m^2 and 3591 RMB/m^2, respectively, which shows that the absolute fluctuation of housing prices is slightly larger than that of land prices.

Table 3-2 shows the annual average housing prices for four cities and the returns based on 2000. As can be seen from the table, the average prices for Beijing, Tianjin, Shanghai and Chongqing all continue to rise. The rising speed is slow before 2004. For example, the housing prices for Beijing in 2004 rose by 24% from 2000, and that of Chongqing rose by 35%. However, since 2005, the rising amplitude had quickened significantly. Among the four cities, housing prices for Tianjin and Shanghai doubled, while the prices for Beijing and Shanghai rose more than 50%. Since then, house prices kept rising sharply, and the returns for four cities were 397%, 363%, 431% and 363%, respectively. From the table, it can be found that 2005 is a watershed in house prices change. In addition, there are some structural changes in housing prices in 2011. The rising speed of housing prices slowed down in 2011 obviously, while the returns for Beijing even dropped from to 353% in 2010 to 331%, and that for Shanghai only rose from 392% to 396%. It shows that, there are some factors changing Chinese housing prices generated mechanism in 2004 and 2010, which may be the policies made by the central government.

Table 3-3 shows the annual average land prices for four cities and the returns based on 2000. The land price is also showing a rising trend in the sample period, and has a relatively apparent change since 2005. As it can be seen, 2005 is also the divide of land prices.

The changes of housing prices and land prices in 2005 are mainly caused by the reform of land use right granting system implemented in 2004. It is that the land use right is granted with IAL system instead of negotiating system. This system strengthens the monopoly of land market, reduces the barriers to entry, and then pushes up land prices and housing prices. Therefore, the implementation of the IAL system has a profound impact on the real estate market.

Table 3- 2 Description of average housing prices

Variable	HP (RMB/m^2)				Returns Based on 2000			
Year	BJ	TJ	SH	CQ	BJ	TJ	SH	CQ
2000	4051	1917	2936	1113				
2001	4913	2361	3683	1167	21%	23%	25%	5%
2002	4761	2468	4052	1241	18%	29%	38%	12%
2003	4742	2551	4950	1388	17%	33%	69%	25%
2004	5028	3104	5648	1506	24%	62%	92%	35%
2005	**6392**	**3905**	**6690**	**1892**	**58%**	**104%**	**128%**	**70%**
2006	8169	4659	7183	2079	102%	143%	145%	87%
2007	11377	5672	8197	2510	181%	196%	179%	126%
2008	12639	6033	8253	2624	212%	215%	181%	136%
2009	13464	6838	12634	3213	232%	257%	330%	189%
2010	18336	8152	14451	3962	353%	325%	392%	256%
2011	**17445**	**8786**	**14574**	**4527**	**331%**	**358%**	**396%**	**307%**
2012	16967	8356	14013	4823	319%	336%	377%	334%
2013	18658	8830	16496	5244	361%	361%	462%	371%
2014	20124	8875	15590	5293	397%	363%	431%	376%

Source: calculated by the author.

Table 3- 3 Description of average land prices

	LP (RMB/m^2)				Returns Based on 2000			
Year	BJ	TJ	SH	CQ	BJ	TJ	SH	CQ
2000	2437	1587	2933	1052				
2001	2499	1513	3049	1129	3%	-5%	4%	7%
2002	2576	1561	3288	1281	6%	-2%	12%	22%
2003	2660	1799	3458	1391	9%	13%	18%	32%
2004	2764	1869	3533	1408	13%	18%	20%	34%
2005	**2941**	**2021**	**3695**	**1504**	**21%**	**27%**	**26%**	**43%**
2006	3901	2181	4595	1279	60%	37%	57%	22%
2007	4523	2364	4761	1531	86%	49%	62%	46%
2008	5863	2882	6093	1866	141%	82%	108%	77%
2009	6989	4125	8763	2072	187%	160%	199%	97%
2010	8161	4634	10888	2268	235%	192%	271%	116%
2011	**9003**	**4979**	**11854**	**2731**	**269%**	**214%**	**304%**	**160%**
2012	9014	5109	13715	2775	270%	222%	368%	164%
2013	9505	5355	15250	3454	290%	237%	420%	228%
2014	10182	5539	17018	4058	318%	249%	480%	286%

Source: calculated by the author.

The returns of housing and land for Beijing, Tianjin, Shanghai and Chongqing are presented in Figure 3-5, 3-6, 3-7 and 3-8. While HPr and LPr represent the return of housing and land prices, respectively. The size of housing returns will be seen on the left longitudinal axis, and that of land prices will be seen on the right one.

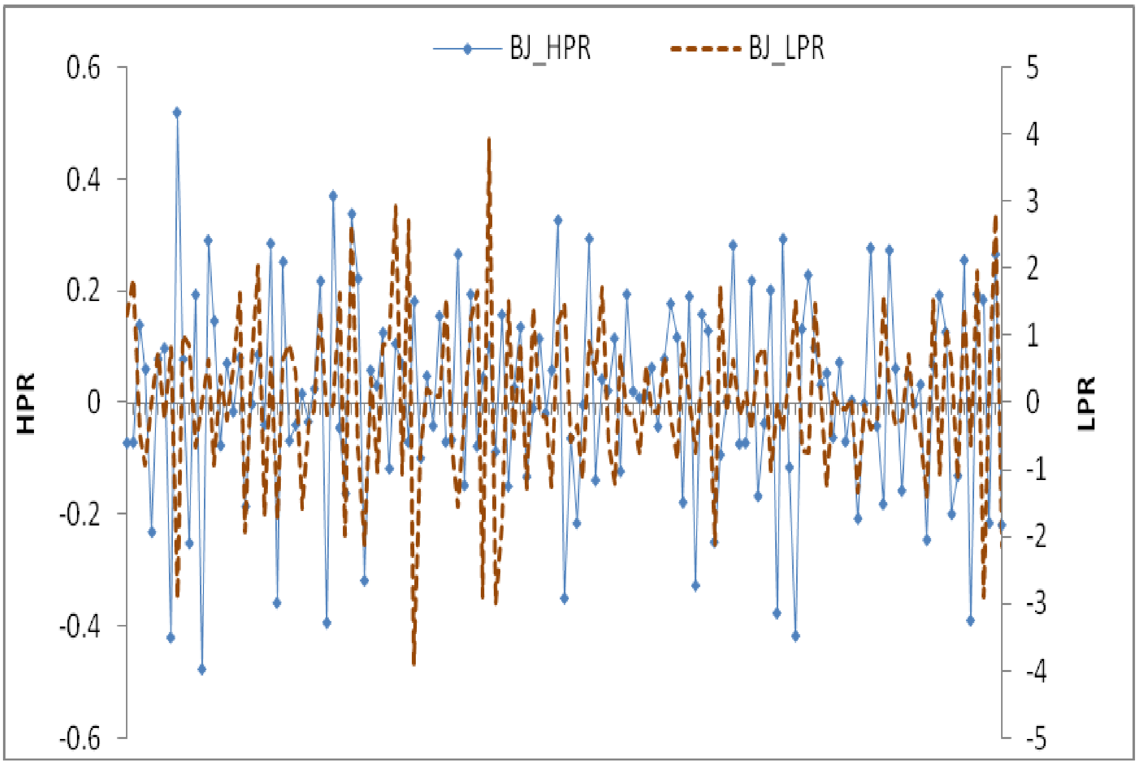


Figure 3- 5 Monthly returns of housing and land for Beijing

Source: calculated by the author.

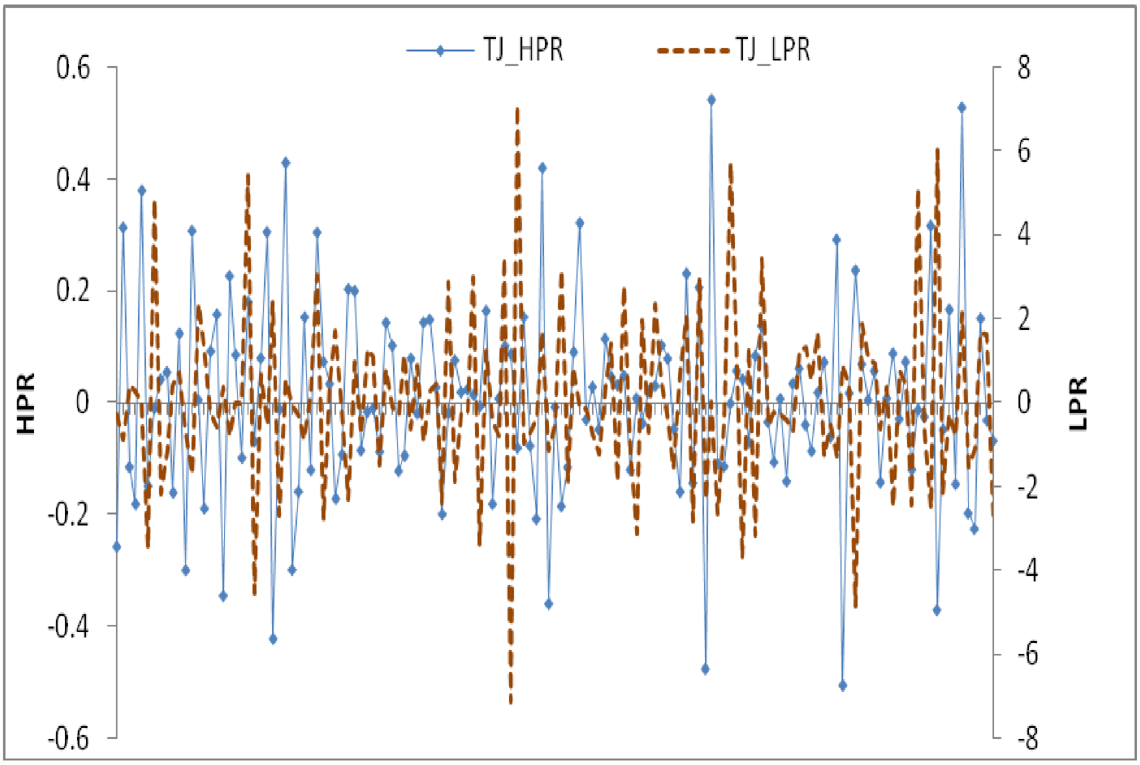


Figure 3- 6 Monthly returns of housing and land for Tianjin

Source: calculated by the author.

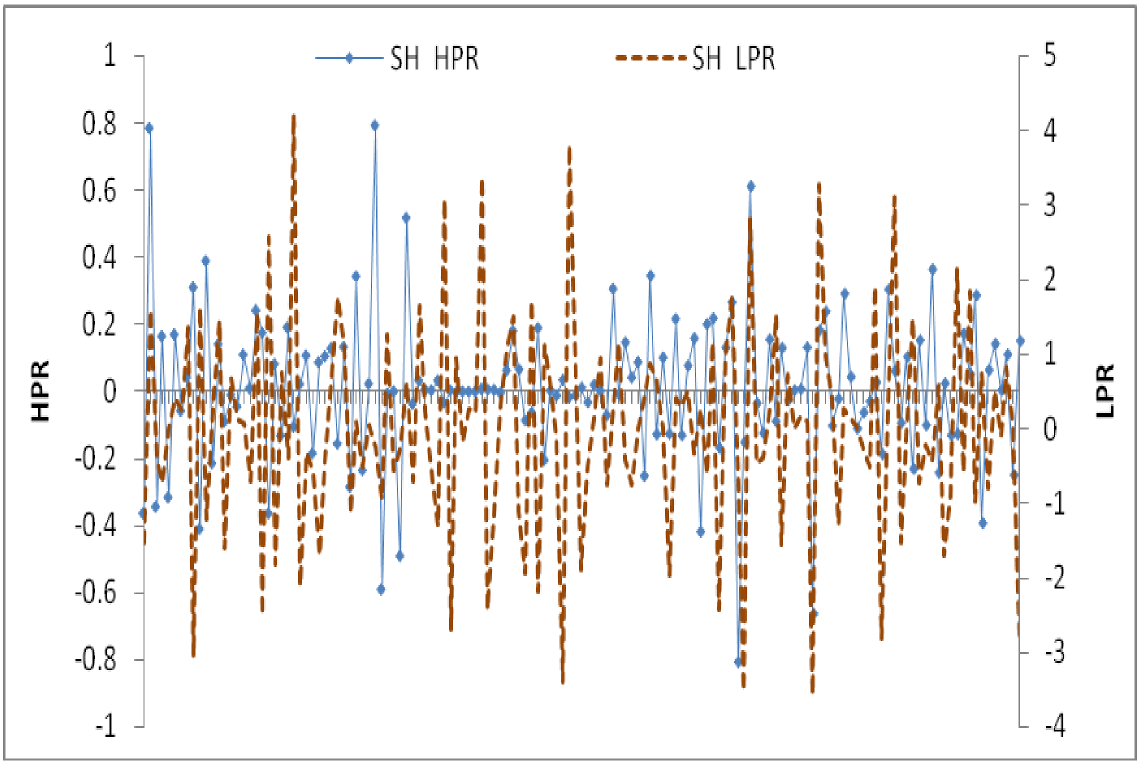


Figure 3- 7 Monthly returns of housing and land for Shanghai

Source: calculated by the author.

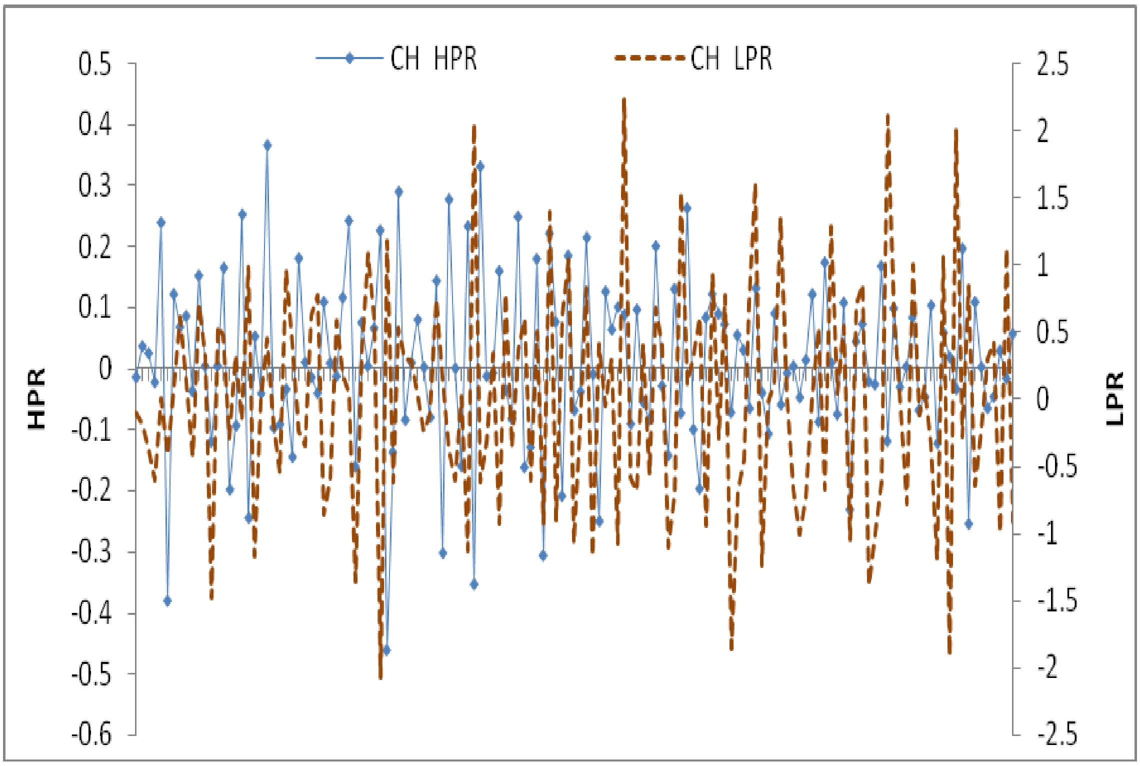


Figure 3- 8 Monthly returns of housing and land for Chongqing

Source: calculated by the author.

Table 3-4 reports the annual return or growth rate of housing prices for four cities. It shows that, the annual average HPr for Shanghai is 14%, ranking first in the four cities, while HPR for the other three cities are roughly equal. The maximum HPr for Shanghai is 53%, and also the highest one. For the perspective of standard deviation, the fluctuations of Beijing and Shanghai are larger than the other two cities.

Table 3-5 contains the annual growth rate of land prices for four cities. It can be seen obviously that the annual average LPr of Shanghai is the highest, reaching 14%, and while that of Tianjin is the lowest. The fluctuations of Tianjin and Shanghai are larger than the other two cities.

Table 3- 4 Description of annual average housing returns

Statistic	BJ	TJ	SH	CQ
mean	13%	12%	14%	12%
median	9%	11%	14%	9%
max	39%	26%	53%	26%
min	-5%	-5%	-5%	1%
Std. err.	14.8%	9.8%	14.8%	7.9%

Source: calculated by the author.

Table 3- 5 Description of annual average land returns

Statistic	BJ	TJ	SH	CQ
mean	11%	10%	14%	11%
median	7%	8%	10%	10%
max	33%	43%	44%	24%
min	0%	-5%	2%	-15%
Std. err.	10.3%	11.5%	12.1%	10.4%

Source: calculated by the author.

3.2 Research methods

This thesis attempts to study the relationship between housing prices (HP) and land prices (LP). To avoid the heteroscedasticity of data, the logarithms of HP and LP are used to make models, and named LNHP and LNLP, respectively.

3.2.1 Methods of studying price discovery

To further study the long-run and short-run causality relationships between Chinese housing prices and land prices quantitatively, and effectively solve the problems that low explaining ability brought by the short time-series data, the panel data is used to make econometric analysis in this thesis. There are several advantages of panel data comparing with time-series data. First is to reduce the estimation deviation, construct a more reliable parameter statistics, and improve the effectiveness of the parameter estimation. Second is to weaken the effect of multi-collinearity. As the explaining variables change in two directions at the same time, the possibility of a strong correlation between them is greatly reduced by the increasing potential influencing factors. Third is to enable us to identify and measure some factors that cannot be identified by pure cross-section model and pure time-series model. The panel data not only can reflect the relationship between housing prices and land prices for a certain period, but also can reflect the relationship for every city. Therefore, the panel data has the advantages of time-series data and cross-section data simultaneously.

3.2.1.1 Specification of panel data model

There are three kinds of panel data models in general (Greene, 2003; Cheng, 2003; Heij, 2005):

Pooled model:

$$y_{it} = \alpha + \beta x_{it} + \varepsilon_{it}, i = 1, 2, \cdots, n; t = 1, 2, \cdots, T \qquad (3\text{-}1)$$

Variable intercept model:

$$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it}, i = 1, 2, \cdots, n; t = 1, 2, \cdots, T \qquad (3\text{-}2)$$

Variable slope model:

$$y_{it} = \alpha_i + \beta_i x_{it} + \varepsilon_{it}, i = 1, 2, \cdots, n; t = 1, 2, \cdots, T \qquad (3\text{-}3)$$

x_{it} is a $1 \times K$ vector， β_i is a $K \times 1$ vector， and K is the number of explaining variables.

When setting up the panel data model, we should choose the correct type firstly. Otherwise it will produce a large estimation error. Therefore, a test is needed to determine the model type.

Hypothesis 1: if the slopes and intercepts are the same for different cross-sections and different periods, the pooled model should be chosen.

$$H_1 : \alpha_1 = \alpha_2 = \cdots = \alpha_n, \beta_1 = \beta_2 = \cdots = \beta_n$$

Hypothesis 2: if the slopes are the same, but the intercepts are different, the variable intercept model should be chosen.

$$H_2 : \beta_1 = \beta_2 = \cdots = \beta_n$$

Three kinds of models are estimated by using the method of OLS (ordinary least squares), and get the RRS (sum of residual squares) of model. Assuming that the RRS of pooled model, variable intercept model and variable slope model are represented by RSS_1, RSS_2 and RSS_3 respectively, this thesis can construct the below statistics to test hypothesis 1 and hypothesis 2.

The statistic to test hypothesis 1:

$$F_1 = \frac{(RSS_3 - RSS_1)/[(n-1)(K+1)]}{RSS_1/[n(T-K-1)]} \sim F[(n-1)(K+1), n(T-K-1)]$$

The statistic to test hypothesis 2:

$$F_2 = \frac{(RSS_2 - RSS_1)/[(n-1)K]}{RSS_1/[n(T-K-1)]} \sim F[(n-1)K, n(T-K-1)]$$

n is the number of cross sections, T is the numbers of periods. Statistic F_1 is used to test whether reject hypothesis 1 or not. If the value of F_1 is smaller than the critical value, we cannot reject the null hypothesis, and then the pooled model will be chosen. While if F_1 is bigger than the critical value, we should test hypothesis 2. If F_2 is smaller than the critical value, the null hypothesis will not be rejected, and then the variable intercept model is correct, otherwise variable slope model should be chosen.

3.2.1.2 Unit root test for panel data

Studying the price discovery between housing market and land market is to test whether there is a mean value transmission between the two prices. The stability of LNHP and LNLP should be test before establishing the econometric models. Because there are different models for stationary and nonstationary data, if we use the stationary models for nonstationary data, it may appear the phenomenon of spurious regression. Therefore, the first step is to test the stability of data when modeling.

Levin & Lin (2002) establishes the LLC statistic and tests the unit root of panel data at the earliest with the precondition that the residual is homoscedasticity, basing on the pooled model. Harris & Tzavalis (1999) proves that the test power of LLC method is poor when the time span is short and they establish the Harris and Tzavalis method. Im Pesaran and Shin (2003) establishes the IPS method, and they set up the W test by considering the heteroscedasticity and autocorrelation of residual in 2003. Due to data used in this thesis covers 136 months, and the time span is relatively long, W test is adopted to test the unit root of panel data.

The IPS method established by Im Pesaran and Shin (2003) is specified as below:

The $ADF(p_i)$ regression model is established firstly.

$$\Delta \mathrm{y}_{\mathrm{i,t}} = \alpha_i + \beta_i y_{i,t-1} + \sum_{j=1}^{p_i} \rho_{ij} y_{j,t-j} + \varepsilon_{i,t} \quad i = 1, 2, \cdots, N; \;\; t = 1, 2, ..., T$$

After conducting the unit root test for *N* individuals, getting the corresponding *t* values, averaging these *t* values, we construct the statistic: $\tilde{t} - bar_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_i T_i(p_i, \rho_i)$.

The null hypothesis and alternative hypothesis are：

$$H_0: \;\; \beta_i = 0$$
$$H_1: \beta_i < 0, \quad i = 1, 2, ..., N_1, \quad \rho_i = 0, \;\; i = N_1 + 1, N_1 + 2, ..., N$$

Based on the ADF-t statistics of *N* individuals, constructing the below statistics.

$$W_{tbar}(p, \rho) = (\sqrt{N}[\tilde{t} - bar_{NT} - a_{NT}] / \sqrt{b_{NT}} \xrightarrow{TN} N(0,1)$$
$$a_{NT} = (1/N)\sum_{i=1}^{N} E[t_{iT}(p_i, 0) \mid \beta_i = 0]$$
$$b_{NT} = (1/N)\sum_{i=1}^{N} v\,\mathrm{ar}[t_{iT}(p_i, 0) \mid \beta_i = 0]$$

Therein, $\tilde{t} - bar_{NT}$ is the ADF-t statistic for *N* cross-sections, lagged *p* periods, while $E[t_{NT}(p,0)], \mathrm{var}[t_{NT}(p,0)]$ are the average values of ADF-t statistics and t values for N cross-sections.

Im, Pesaran & Shin (2003) demonstrates that when the null hypothesis holds, $T \to \infty, N \to \infty$, or $N/T \to k$, and *k* is a finite number, statistic $W_{tbar}(p, \rho)$ will converge to a normal distribution function.

3.2.1.3 Models for stationary data

(1) Granger causality test for panel data

If LNHP and LNLP are stationary, then we can directly use the two variables to establish econometric model. The Granger causality test is adopted by this thesis, which is proposed by Granger in 1969. He thinks that if variable X is the Granger cause of variable Y, the change of X will lead the change of Y. Therefore, when regressing Y on other variables, the lags of X should have a significant explanation power on Y, then X is called the "Granger cause" of Y (Granger, 1969). However, if the data is not stationary, the Granger causality test is no more applicable, so the unit root test is essential.

This thesis will establish the PVAR (panel vector auto regression) model to study whether there is mean value transmission between stationary housing and land prices. The model is specified as below.

$$LNHP_{i,t} = \alpha_i + \sum_{k=1}^{m} \alpha_k LNHP_{i,t-k} + \sum_{l=1}^{m} \beta_l LNLP_{i,t-l} + \varsigma_{i,t} \tag{3-4}$$

$$LNLP_{i,t} = \overline{\alpha}_i + \sum_{k=1}^{m} \overline{\alpha}_k LNHP_{i,t-k} + \sum_{l=1}^{m} \overline{\beta}_l LNLP_{i,t-l} + \xi_{i,t} \tag{3-5}$$

In model (3-4) and (3-5), $HP_{i,t}$ and $LP_{i,t}$ are the average housing price and average land price for city *i* at time *t*. *LNHP* and *LNLP* are the logarithmic forms of *HP* and *LP*. The lag order *m* is decided by the information criterion including AIC, BIC and HQIC, and the main principle is to choose the model that has the smallest values of information criterion.

We will find out whether there is mean value transmission between housing and land markets by estimating model (3-4) and (3-5) and conducting the Granger causality test. Firstly, we will jointly test the hypothesis that $\beta_1 = \beta_2 = \cdots \beta_m = 0$, which are the estimation coefficients of model (3-4). If the null hypothesis holds, it shows that the land prices cannot discover housing prices, and the mean value information of land markets cannot be passed to housing market. Secondly, we will jointly test the estimation coefficients of model (3-5) with the null hypothesis that $\overline{\alpha}_1 = \overline{\alpha}_2 = \cdots = \overline{\alpha}_m = 0$. If the hypothesis holds, it indicates that housing prices cannot discover land prices, and the information of housing market cannot be transmitted to land market.

(2) Impulse response function analysis

Granger causality test is the block significance test of the coefficients of PVAR model, the results of which can clarify that whether the lags of housing prices and land prices have effect on each other, but cannot illustrate whether the effect is positive or negative, and how long the effect lasts. However, these results can be obtained with the IRF (impulse response function) analysis of PVAR model.

Impulse response function can track the responses of explained variable to the shock of every explaining variable in the PVAR equation. Its principle is: firstly, we impose a unit shock to the error term of each variable in each equation, and obtain the effect of this unit shock to every variable in the whole PVAR system for a certain period. Therefore, if there are g variables in the equations, we can observe g^2 impulse response curves. In this thesis, the system consists of housing prices and land prices. That the implementation of impulse response analysis is to impose a unit positive shock to the error term of housing prices (or land prices), and then observe the effect of this shock on land prices (or housing prices) and themselves. If the system is stable, the effects of this shock will gradually disappear, which means that the information brought with the shock is completely absorbed by the market. Whether the effect of the shock is positive or negative can be known through the impulse response function, as well as how long the effect will last. Because there are only two variables in the system, we will observe 4 impulse response curves.

Therefore, in order to further understand the efficiency of information transmission between housing market and land market, clarify the information transmission speed, this thesis will conduct an impulse response function analysis, and calculate the confidence interval of the impulse responses with Monte Carlo simulation method. The procedure used to estimate the PVAR model and impulse response analysis is borrowed from Love & Zicchino (2006) and Lian & Chung (2008).

3.2.1.4 Models for nonstationary data

(1) Cointegration test of panel data

If LNHP and LNLP both are nonstationary and both I (d), which means that they will be stable after d order differences, then it is needed to examine whether there is a cointegration relationship between the two variables.

The study on the cointegration theory of panel data began in 1995. Pedroni (1999) and McCoskey and Kao (1998) *et al.* study the spurious regressions of panel data and conducts the cointegration test respectively. Kao (1999) finds that LSDV (Least Squares Dummy Variables) estimation of panel data is super consistent. However, the t statistic of regression coefficient is divergent. Therefore, the statistical inference on regression coefficient is wrong. With the development of the unit root test theory, the cointegration theory of panel data gets rich in the past decades. According to the basic thought of testing method, there are two types of panel cointegration test.

The first kind of panel cointegration test is based on the unit root test of the residual of conintegration regressions of panel data, which is the generalized type of the Engle Granger two-steps method, often referred to as the first generation of panel cointegration test. There are some representative researches such as Kao (1999), McCoskey and Kao (1998), Pedroni (1999, 2004) etc. The 7 statistics constructed by Pedroni are used to test the panel cointegration relationship. The former 4 of which are described within-dimensions, namely Panel v, Panel rho, Panel PP and Panel ADF statistics, while the other three are described between-dimensions, namely Grouprho, Group PP and Group ADF statistics. Pedroni points out that each standardized statistic tends to be normal distribution, but under the condition of small sample size, the Panel ADF and Group of ADF statistics have better test power, and the two statistics will prevail when the results are not consistent. The distinctive features of the first generation of panel cointegration test are shown as below. (1) It ignores the possible invisible factors, or tries to overcome the invisible mutual effects with removing trend methods or with the aid of observable mutual effects. (2) It is usually applicable to the special circumstances that there is one relationship at most among the time-series data of different individuals. (3) There may be spatial correlation among panel data in the same period, but in general, we assume there is no spatial correlation.

Another kind of panel cointegration test is developed from the promotion of Johansen trace test, which is called the second generation of panel cointegration test. Compared to the first generation, the second generation can not only examine multi-cointegration relationships, but also allow the existence of stationary or non-stationary common elements in the panel data, which is the spatial correlation. For example, the cointegration test methods proposed by Larsson *et al.* (2001), Banerjee *et al.* (2004), Breitung (2005) all belong to the second-generation test.

This thesis will adopt the second-generation panel cointegration test, which is the Johansen Fisher method (Johansen, 1995; Fisher, 1934). The specific procedures are:

Firstly, we conducts Jonhansen cointegration test for every cross-section, obtain the p value of the trace statistic of individual i, and name it π_i .

Secondly, using the methods of Fisher, we construct the panel cointegration test statistic, and specify as below:

$$Fisher = -2\sum_{i=1}^{n}\pi_i$$

(2) Vector Error Correction Model of panel data

Engle and Granger (1987) points out that if LNHP and LNLP both are I(d) and there is cointegration relationship between them, the error correction model should be used to examine the price discovery between the two prices. Based on last part, this thesis establishes VECM (Vector Error Correction Model) to analyze the short run relationship between LNHP and LNLP and the correction speed of market when the price deviates from their long-run equilibrium.

$$\Delta LNHP_{i,t} = \alpha_{i,0} + \sum_{j=1}^{m}\alpha_k \Delta LNHP_{i,t-j} + \sum_{k=1}^{n}\gamma_k \Delta LNLP_{i,t-k} + \lambda ecm^{(HP)}{}_{i,t-1} + \mu_{i,t} \qquad (3\text{-}6)$$

$$\Delta LNLP_{i,t} = \overline{\alpha}_{i,0} + \sum_{j=1}^{q}\overline{\alpha}_k \Delta LNHP_{i,t-j} + \sum_{k=1}^{p}\overline{\gamma}_k \Delta LNLP_{i,t-k} + \theta ecm^{(LP)}{}_{i,t-1} + v_{i,t} \qquad (3\text{-}7)$$

$\Delta LNHP_{i,t}$ and $\Delta LNHP_{i,t}$ are the first differences of LNHP and LNLP. The models (3-6) and (3-7) are named housing model and land model, respectively.

In model (3-6), if the joint hypothesis that coefficients γ_i all equal to zero does not hold, land prices are the Granger cause of housing prices. Adding the lags of land prices in model (3-6) will improve the explaining ability, which shows that the changes of housing prices in short-term not only depend on the historical value of themselves, but also depend on the land prices and the lag of the error correction term, which is $ecm^{(HP)}{}_{i,t-1}$.

For the housing market, $ecm^{(HP)}$ reflects the extent that housing price deviates from its long run equilibrium relationship with land price, which is the residual when regressing LNHP on LNLP. If $ecm^{(HP)} > 0$, LNHP is higher than its long-run equilibrium, meaning that housing prices are too high relative to the given land prices, which generally appears in the real estate boom period. If the housing market is efficient, the market will correct the deviation of LNHP in the next period, therefore the coefficient of the error correction term $ecm^{(HP)}{}_{i,t-1}$ in model (3-6) will be negative and statistically significant. We can know that LNHP will callback at a rate of $\lambda * 100\%$ ($ecm^{(HP)}{}_{i,t-1} > 0$, λ is negative, and the housing prices in the short run will decrease). If $ecm^{(HP)}{}_{i,t-1} < 0$, it shows that LNHP is lower than its long-run equilibrium, meaning that relative to the given land prices, the housing prices are too low, which generally appears in the real estate downturn. If the housing market is efficient, the LNLP will correct its deviation in the next period, therefore the coefficient of the error correction term $ecm^{(HP)}{}_{i,t-1}$ in model (3-6) should be negative and statistically significant. LNHP will callback at a rate of $\lambda*100\%$ ($ecm^{(HP)}{}_{i,t-1} < 0$, λ is negative, and the housing prices in the short run will increase).

In general, if the coefficient λ is negative and significant, it indicates that LNHP and LNLP are cointegrated, and also shows that when LNHP deviates from the long-run equilibrium relationship, there is an error correction mechanism in housing market. The market callbacks the housing price in the next period at a rate of $\lambda*100\%$. Therefore, λ reflects the information efficiency of housing market.

In model (3-7), if the joint hypothesis that coefficients $\overline{\alpha}_i$ all equal to zero does not hold, housing prices is the Granger cause of land prices, showing that the change of land prices in short-term not only depends on the historical value of themselves, but also depends on the housing prices and the lag of the error correction term, which is $ecm^{(LP)}{}_{i,t-1}$.

For the land market, $ecm^{(LP)}$ reflects the extent that LNLP deviates from its long-run equilibrium relationship with housing price, which is the residual by regressing LNLP on LNHP. If $ecm^{(LP)}{}_{i,t-1} > 0$, LNLP is higher than its long-run equilibrium, meaning that relative to the given housing prices, the land prices are too high, which generally appears in the boom period of land market. If $ecm^{(LP)}{}_{i,t-1} < 0$, it shows that LNLP is lower than its long-run equilibrium, which generally appears in the downturn period of land market. If the land market is efficient, the LNLP will correct its deviation in the next period, therefore the coefficient of the error correction term $ecm^{(LP)}{}_{i,t-1}$ in model (3-7) should be negative and statistically significant. LNLP will be call-backed at a rate of $\theta*100\%$.

To sum up, if the coefficient θ is negative and significant, it indicates that LNHP and LNLP are cointegrated, and also shows that when LNLP deviates from the long-run equilibrium relationship, there is an error correction mechanism in land market. Land price will be adjusted in the next period at the rate of $\theta*100\%$. Therefore, θ reflects the information efficiency of land market.

3.2.2 Methods of studying volatility transmission

Researches on financial markets suggest that there is a close relationship between the volatility of asset prices and the market information, and the volatility can reflect the speed of obtaining the information for every market (Ross, 1989).

In order to understand the volatility relationship between housing market and land market completely, we establish a univariate GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model for the returns of housing and land for four cities separately, to study the volatility characters of housing prices and land prices. Then we establish the bivariate GARCH model to study the volatility spillover between returns of housing and land. Before the GARCH model is set up, we need to make sure the returns of housing and land are stationary data.

3.2.2.1 Univariate GARCH model

Most of existing studies show that the return of financial asset is characterized by its heteroscedasticity, and the main features are volatility clustering, persistence and asymmetry (Bollerslev, 1986; Nelson, 1991; Engle & Ng, 1993). Volatility clustering refers to that the large or small fluctuations appear in groups, volatility persistence refers to that there may be some kinds of autocorrelations in the conditional variances, and volatility asymmetry refers to that response of asset returns to bad news is faster and the volatility caused by bad news is stronger than that caused by good news. Wong *et al.* (2006) studies Hongkong real estate market, and finds that the volatility character of returns of housing and land are similar to the financial market, existing volatility clustering and persistence. This thesis attempts to study whether there are volatility clustering, persistence and asymmetry in Chinese housing and land prices firstly.

(1) The volatility clustering and persistence of housing prices and land prices

GARCH model and EGACH (Exponential Generalized Autoregressive Conditional Heteroskedasticity) model are mainly used to study the volatility clustering and volatility persistence.

1) GARCH(1,1) model

$r_{hp,t}$ and $r_{lp,t}$ are the return of housing and land at time t respectively. The calculation formulas are $r_{hp,t} = \ln(HP_t / HP_{t-1})$ and $r_{lp,t} = \ln(LP_t / LP_{t-1})$.

Taking the housing returns as an example, this thesis specifies the GARCH (1, 1) model as below.

$$r_{hp,t} = c + \sum_{i=1}^{p} a_i r_{hp,t-i} + \sum_{i=1}^{p} b_i u_{t-i} \tag{3-8}$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \varepsilon_t \tag{3-9}$$

Model (3-8) is named mean equation and model (3-9) is called variance equation. u_{t-i} is the disturbance term of mean equation, σ_t^2 is the conditional volatility of disturbance term. In order to make σ_t^2 to be positive and a stationary process, these below constraints should be satisfied.

$$\begin{cases} 0 < \alpha_0 \\ 0 < \alpha_1 \\ 0 < \beta_1 \\ 0 \le (\alpha_0 + \alpha_1 + \beta_1) \le 1 \end{cases} \tag{3-10}$$

The mean equations are used to describe the ARMA (p, q) process of return rates of houses for every city. The value of *p* and *q* are obtained by comparing the goodness of fit of the models and the information criterions such as AIC and SC.

If the estimated coefficient of α_1 is statistically significant, there is volatility clustering in housing returns, while if the estimated coefficient of β_1 is statistically significant, there is volatility persistence in housing returns. To know whether there is volatility clustering and persistence in land returns, r_{lp} should be used in (3-8), instead of r_{hp} .

2) EGARCH (1,1) model

Nelson (1991) improves the mapping relationship between σ_t^2 and u_{t-i}^2 based on GARCH model, and then proposes the EGARCH model. Comparing with GARCH model, the nonnegative constraints in (3-10) are not necessary, and the solving process is more flexible. The basic form of ARMA-EGARCH model is specified as below.

$$r_{hp,t} = c + \sum_{i=1}^{p} a_i r_{hp,t-i} + \sum_{j=1}^{q} b_j u_{t-j} \tag{3-11}$$

$$\ln(\sigma_t^2) = \alpha_0 + \alpha_1 \left| \frac{u_{t-1}}{\sigma_{t1}} \right| + \beta_1 \ln(\sigma_{t-1}^2) \tag{3-12}$$

The left side of model (3-12) is the logarithmic form of σ_t^2, therefore no matter α_1 is positive or not, σ_t^2 should be positive. The mean equation is still the ARMA (p, q) process of return rates of housing for different cities. If the coefficient α_1 is statistically significant, there is volatility clustering in housing returns. If β_1 is statistically significant, there is volatility persistence in housing returns.

Similarly, the land model is established by replacing r_{hp} with r_{lp} in model (3-11).

(2) The volatitly asymmetry of housing prices and land prices

TGARCH (Threshold Generalized Autoregressive Conditional Heteroskedasticity), PGARCH (Partial Generalized Autoregressive Conditional Heteroskedasticity) and asymmetric EGARCH model are commonly used to describe the "leverage effect" of volatility of asset prices. Comparing to TGARCH and PGARCH model, the asymmetric EGARCH model needs less constraints and has more flexible solution process. Meanwhile, asymmetric EGARCH model can distinguish the effect of “good news” and “bad news” on the volatility of prices. For the asymmetric effect term, the positive new information represents “good news”, and the negative new information represents “bad news”. Therefore, this thesis uses the asymmetric EGARCH model to study the volatility asymmetry of housing returns and land returns.

The basic form of EGARCH (1, 1) model is specified as below.

$$r_{hp,t} = c + \sum_{i=1}^{p} a_i r_{hp,t-i} + \sum_{j=1}^{q} b_j u_{t-j} \tag{3-13}$$

$$\ln(\sigma_t^2) = \alpha_0 + \alpha_1 \left| \frac{u_{t-1}}{\sigma_{t-1}} \right| + \gamma \frac{u_{t-1}}{\sigma_{t-1}} + \beta_1 \ln(\sigma_{t-1}^2) \tag{3-14}$$

$\gamma \frac{u_{t-1}}{\sigma_{t-1}}$ of the variance equation is the asymmetric effect term. If the coefficient of γ is statistically significant, the effect of new information on volatility of housing prices is asymmetrical. If $\gamma > 0$, the response of market to good news is much stronger, and otherwise the bad news bring bigger fluctuation.

3.2.2.2 Bivariate GARCH model

Because the univariate GARCH model can only capture the conditional variance of returns of single asset, and cannot measure the volatility spillover between assets of different markets, the multivariate GARCH model is usually used, which can describe the correlation between volatility of different asset returns. The existing multivariate GARCH model mainly includes VECH model and the BEKK-GARCH model proposed by Engle & Kroner (1995).

Because the VECH has too many coefficients, the BEKK-GARCH model will be used in this thesis.

The mean equations are specified as below.

$$r_{hp,t} = \alpha + \sum_{k=1}^{m} \alpha_k r_{hp,t-k} + \sum_{l=1}^{n} \beta_l r_{lp,t-l} + \varsigma_t \tag{3-15}$$

$$r_{lp,t} = \overline{\alpha}_i + \sum_{k=1}^{m} \overline{\alpha}_k r_{hp,t-k} + \sum_{l=1}^{n} \overline{\beta}_l r_{lp,t-l} + \xi_{i,t} \tag{3-16}$$

The conditional variation equations are specified as below.

$$\sigma_{hp,t}^2 = c_1 + a_1 \varepsilon_{hp,t\text{-}1}^2 + b_1 \sigma_{lp,t\text{-}1}^2, \qquad \varepsilon_{hp,t} \big| \Omega_{t\text{-}1} \sim N(0, \sigma_{hp,t}^2) \tag{3-17}$$

$$\sigma_{lp,t}^2 = c_2 + a_2 \varepsilon_{lp,t-1}^2 + b_2 \sigma_{hp,t-1}^2, \quad \varepsilon_{lp,t} \big| \Omega_{t-1} \sim N(0, \sigma_{lp,t}^2) \tag{3-18}$$

c_1 and c_2 are the intercepts, a_1 and a_2 are the ARCH terms of the conditional variation of housing returns and land returns, b_1 and b_2 are the GARCH terms of the conditional variation of housing returns and land returns, which represent the volatility clustering.

$$\begin{bmatrix} \varepsilon_{h,t} \\ \varepsilon_{l,t} \end{bmatrix} \Bigg| \Omega_{t-1} \sim N(0, H_t) \\ H_t = C^T C + A^T \varepsilon_{t-1} \varepsilon_{t-1}{}^T A + B^T H_{t-1} B \tag{3-19}$$

H_t is a 2×2 conditional covariance matrix, C is a 2×2 constant symmetric parameters matrix, and A and B are 2×2 unconstrained parameters matrix.

$$\begin{bmatrix} h_{11,t} & h_{12,t} \\ h_{21,t} & h_{22,t} \end{bmatrix} = \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}' \begin{bmatrix} \varepsilon_{hp,t-1}^2 & \varepsilon_{hp,t-1}\varepsilon_{lp,t-1} \\ \varepsilon_{hp,t-1}\varepsilon_{lp,t-1} & \varepsilon_{lp,t-1}^2 \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \\ + \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}' \begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \tag{3-20}$$

Below is the expanded form of these parameters.

$$h_{11,t} = c_{11} + (a_{11}\varepsilon_{hp,t-1} + a_{21}\varepsilon_{lp,t-1})^2 \\ + (b_{11}^2 h_{11,t-1} + 2b_{11}b_{21}h_{12,t-1} + b_{21}^2 h_{22,t-1}) \tag{3-21}$$

$$h_{12,t} = c_{12} + [a_{11}a_{12}\varepsilon_{hp,t-1}^2 + (a_{11}a_{21} + a_{11}a_{22})\varepsilon_{hp,t-1}\varepsilon_{lp,t-1} + a_{21}a_{22}\varepsilon_{lp,t-1}^2] + [b_{11}b_{12}h_{11,t-1} + (b_{11}b_{21} + b_{11}b_{22})h_{12,t-1} + b_{21}b_{22}h_{22,t-1}] \tag{3-22}$$

$$h_{22,t} = c_{22} + (a_{12}\varepsilon_{hp,t-1} + a_{22}\varepsilon_{lp,t-1})^2 + (b_{12}^2 h_{11,t-1} + 2b_{12}b_{22}h_{12,t-1} + b_{22}^2 h_{22,t-1}) \tag{3-23}$$

$h_{11,t}$ and $h_{22,t}$ are the conditional variations of housing returns and land returns, $h_{12,t}$ is the conditional covariance. With respect to the univariate GARCH model, the BEKK-GARCH model allows the conditional variation of housing and land returns affect each other, therefore it can be used to study the volatility spillover effect. The implications of these parameters are: a_{11} (a_{22}) shows the effect of information from housing market (land market) to the volatility of housing returns (land returns), which is the ARCH term; b_{11} (b_{22}) indicates the volatility persistence of housing returns (land returns), which is the GARCH term; a_{12} (a_{21})measures the spillover effect of housing market (land market) to land market (housing market), that is the influence of the historical volatilities of housing returns (land returns) on the current volatility of land returns (housing returns). Therefore, the coefficients of a_{12} and a_{21} can tell us that whether there is volatility spillover and volatility information transmission between Chinese housing market and land market.

Chapter 4: Information Transmission between Chinese Housing Market and Land Martket

This chapter studies the mean information transmission and volatility information transmission between Chinese housing and land markets by using the methods such as stationary test, Granger causality relationship test, cointegration test, impulse response function, vector error correction model, univaritate and bivariate GARCH model and so on. Both the information transmission direction and transmission speed are examined.

4.1 Accounting relationship between housing prices and land prices

Liu &Liu (2003) analyzes the mathematic relationship between housing prices and land prices from the perspective of plot ratio. Deng (2010) also expounds it. They assumes that P_h is the housing price, P_l is the land price, F is the plot ratio, C is the construction cost, γ_1 represents all the taxes, and γ_2 is the average profit ratio. The units of housing price, land price and construction cost all are RMB/m^2.

Then the floor price is $P_{hl} = P_l / F$, and we have:

$$\begin{aligned} P_h &= P_{hl} + C + (P_{hl} + C) \times (\gamma_1 + \gamma_2) \\ &= P_{hl} \times (1 + \gamma_1 + \gamma_2) + C \times (1 + \gamma_1 + \gamma_2) \\ &= P_l \times \frac{(1 + \gamma_1 + \gamma_2)}{F} + C \times (1 + \gamma_1 + \gamma_2) \\ &= A + B \times P_l \end{aligned}$$

$$A = C \times (1 + \gamma_1 + \gamma_2) \text{ , } B = (1 + \gamma_1 + \gamma_2) / F$$

From the above, we know that housing price is positive linearly correlated with land price. The coefficient B and A are affected by the plot ratio, construction cost, taxes and so on. Their basic relationship can be described by Figure 4-1 and 4-2.

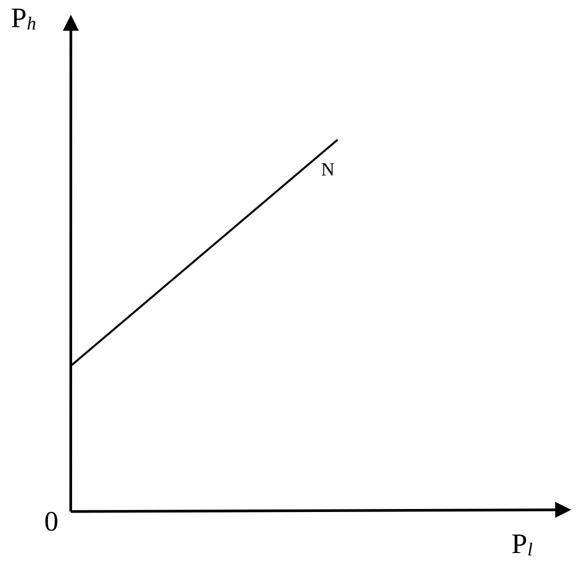


Figure 4- 1 Relationship between housing price and land price

Source: Deng, C. (2010), *Influencing Factors and Volatility Characters of Chinese Housing Prices*, Ph.D. Thesis, School of Economics and Management, University of Electronic Science and Technology of China.

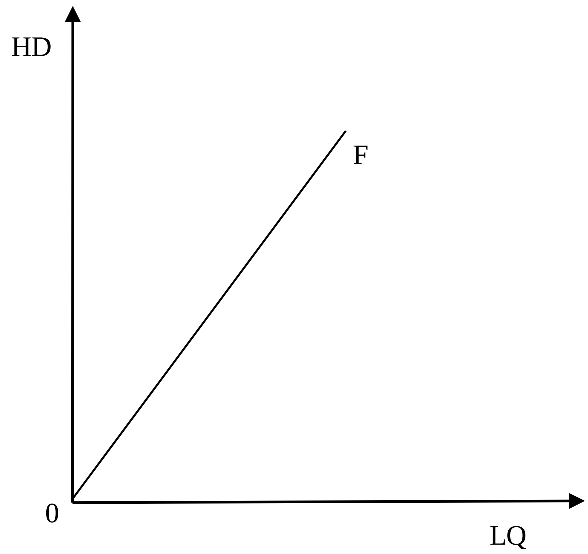


Figure 4- 2 Plot ratio

Source: Deng, C. (2010), *Influencing Factors and Volatility Characters of Chinese Housing Prices*, Ph.D. Thesis, School of Economics and Management, University of Electronic Science and Technology of China.

The four quadrant model (Di Pasquale and Wheaton, 1992; Fisher, 1992; Fisher, Hudson-Wilson and Wurtzebach, 1993) can well describe the transition of prices, demands and supplies between land market and housing markets, seen Figure 4-3.

Figure 4-3 shows the four quadrant model representing the relationship between house price and land price. We should analyze this figure from quadrant one. In the first quadrant, horizontal axis shows the quantity of housing supply, and the longitudinal axis exhibits the housing price. We can find that the demand curve of housing is downward, indicating that with the rise of housing price, the demand quantity will decrease. The housing supply curve is upward, showing that the supply quantity will increase as the housing price rises up. In the second quadrant, the relationship between land supply quantity and housing supply quantity is described. It can be seen that the two are positively correlated, and that land supply increases will lead to an increase in housing supply. The third quadrant shows the relationship between land supply quantity and land price, which is similar to the relationship between housing supply and housing price. The slope of demand curve is negative and that of supply curve is positive. From the relationship among the first three quadrants, we can find that the housing price has a positive relationship with land price.

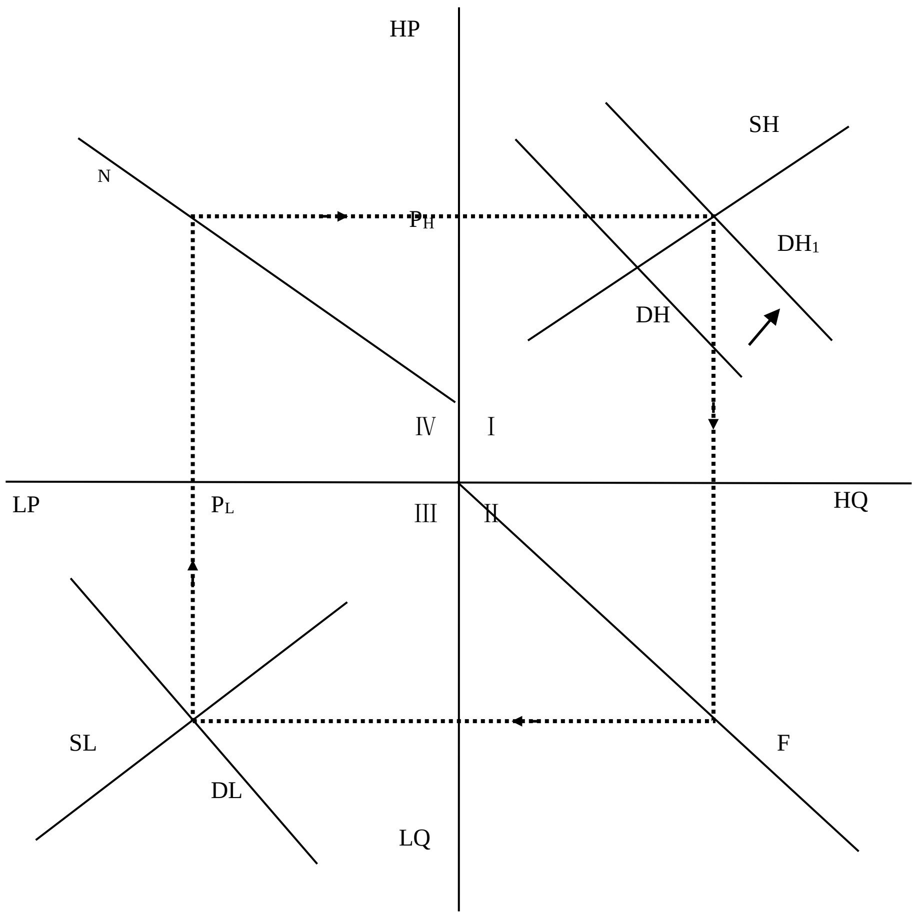


Figure 4- 3 Four quadrant model

Source: Deng, C. (2010), *Influencing Factors and Volatility Characters of Chinese Housing Prices*, Ph.D. Thesis, School of Economics and Management, University of Electronic Science and Technology of China.

We can also find that, if the demand of housing increases, the demand curve will move from DH to DH_1, and then the rise of housing demand will increase the demand of land.

Finally, the new equilibrium of housing price and land price will be reached.

4.2 Empirical study on the information transmission efficiency

4.2.1 Empirical study on the mean information transmission

4.2.1.1 Stationary test

The logarithmic forms of monthly average housing prices (LNHP) and average land prices (LNLP) from the March 2002 to June 2014 are used in this thesis. Firstly, the IPS method is used to conduct the unit root test, to clarify whether LNHP and LNLP are stationary or not. The results are shown in Table 4-1.

Table 4- 1 Stationary tests for housing prices and land prices

Variable	Statistic	P value	I(d)	
LNHP	-9.2055	0^{***}	I(0)	Stationary
LNLP	-1.79374	0.0364^{**}	I(0)	Stationary

Note: ***, **, *denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

It can be seen from the above table that, the s of LNHP and LNLP both are smaller than the critical value, so the null hypothesis should be rejected, and the two variables are stationary. They can be used to estimate the Granger causality relationship model and conduct the impulse response function directly.

4.2.1.2 Estimate the PVAR model

This thesis references the methods of Love & Zicchino (2006) and Lian & Chung (2008) to estimate the model (3-4) and (3-5) and obtain the results of the impulse response function.

(1) Determine the lag order *m* of PVAR model

This thesis uses the information criterion such as AIC, BIC and HQIC to determine the lag order, with which the value of corresponding statistic is the smallest. Considering the bigger the lag order, the more information will be lost, this thesis confines the range to be [1, 10]. The results are as shown in Table 4-2.

It can be seen from the table that, according to AIC, the best lag order is seven, but it will be three if according to BIC and HQIC. To keep the degree of freedom and minimize the information loss, we choose the PVAR model lagging three orders. A complicated model will be chosen according to AIC, and a refined model is tended to be chosen according to the BIC and HQIC.

Table 4- 2 Values of information criterions with different lag order

Lag order	AIC	BIC	HQIC
1	2.57867	2.67458	2.61619
2	2.33389	2.46251	2.38423
3	2.19552	2.35723*	2.25883*
4	2.21342	2.40861	2.28986
5	2.18848	2.41753	2.27821
6	2.16663	2.42995	2.26982
7	2.15906*	2.45707	2.27588
8	2.16953	2.50264	2.30015
9	2.1665	2.53513	2.3111
10	2.16043	2.56503	2.3192

Note: ***, **,*denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

(2) Estimate the PVAR model

The regression results of model (3-4) and (3-5) are exhibited in Table 4-3. The results in Table 4-3 show that, in the housing price model, LNHP (-1), LNHP (-2) and LNLP (-1) all have significant effects on current housing prices, while the coefficients of other variables are not statistically significant. In the land price model, LNLP(-1)、LNLP(-2) and LNLP(-3) can significant explain the current land prices at the 1% level. It indicates that the land price is likely to affect housing prices, but housing prices may be not the cause of land prices. To obtain the accurate results, we will jointly test the null hypothesis $\beta_1 = \beta_2 = \cdots \beta_m = 0$ and $\overline{\alpha}_1 = \overline{\alpha}_2 = \cdots = \overline{\alpha}_m = 0$, which are the null hypothesis of Granger causality test. If the former hypothesis holds, it shows that land prices cannot discover housing prices, and the mean value information of land prices is not transmitted to housing market. While if the latter hypothesis holds, it indicates that housing prices cannot find land prices, and the information of housing market is not transmitted to land market. Test results are shown in Table 4-4.

Table 4- 3 Estimation and test results of PVAR model

Housing price model (3-4)		Land price model (3-5)	
Dependent variable	Coefficient	Dependent variables	Coefficient
LNHP(-1)	0.168**	LNHP(-1)	0.005
T value	-2.963	T value	-0.815
LNLP(-1)	0.612*	LNLP(-1)	0.367***
T value	-1.776	T value	-6.637
LNHP (-2)	0.097*	LNHP (-2)	0.006
T value	-1.81	T value	-0.984
LNLP (-2)	0.393	LNLP (-2)	0.244***
T value	-1.175	T value	-5.096
LNHP (-3)	0.075	LNHP (-3)	0.006
T value	-1.556	T value	-0.983
LNLP(-3)	0.214	LNLP(-3)	0.325***
T value	-0.723	T value	-7.647

Note: ***, **,*denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

Table 4- 4 Granger causality test for housing and land prices

Null hypothesis	Statistic	P value
LNLP is not the Granger cause of LNHP	24.261	0***
LNHP is not the Granger cause of LNLP	2.3552	0.502

Note: ***, **,*denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

According to the results of Table 4-4, we can reject the null hypothesis that “LNLP is not the Granger cause of LNHP” at the 1% level, which means that the change of land prices will lead to the change of housing prices in the short run, and the price information is transmitted from land market to housing market.

But on the other hand, we cannot reject the null hypothesis that " LNHP is not the Granger cause of LNLP ", indicating that the change of housing prices cannot lead to the significant change of land prices, and the price information of housing market is not transmitted to land markets, obtained by the land demanders and suppliers and reflected in the land prices.

4.2.1.3 Results of impulse response function analysis

In order to further clarify the signs and persistent periods of the influences of housing prices and land prices on each other, this thesis will conduct an impulse response function analysis on the PVAR model consisting of housing prices and land prices. The results are presented in Figure 4-4. In these figures, the solid lines in the middle show the responses to the impulse in every period, and the two dotted lines show the confidence interval at the 95% level obtained by the Monte Carlo simulation method. The observation window contains 6 periods.

Figure (a) reflects the responses of housing price to the unit shock of itself. As the figure shows, the unit shock of housing price at period 0 will lead to an increase of the future housing prices, but the effect experiences a rapid attenuation from period 1 and levels off.

Figure (b) presents the responses of housing price to the unit shock of land price. The results show that, when giving a unit shock to the land price at period 0, this shock will be transmitted to the housing market at period 1 and have a positive effect on housing prices. It shows that the effect of information of land market on housing market is lagged, and will be absorbed by the market during 3 periods, and then the housing prices become stable.

Figure (c) shows the responses of land price to the unit shock of housing price. It can be seen that the responses are positive but very small, and the maximum response is 0.0349, confirming the previous conclusions that there is no statistically significant influence of housing prices on land prices.

Figure (d) shows the response of land price to the unit shock of itself. We can find that the rise of current land prices will increase the future land prices, and the maximum response is 0.1553, which is smaller than the effect of the shock of housing price on itself (the maximum response is 1.1876, which can be seen in (a)). The effect of the unit shock on land prices will start to level off from the fourth period.

We can draw the following conclusions from the four figures.

Firstly, the changes of current housing prices or land prices not only affect their own future prices, and their information will be transmitted to the other markets, leading to the rise of land prices or housing prices. The effect of land prices on housing prices is much bigger and more significant.

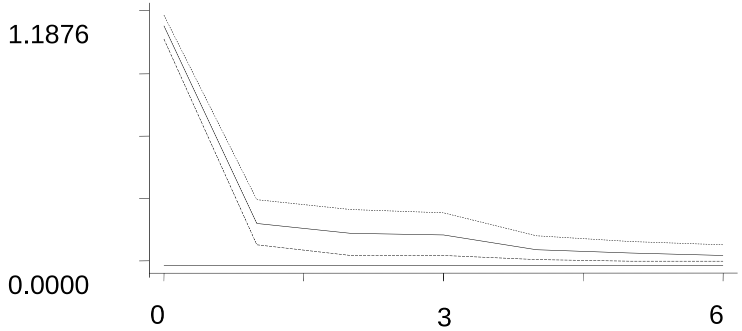
Secondly, the speed of information transmission is significant faster in housing market, in which the new information will be totally reflected in housing prices during 3 periods. While in land market, it needs 4 periods for new information to be totally reflected in land prices.

4.2.1.4 Robustness check

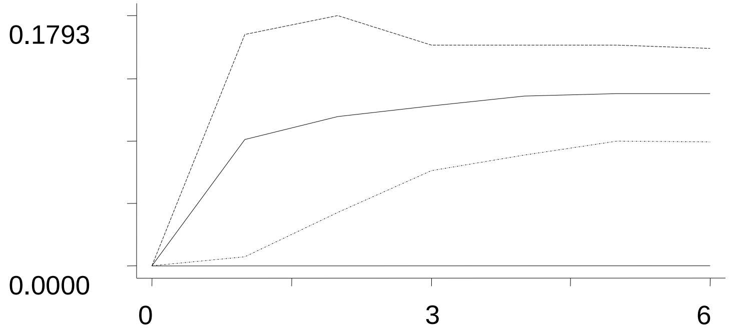
As stated earlier, the quarterly data is much more reliable than the monthly data, therefore this thesis will use the quarterly average housing prices and land prices to conduct the robustness check, to test whether the results obtained from the monthly data still hold or not. Because of data limitation, this thesis gets 58 quarterly prices from the first quarter of 2000 to the second quarter of 2014.

(1) Stationary test

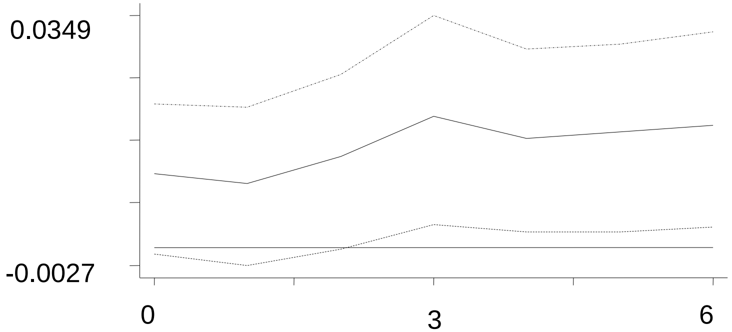
Table 4-5 shows stationary test for the level and first order difference of quarterly average housing prices and average land prices. The results indicate that the IPS statistic values of LNHP and LNLP both are larger than the critical value, and the null hypothesis that “it is not stationary” cannot be rejected. However, the statistic values of their first order differences △LNHP and △LNLP both are lower than the critical value, showing that they are stationary variables. Therefore, we can conclude that the quarterly LNHP and LNLP both are integrated of order1, namely I (1). As the two variables are integrated of the same order, they may have cointegration relationship, which means the equilibrium relationship in the long run. To confirm this possibility, we need to conduct a cointegration relationship test.



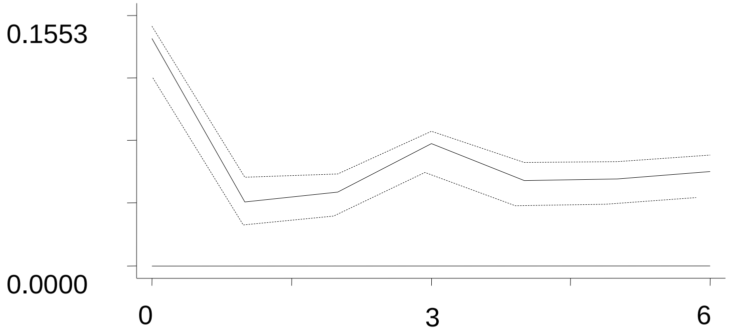
(a) Responses of LNHP to LNHP shock



(b) Responses of LNHP to LNLP shock



(c) Responses of LNLP to LNHP shock



(d) Responses of LNLP to LNLP shock

Figure 4- 4 Results of impulse response analysis

Source: estimated by the author.

Furthermore, we can find that the quarterly data is I (1) and the monthly data is I (0), exhibiting different features. This may be because there is no significant difference in the samples of quarterly data, the housing prices and land prices have obvious trends that may cause them to be non-stationary. On the contrary, the significant differences in the samples of monthly data may weaken then time trend, and make them stationary.

Table 4- 5 Stationary tests for the quarterly housing prices and land prices

Variable	Statistic	P value	I(d)	
LNHP	1.27269	0.8984	not stationary	I(1)
△LNHP	-19.9075***	0	stationary	
LNLP	1.94016	0.9738	not stationary	I(1)
△LNLP	-22.0332***	0	stationary	

Note: ***, **, *denote that the statistic is statistically different from zero at the significant level of 1%, 5% and 10%. △LNHP and △LNLP are the first order differences of LNHP and LNLP.
Source: estimated by the author.

(2) Cointegration test

Table 4-6 contains the cointegration test results for the quarterly LNHP and LNLP with the Johansen Fisher test. It can be seen from the results that, the statistic for the null hypothesis“ None” and “ At most 1” both are significant at the 1% level, showing that there is one cointegration relationship between quarterly housing prices and land prices. It also means that the relationship between the two prices is stable in the long term, and if one of them diverges from the long-term equilibrium, the market will correct the error in the next period. Therefore, this thesis will use the error correction model to study the mean value transmission between housing prices and land prices, which is also called price discovery.

Table 4- 6 Cointegration test for the quarterly housing prices and land prices

Null hypothesis	Statistic	
The number of cointegration relationships	(from trace test)	Prob.
None	106***	0
At most 1	271***	0

Note: ***, **, *denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

(3) Results of vector error correction model

Firstly, we run the cointegration regressions by regressing LNHP on LNLP and regressing LNLP on LNHP. The error terms of the two regression are the error correction terms (ECTs) of model (3-6) and (3-7), named ecm^{HP} and ecm^{LP}, respectively. Secondly, we need to check whether the two ECTs are stationary or not, because only the stationary variable can be added into the models directly. The test results are shown in Table 4-7, indicating that the two variables are stationary.

Table 4- 7 Stationary tests for the error correction terms

Variable	Statistic	P value	I(d)	
ecm^{HP}	39.1917***	0.00	I(0)	Stationary
ecm^{LP}	14.3406*	0.07	I(0)	Stationary

Note: ***, **,*denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

After the stationary test, we need to determine the lag orders m and n for model (3-6) and the lag orders of p and q for model (3-7). Based on the AIC and SC, the optimal lag structure for model (3-6) contains one lagged LNHP and three lagged LNLP, and the optimal lag structure for model (3-7) contains one lagged LNHP and four lagged LNLP. The regression results are presented in Table 4-8.

From Table 4-8, we can find that, in the housing price model, the lagged LNHP and lagged LNLP both can explain the current housing prices significantly. The Wald statistic for the null hypothesis "the coefficients of variables △LNLP (-1), △LNLP (-2) and △LNLP (-3) all are zero" is 3.582, which reject the null hypothesis at the 5% significance level. On the other hand, the coefficient of △LNHP (-1) in the land price model is not significantly different from zero. This indicates that the land prices in the past contribute significantly to the current housing price changes, while the past housing prices do not affect the current land prices. From the perspective of information transmission, the mean information of land prices is efficiently transmitted to housing market and reflected in the housing prices, while on the contrary, the mean information of housing prices is not transmitted to land market, which is consistent with the results obtained with the monthly data.

Moreover, if housing prices and land prices temporally deviate from their long-run equilibrium relationship, the market will correct the error in the next period, while the coefficients of the error correction terms of model (3-6) and (3-7) can measure the speed of market adjustments toward equilibrium and also indicate the information transmission in (not between) housing market and land market. The results show that, the coefficients of ECMs of housing price model and land price model are -0.354 and -0.102, both of which are different from zero at the 5% significance level. It indicates that the deviation of housing prices from the equilibrium will be corrected 35.4% in the next period, and that of land prices will be corrected 10.2%. It shows that housing prices react more quickly to market disparity than do land prices, and the housing market is more informationally efficient than the land market, which is also consistent with the results obtained with the monthly data.

Table 4- 8 Estimation results of VECM

Model	Housing price model		Land price model	
Variable	Coefficient	T value	Coefficient	T value
c	0.043***	6.592	0.037***	4.038
△LNHP (-1)	-0.220***	-2.700	-0.032	-0.443
△LNLP (-1)	-0.030	-0.879	-0.242***	-3.170
△LNLP (-2)	-0.080**	-2.181	-0.247***	-3.556
△LNLP (-3)	-0.104***	-3.223	-0.276***	-4.235
△LNLP (-4)			0.564***	9.098
ecm^{HP}(-1)	-0.354***	-4.668		
ecm^{LP}(-1)			-0.102***	-2.266
Wald test	3.582**		0.196	

Note: ***, **, *denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level. In the housing price model, null hypothesis of Wald test is that the coefficients of variables △LNLP (-1), △LNLP (-2) and △LNLP (-3) all are zero, while in the land price model, the null hypothesis is that the coefficients of △LNHP (-1) is zero.
Source: estimated by the author.

4.2.2 Empirical study on the volatility information transmission

Because only the time-series data can be used to study the volatility spillover, we need to analyze the volatility spillover between housing market and land market for Beijing, Shanghai, Tianjin and Chongqing, respectively.

4.2.2.1 Volatility features of housing prices and land prices

(1) Volatility clustering and volatility persistence

To avoid the situation that the coefficients of the GARCH term and ARCH term are less than zero which is against the nonnegative constraints of GARCH model, this thesis use

EGARCH model study the volatility clustering and volatility persistence of housing returns and land returns for four cities respectively. The EGARCH model relaxes the nonnegative constraints of GARCH model, therefore has a more flexible solving process. Concrete models are specified as (3-11) and (3-12).

The estimation results of model (3-12) are presented in Table 4-9. If the estimated coefficient of α_1 is significant different from zero, the housing returns (land returns) has volatility clustering, and while if β_1 is significant, it has volatility persistence.

Table 4- 9 Estimation results of the volatility equation of EGARCH model

Model		**Housing price model**		**Land price model**	
City	**Parameter**	**Coefficient**	**T value**	**Coefficient**	**T value**
BJ	α_0	-2.397***	-2.557	-0.322**	-2.239
	α_1	0.528***	2.787	0.593***	3.293
	β_1	0.433*	1.667	0.464*	1.816
TJ	α_0	-2.273***	-4.052	0.929***	2.612
	α_1	0.863***	4.919	0.552***	3.375
	β_1	0.567***	3.989	0.045	0.227
SH	α_0	-1.651***	-41.927	0.558	1.613
	α_1	1.623***	13.206	0.425***	2.540
	β_1	0.833***	44.211	-0.247	-0.695
CQ	α_0	-3.688***	-4.025	-0.860***	-3.936
	α_1	0.826***	3.459	0.503***	2.162
	β_1	0.232	0.960	-0.114	-0.386

Note: ***, **,*denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

From the results of Table 4-9, it can be found that in the housing price model, the coefficients of α_1 for Beijing, Shanghai, Tianjin and Chongqing are different from zero at the 1% significance level, indicating that there is obvious volatility clustering in housing returns, namely ARCH effect. The coefficients of β_1 are significant for Beijing, Tianjin and Shanghai at the 10% level, and only not significant for Chongqing, showing that in most of cites, the housing returns have volatility persistence, namely GARCH effect.

Both the two effects show that the volatility of housing returns is time varying, and contain more information. This conclusion is consistent with the results of some foreign researches. For example, for more than half of all states in USA, housing price growth rate has ARCH effect (Miles, 2008), the volatility of housing prices of San Francisco and Connecticut is time-varying (Dolde & Tirtiroglue, 1997), and house price growth rate of 17% of America cities has time-varying variance (Miller & Peng, 2006).

In the land price model, the coefficients of α_1 for all the four cities are significant at the 1% level, suggesting that land price growth rate has volatility clustering, and while the coefficient of β_1 is significant only for Beijing, show that the volatility persistence of land returns is not very obvious.

(2) Volatility asymmetry

In the capital markets, many studies find that, the response of stock prices to new information is not symmetric, and the negative information is more likely to increase volatility than the positive information. Engle and Ng (1993) draws the asymmetric curve of good news and bad news, called "leverage effect", allowing the response of volatility to the market decline more rapidly than that to the market rise.

The thesis uses the asymmetric EGARCH model to study the volatility asymmetry of housing and land prices, and the models are specified as (3-13) and (3-14). In model (3-14), if γ is significant different from zero, it indicates that the impact of good and bad news to the housing prices volatility is asymmetric. To be specific, if $\gamma > 0$, it shows that the market reaction is stronger to good news, while on the contrary, the bad news takes larger prices volatility.

It can be seen from Table 4-10 that, in the housing price model, the coefficients of α_1 and β_1 are still significant for four cities, showing that the volatility clustering and persistence of housing returns still exist. For the coefficient of γ , it is statistically different from zero for four cities at the 1% level, indicating that the volatility of housing returns is not symmetric. As the coefficients of γ are positive, it suggests that the market has a stronger response to good news, which is not consistent with many results of financial market, but is conform with some findings in real estate market.

In the land price model, the coefficients of α_1 are significant for all the cities at the 1% level, and β_1 is significant for Beijing and Tianjin, and not significant for Shanghai and

Chongqing, which means that the land returns have significant volatility clustering and the volatility persistence only exists in some cities. The coefficients of γ for Beijing and Tianjin are positive significant and negative for Shanghai and Chongqing, showing that for the first two cites, land returns have a significant stronger response to good news, while for the latter two cities, land returns react much more strongly to bad news, and the difference is not significant.

Table 4- 10 Estimation results of the volatility equation of asymmetric EGARCH model

Model		**Housing price model**		**Land price model**	
City	**Parameter**	**Coefficient**	**T value**	**City**	**Parameter**
BJ	α_0	-1.651***	-1.651	-0.264*	-1.767
	α_1	0.255***	0.255	0.462**	2.419
	γ	0.584***	0.584	0.601***	3.920
	β_1	0.007***	0.007	0.314**	2.275
TJ	α_0	-2.261***	-49.19	1.265***	60.53
	α_1	0.854***	49.92	-0.982***	-53.93
	γ	0.569***	47.23	0.712***	206.7
	β_1	0.059***	24.32	0.040***	207.7
SH	α_0	-1.392***	-32.80	0.559*	1.627
	α_1	0.167***	49.87	0.423***	2.530
	γ	0.584***	128.9	-0.246	-0.693
	β_1	0.036***	32.30	-0.008	-0.072
CQ	α_0	-1.861***	0.045	-0.851***	-3.935
	α_1	0.220***	0.004	0.474***	2.014
	γ	0.565***	0.004	-0.140	-0.446
	β_1	0.010***	0.001	-0.118	-0.953

Note: ***, **,*denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

4.2.2.2 Volatility transmission between housing market and land market

This thesis uses the BEKK-GARCH model to study whether there is volatility spillover between housing market and land market. The structure of mean equation is VAR, the lag orders of which are decided by the information criterions AIC and SIC. The specified forms are shown as model (3-15) - model (3-23).

The implications of these parameters are: a_{11} (a_{22}) shows the effect of information from housing market (land market) to the volatility of housing returns (land returns), which is the ARCH term; b_{11} (b_{22}) indicates the volatility persistence of housing returns (land returns), which is the GARCH term; a_{12} (a_{21})measures the spillover effect from housing market (land market) to land market (housing market), that is the influence of the historic volatility of housing returns(land returns) on the current volatility of land returns (housing returns). Therefore, the coefficients of a_{12} and a_{21} can tell us that whether there is volatility spillover and variation information transmission between Chinese housing market and land market.

From Table 4-11, it can be found that, the coefficients of a_{11} and a_{22} are significant positive at the 5% level. It indicates that after considering the relationship between housing market and land market, the housing returns and land returns still have significant volatility clustering. Meanwhile, it can also be found that b_{11} for three of four cities are significant, showing that the volatility persistence still exists in housing returns. However, b_{22} is only significant for Beijing, showing that the land returns do not have a significant GARCH effect. These conclusions are consistent with those results got from the univariate GARCH model.

After investigating the volatility clustering and volatility persistence of housing returns and land returns, we will examine the volatility spillover between the two markets, which is measured by the coefficients of a_{12} and a_{21}. Firstly, from the perspective of absolute value of coefficients, a_{12} is larger than a_{21} for four cities, showing that volatility spillover from housing market to land market is larger than that from land market to housing market. Secondly, regarding to the signs of these coefficients, we can find that some of them are positive and some are negative, which indicates that the housing returns and land returns cannot stabilize each other in all cities, and in some of cities, they will increase each other's fluctuation. Finally, from the perspective of statistical significance of coefficients, only a_{21} for Shanghai and Chongqing is significant at the 5% level and the left are all not significant. It indicates that, in statistical sense, only the land market has volatility spillover to housing market, and there is no volatility spillover from housing market to land market. Furthermore, the volatility spillover from land market to housing market is by means of ARCH effect, which means that a lagged volatility of land returns will affect the current volatility of housing returns, while the reverse does not hold. It also further confirms that land market is the information center of Chinese real estate market, the land prices not only can discover housing prices, but also have a volatility spillover effect on housing prices.

In addition, we find that the coefficients of b_{12} and b_{21} are not significant for four cities. It shows that the volatility spillover between housing market and land market is not by means of GARCH term.

Table 4- 11 Estimation results of the volatility equation of BEKK-GARCH model

City	**BJ**		**TJ**	
Parameter	**Coefficient**	**T value**	**Coefficient**	**T value**
c_{11}	0.108***	3.683	0.082***	2.037
c_{12}	-0.287	-0.588	0.964	0.831
c_{22}	0.514	0.778	1.082	0.832
a_{11}	0.450***	3.406	0.651***	4.816
a_{12}	**-1.048**	**-1.560**	**0.196**	**0.162**
a_{21}	**0.000**	**0.005**	**-0.001**	**-0.092**
a_{22}	0.568***	4.141	0.613***	5.165
b_{11}	0.668***	3.543	0.567***	2.659
b_{12}	2.218	1.399	-5.059***	-1.856
b_{21}	-0.003	-0.084	0.023	1.392
b_{22}	0.556***	2.069	-0.255	-0.943
City	**SH**		**CQ**	
Parameter	**Coefficient**	**T value**	**Coefficient**	**T value**
c_{11}	0.026***	2.620	0.105***	13.009
c_{12}	0.265	0.566	0.025	0.173
c_{22}	1.196***	4.251	0.624 ***	3.574
a_{11}	1.258***	10.491	0.302**	2.253
a_{12}	**0.715**	**0.981**	**1.123**	**1.353**
a_{21}	**0.013****	**1.999**	**-0.045****	**-2.166**
a_{22}	0.425***	4.156	0.358**	2.190
b_{11}	0.566***	12.318	-0.057	-0.133
b_{12}	-0.270	-0.510	-0.696	-0.301
b_{21}	-0.006	-0.481	0.005	0.076
b_{22}	0.347	0.834	0.359	0.663

Note: ***, **, *denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

Chpater 5: Effect of Adminstrative Policy on the Information Transmission Efficiency of Chinese Real Estate Market

Since 2003, Chinese central government has introduced several rounds of macro-control policies, which contains the tax, credit, financial and other non-mandatory tools, and also includes the compulsory tools such as government planning, administrative order and so on. Among them, because of its authority, coerciveness, directness and verticality, the administrative command becomes the important supplementary means to regulate the property market. In the past ten years, Chinese central government produced a series of executive orders to control the real estate markets, which covers the way and structure of land supply, measures concerning protection of arable land, land inventory, the qualifications of housing purchase and so on. However, there are two types of administrative command attracting widespread concerns from industry and academia, due to their persistence, universality and the fundamental impact on the market supply and demand structure. They are the IAL (Invitations to tender, Auctions, or Listings) land use right granting system and HPR (Housing Purchasing Restriction) policy. IAL system was introduced in 2003 and fully implemented in 2004, while the HPR policy was introduced in 2010. They act on land market and housing market respectively, and the former lowers the entry threshold of land market, while the latter increases the entry threshold of housing market. The two policies change the formation mechanism of housing prices and land prices through its long-term and fundamentally effect on the demand structure of houses and land, and also may affect the information transmission mechanism between the two markets. This chapter attempts to study whether the two administrative policies change the information transmission efficiency of Chinese real estate market or not.

5.1 Land granting system and house purchase restriction

5.1.1 Reform history of Chinese land granting system

Land granting system is based on the land property rights system. There are two kinds of land property rights. One is freehold, and the other one is leasehold. Freehold refers to that the proprietor of the purchased house also has the permanent ownership and use right of the attached land. Lease refers to that the proprietor of the purchased house does not have the ownership, and only have the use right of the attached land. The use right is divided into two kinds: terminable one and indefinite one.

Due to the different history and national conditions, different countries have different provisions on land property rights. Most countries in the world implement the private ownership system. Private persons own most of the land, and the land can be freely sold or leased. Therefore, the land resource is mainly allocated by the market. For example, in America, 58% of its land is privately held, and only 42% of the land is held by the government, among which 32% is held by federal government and the left 10% is held by state and local government. The ownership right of land includes the mining rights of underground resources, the ground right and the space right. The owner can sell or lease these three kinds of rights separately. The government cannot arbitrary expropriate the land and the attached houses. The fair compensation, due process of law and the principle of public use are needed. The land expropriation for free will not be approved generally unless for the purpose of protecting the public safe and health and so on, which is strictly restricted by law. There are many countries have the similar land property system, such as France, Belgium, Spain, Germany, Austria, Switzerland and so on.

While for Britain and most of the commonwealth countries, such as Canada, India, and so on, their land ownership and use right are separated, which is similar to the system of China. According to the law, the land is owned by the King, and the individual, enterprises and other organizations only can acquire the land use rights. However, the King does not control the land truly, and the proprietor who has the indefinite use right owns all rights of the land except the ownership. Therefore, the land is privately held actually in these countries.

The public ownership system is implemented in China, which is different from many countries. In China, the land ownership belongs to state or the collectives, and the enterprises and individuals can only obtain the land use right. The residential land use right is granted for 70 years, the industrial land use right is granted for 50 years and the commercial one is granted for 40 years. Different from Britain, Chinese governments have strong control on the land market, and the income of land is mostly obtained by them.

Land granting refers to the granting of land use right. The land granting system of China experienced three phases: administrative transfer, negotiation transfer, and IAL system. Next, this thesis will expound the three stages respectively.

(1) Phase of administrative granting

For a long time, we denied the objective existence of land value, and used the land freely and uniformly. Therefore, there was no land market in China before 1988. At this stage, enterprises, other organizations and individuals could only obtain the land use right through the government granting, and use the land freely and indefinitely. As a result, the land was nontransferable. The government completely controlled the quantity, time and speed of land supply, and the land granting was complete a non-market behavior.

(2) Phase of negotiation transfer

After the reform and opening up, with the establishment of the market economy system, there was a new understanding on the value of the land resources and market allocation mechanism. In 1988, the Constitution Amendment Act to Article 10 came into play, allowed land use right to be transferred in accordance with law, stating the recovery of Chinese real estate market and the beginning of the reform of marketization of land market. On June 28, 1999, the Bureau of Land Management of China issued “Methods to Determine the Lowest Prices of Stated-Owned Land Use Right for Negotiation Transfer”, which required to overall consider these basic factors such as requisition fee, land development fee, bank interest and the pure profit of land when determining the lowest price of negotiation transfer. It also required the land management departments of province governments, governments of autonomous regions and municipalities and other relevant departments to decide the lowest prices together, and issue the notices to the municipal and prefectural land management departments after the approval of the people's government.

The lowest price of negotiation transfer should be decided according to the basic land prices of different land use such as commercial, residential and industrial land use and so on, and the land condition. The specific proportion should be decided by provinces, autonomous regions and municipalities. The lowest price of the land used by the projects or industries supported or encouraged by nationality could be decided according to the industries classification or projects classification.

At this stage, enterprises, other organizations and individuals could meet their land demand through two approaches. First was to negotiate with the government in the primary market, and obtain the land use right through negotiation transfer. The second was to negotiate with the enterprises, other organizations and individuals who had the land use rights in the secondary market, and buy the land use right from them. Under the background of negotiation transfer, the governments at all levels had greater autonomy, and land use right granting system is not fully market-oriented. The state-owned enterprises were more likely to succeed in negotiations with the government, and obtained the land use right, and while other enterprises which were lack of government relations were difficult to obtain land use rights. Because of the late implementation of Land Reserve System, there are plenty of land use rights in the secondary market before 2001. The land demanders can meet their needs in the secondary market. Therefore, under this kind of supply and demand structure, the average trading price of land reflected the real demand of land largely.

(3) Phase of IAL system

Under the negotiation transfer system, the buyer and seller always intentionally reported a lower transaction land prices, which led to massive tax losses of government. To regulate the granting behavior of state owned land use right, optimize the allocation of land resources, and establish an open, fair and just land use system, on May 9, 2002, Chinese Ministry of Land and Resources issued “Stipulations on the Granting of Stated-owned Land Use Right with Invitation to Tender, Auction and Listing”, which required all kinds of profit-oriented land such as commercial, tourism, entertainment and commodity residential land and so on, should be granted through invitation to tender, auction and listing. This rule was started on July 1, 2002, but fully implemented on August 31, 2004.

Invitations to tender refer to that the local governments announce the invitations to bid on give land publicly, and the land user is decided by the bid results.

Auctions refer to that the local governments issue the auction announcement, and the bidders quote at a designated time and place. The land user is decided by the bid prices.

Listings refer to that the local governments issue the listing announcement, and the bidders quote their prices in the specified period. The land user is decided by the quotation prices.

5.1.2 Housing purchasing restriction (HPR)

At the beginning of 2010, China's macro economy gradually got warm, the real estate market rebounded firstly, presented a trend of rapid rise, and the housing prices of many cities rose to record highs.

For this, Chinese state council started a new round of macro-control, marked by the issuing of “A Notice on Resolutely Curbing the Quickly Rise of Housing Prices of Some Cities” on April 17, 2010. On April 30, 2010, Beijing government introduced the housing purchase restriction firstly in the national wide. The specific contents are: “the residents who have one house, and the non-residents who hold valid temporary residence permit in Beijing, have no house, and have paid the social insurance and personal income tax in Beijing for five years, can buy at most one house more(including the newly-built and second hand commercial houses); the residents who have two or more houses, and the non-residents who own one houses or cannot offer the valid temporary residence permit and prove that paying the social insurance and personal income tax in Beijing for five years, cannot buy houses anymore."

On September 20, 2010, the relevant ministries and commissions issued the notice, launched five measures to further promote the real estate regulation, which required the local government to work out the detailed rules for the implementation of measures. The cities already had the implementation details should adjust and complete the rules according to the five measures. The central government strictly implemented the accountability system to the local government, to guarantee the implementation of the policies.

Then, the implementation details of other cities were introduced one and after another. On September 29, 2010, 16 cities including Shanghai and Shenzhen had introduced the housing purchase restriction policy, and before February, 2011, HPR was implemented in 36 cities. In August, 2011, the Ministry of Housing and Urban-rural Development announced the standard of housing purchase restriction for the second and third tiers cities. Until then, HPR was promoted throughout the country.

Shanghai introduced the HPR on October 9, 2010, required that "the residents who have one house, and the non-residents who can prove that they have paid the social insurance and personal income tax in Shanghai for one year, can buy at most one house more(including the newly-built and second hand commercial houses); the residents who have two or more than two house, and the non-residents who own one house or cannot offer the prove stated above, cannot buy houses anymore."

Tianjin introduced HPR on October 13, 2010, and the specific contents were: "the residents and non-residents only can buy one house within the internal six district of Tianjin".

On January 28, 2011, Chongqing announced to implement HPR, and its specific contents were: "the non-residents only can but one house and used for self-occupation in Chongqing".

It can be seen that, although Beijing, Shanghai, Tianjin and Chongqing all carried out the HPR, the policies for Beijing and Shanghai are more stringent. Among them, Chongqing just limited the purchasing behavior of non-residents. However, the implementation of HPR quickly curbed the housing demand, especially the speculative demand, and had a significant effect on the demand structure. According to the statistical data, the 4 of 15 cities that implemented HPR experienced a decrease of housing prices in September, 2010. Moreover, the amount of housing prices rise in other cities also narrowed.

5.2 Analysis on the effect of IAL system and HPR

5.2.1 Analysis on the effect of IAL system

IAL system strengthened the competition of demands of the land market. On the one hand, it played a role in price competition mechanism effectively by establishing relevant procedures to allow more qualified real estate developers and legal persons to participate in bidding. On the other hand, it decreased the barriers to entry into the real estate market for the developers, and provided an open and fair market environment. In such a case, the enterprises, organizations and individual all could take part in land granting, thus there was a dramatic increase in the number of real estate developers.

As Table 5-1 presents, before 2004 when IAL system has not been fully implemented, although the number of real estate developers was rising year by year, the rise range was very small.

In 2004, the total number of real estate development enterprises rose from 37123 in 2003 to 59242 recording a dramatic increase of 59.58%. Meanwhile, the type of developers became more disperse, and the market concentration became lower. To be specific, the number of domestic enterprises increased 20388, which consisted of 217 stated-owned enterprises, 185 collective enterprises and 19986 private ones. The number of new developers from HK, Macau and Taiwan was 799, with a growth rate of 28.13%. There were 932 foreign developers entering into Chinese real estate market and the growth rate was 79.25%. Therefore, we can know that the implementation of IAL system encouraged many new companies to enter into the real estate industry, and changed the previous market structure. The proportion of stated-owned enterprise obviously decreased, and that of foreign enterprises dramatically increased, greatly contributed to the land market competition.

Besides the effect of IAL system on the land demand, the land reserve system implemented in 2001 affected the land supply significantly. Therefore, the influence of IAL system on land prices should be analyzed by combining the effect of land reserve system. IAL system was fully implemented in September 2004 when the land reserve system had been carried out for more than two years. At that time, the land reserve of local government reached a certain quantity, and the stock of land use rights in secondary market decreased significantly, thus the control of local government on land supply channels significantly increased.

Table 5- 1 Numbers and kinds of real estate developers

Year	Total Number	Domestic developers	State -owned	Collective-owned	HK/Macau/ Taiwan developers	Foreign developers
2000	27303	23277	6641	3492	2899	1127
2001	29552	25509	5862	2991	2959	1084
2002	32618	28657	5015	2488	2884	1077
2003	37123	33107	4558	2205	2840	1176
2004	**59242**	**53495**	**4775**	**2390**	**3639**	**2108**
2005	56290	50957	4145	1796	3443	1890
2006	58710	53268	3797	1586	3519	1923
2007	62518	56965	3617	1430	3524	2029
2008	87562	81282	3941	1520	3916	2364
2009	80407	74674	3835	1361	3633	2100
2010	85218	79489	3685	1220	3677	2052
2011	88419	83011	3427	1023	3565	1843
2012	89859	84695	3354	904	3451	1713

Source: 2013 Chinese statistical yearbook.

It presented a structure of “supply monopoly and demand competition” in Chinese land market. To maximize their own interest, the local governments reduced the supply of land to increase the fiscal revenue. Thus, the increasing demand, decreasing supply and the bidding evaluation of IAL system that land use rights went to the highest bidder all promoted the rise of land prices. Meanwhile, with the further implementation of land reserve system, the effect of IAL system on land prices would be even more significant.

According to the four quadrant model, the conversion process between housing prices and land prices is shown in Figure 5-1. As the figure shows, under the IAL system, land supply is totally controlled by the local government, and assumed to be no changed in the short term, but land demand is increasing. The demand curve moves from DL_1 to DL_2, leading the land prices to rise from LP_1 to LP_2, and resulting in an increase of housing prices from HP_1 to HP_2 finally.

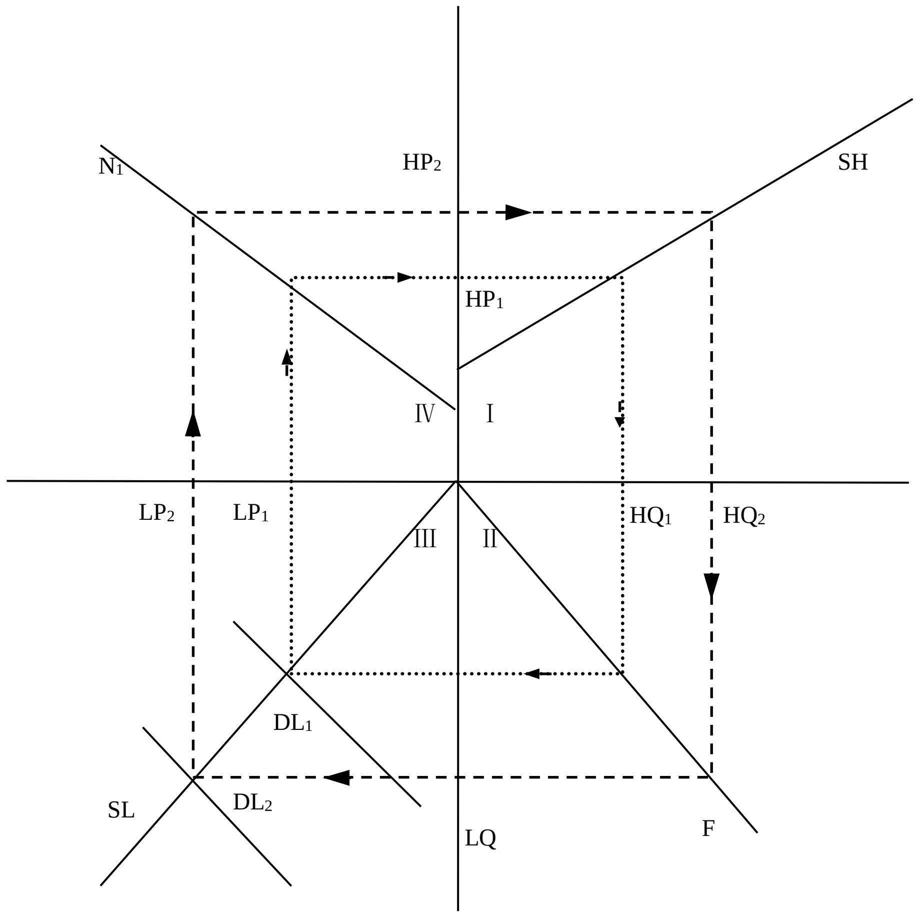


Figure 5- 1 Four quadrant model under the IAL system

Source: analyzed by the author.

In fact, under the joint effect of IAL system and land reserve system, Chinese land prices have been on the rise. For the four municipalities, the average land price of Beijing was 2361 RMB/m^2 in 2004, and was 6869 RMB/m^2 in 2009, with a growth rate of 217%. The average land price of Shanghai was 2210 and 8763 RMB/m^2 in 2004 and 2009, respectively, showing a growth rate of 360%. While the corresponding rate of Tianjin and Chongqing were 221% and 83%. It indicates that the implementation of IAL system and land reserve system greatly increased Chinese land prices, and the promoting effect was more significant in the developed cities.

5.2.2 Analysis on the effect of HPR

Similarly, this thesis analyzes the effect of housing purchase restriction on housing and land prices by using the four quadrant model. In essence, HPR mainly affects the housing demand. The conversion process between housing prices and land prices is shown in Figure 5-2.

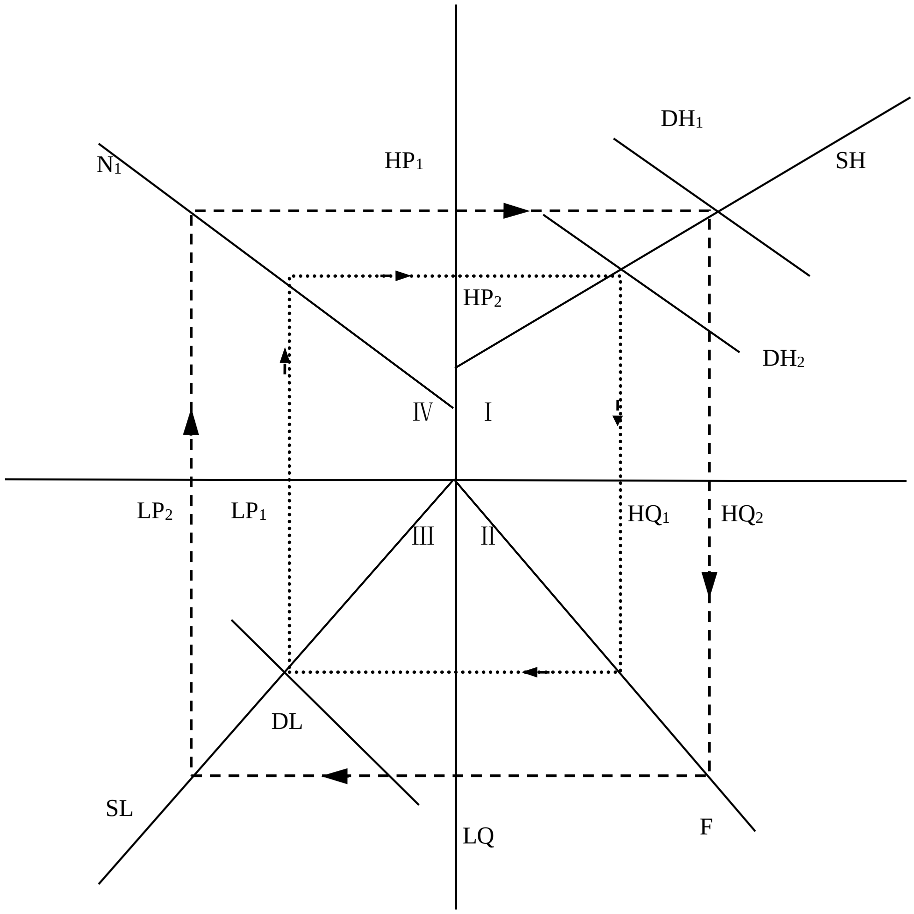


Figure 5- 2 Four quadrant model under the HPR

Source: analyzed by the author.

As shown in Figure 5-2, HPR decreases the housing demand firstly. It moves the demand curve from DH_1 to DH_2, which leads to the housing prices to decrease from HP_1 to HP_2, further reduces the land demand and results in a decrease of land prices finally.

5.3 Effect of administrative policy on the information transmission efficiency

5.3.1 Effect on the mean information transmission efficiency

This thesis will study the effect of the two important administrative policies on the information transmission efficiency of Chinese real estate market. One is IAL system, which is introduced in 2002 and fully implemented on August 31, 2004. The other one is HPR, which is carried out in 2010 for the first time, but the other cities implement this policy at different time. For the four cities studied in this thesis, the implementation time for Beijing is May, 2010, that for Shanghai and Tianjin are October, 2010 and for Chongqing is January, 2011.

To study the effect of the two policies on the information transmission efficiency, we need to divide the overall sample into three sub-periods firstly. The first sub-period is before September, 2004, after which the IAL system was fully implemented. The second sub-period is from September, 2004 to January, 2011, after which the HPR was implemented by the four cities. Therefore, the first sub-sample is not affected by IAL system and HPR, the second sub-sample is only affected by IAL system and while the third sub-sample is affected by both IAL system and HPR. We want to observe the difference of information transmission in the three sub-periods.

Similar to Chapter 4, the thesis studies this question mainly using the monthly data, and uses the quarterly data to conduct the robustness check.

5.3.1.1 Descriptive statistics for sub-samples

Table 5-2 shows the description of housing prices and land prices for three sub-periods. It can be found that, the average housing prices and land prices of sample 3 is significantly higher that of sample 1 and 2, which indicates that with the implementation of IAL system and HPR, the mean value of housing prices and land prices both exhibit rising trends.

5.3.1.2 Stationary test

Similar to the methods used in Chapter 4, this chapter conducts the stationary test for housing prices and land prices of three sub-samples firstly. The results are presented in Table 5-3. The test results show that, all the housing prices and land prices are stationary. As their statistic values are different from zero at the 1% significance level, we can reject the null hypothesis "not stationary". Therefore, we use the level value of LNHP and LNLP to establish the econometric models.

Table 5- 2 Description of housing prices and land prices for sub-samples

Sample	Sample 1		Sample 2		Sample 3	
Statistic	HP	LP	HP	LP	HP	LP
Mean	3133	2094	7335	4156	11690	7939
Median	2923	1907	6707	3553	11142	7278
Maximum	6271	7339	21091	11174	21580	17233
Minimum	1046	1050	1663	1175	4255	2617
Std. Dev.	1476	1262	4370	2677	5380	4345

Source: calculated by the author.

Table 5- 3 Stationary test for housing prices and land prices for sub-samples

Sample	Variable	Statistic	P value	I(d)	
Sample 1	LNHP	-6.87813***	0	I(0)	stationary
	LNLP	-7.27414***	0	I(0)	stationary
Sample 2	LNHP	-8.69959***	0	I(0)	stationary
	LNLP	-8.14999***	0	I(0)	stationary
Sample 3	LNHP	-6.46142***	0	I(0)	stationary
	LNLP	-6.30986***	0	I(0)	stationary

Note: ***, **,*denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

5.3.1.3 Estimate the PVAR model

(1) Determine the lag order *m* of PVAR model

AIC, BIC and HQIC are used to choose the lag order of PVAR model. The results are shown in Table 5-4. For the first sample, according to AIC and HQIC, the lag order should be two, and while according to BIC, the order should be three. For the second sample, the lag order should be six according to AIC and HQIC, and three according to BIC. For the third sample, the lag order is three according to the three criterions. To keep the freedom and reduce the information loss, the lag orders are determined to be two, three and three for the three sub-samples, respectively.

Table 5- 4 Values of information criterion with different lag order for sub-samples

Sample 1			
Lag order	AIC	BIC	HQIC
1	2.98031	3.28543	3.10392
2	2.43266	2.84949*	2.60136
3	2.35178*	2.88602	2.56773*
4	2.42345	3.08131	2.68897
5	2.49112	3.27937	2.80869
6	2.51527	3.4413	2.88753
7	2.53114	3.60305	2.9609
8	2.72682	3.95352	3.21707
9	2.64277	4.03407	3.19665
10	2.77481	4.34152	3.39559
Sample 2			
1	2.44629	2.60708	2.51087
2	2.23337	2.45009	2.32045
3	2.139	2.4129*	2.24911
4	2.15797	2.49033	2.29164
5	2.12015	2.51231	2.27794
6	2.06222*	2.51556	2.24472*
7	2.07871	2.59469	2.28652
8	2.0968	2.67691	2.33054
9	2.13031	2.77611	2.39064
10	2.13031	2.77611	2.39064
Sample 3			
1	2.52023	2.76324	2.61896
2	2.39888	2.72886	2.53297
3	2.30816*	2.72839*	2.47893*
4	2.36838	2.88238	2.57726
5	2.41313	3.02463	2.66161

6	2.49574	3.20875	2.78544
7	2.49738	3.31617	2.82999
8	2.52073	3.44989	2.89806
9	2.54609	3.59055	2.97008
10	2.63072	3.79579	3.10342

Note: ***, **,*denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

Table 5- 5 Estimation and test results of PVAR model for sub-samples

Sample	Sample 1		Sample 2		Sample 3	
Independent variables	HP model	LP model	HP model	LP model	HP model	LP model
LNHP(-1)	0.083	0.015	0.128	0.001	0.300***	0.004
T value	-0.696	-1.056	-1.753	-0.175	-3.258	-0.376
P value	0.486	0.291	0.08	0.861	0.001	0.707
LNLP (-1)	1.796**	0.273**	0.016	0.341***	1.804	0.494***
T value	-2.037	-2.038	-0.039	-5.277	-1.388	-3.158
P value	0.042	0.042	0.969	0	0.165	0.002
LNHP (-2)	0.158*	0.013	0.154	0.005	0.031	-0.004
T value	-1.767	-0.903	-1.844	-0.641	-0.338	(-0.441)
P value	0.077	0.367	0.065	0.521	0.735	0.659
LNLP (-2)	1.785**	0.431***	0.252	0.276***	0.742	0.143
T value	-2.1	-2.983	-0.642	-4.035	-0.581	-0.986
P value	0.036	0.003	0.521	0	0.561	0.324
LNHP (-3)			0.101*	0.003	0.114	-0.003
T value			-1.88	-0.377	-1.088	(-0.308)
P value			0.06	0.706	0.277	0.758
LNLP (-3)			0.665	0.294***	0.058	0.307**
T value			-1.62	-4.644	-0.057	-1.988
P value			0.105	0	0.954	0.047

Note: ***, **,*denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

(2) Estimate the PVAR model

The regression results for model (3-4) and (3-5) are shown in Table 5-5. In the housing price model, the historical land prices have significant effect on the current housing prices for sample 1, but the effect is not significant anymore for sample 2 and 3. In the land price model, the historical values of housing prices have no effect on current land prices for all the three samples.

To study the relationship more exactly, we conduct the Granger causality test based on the PVAR model. The results are contained in Table 5-6.

Table 5- 6 Granger causality test for housing prices and land prices for sub-samples

Sample	Null hypothesis	Statistic	P value
Sample 1	LNLP is not the Granger cause of LNHP	24.26^{***}	0.00
	LNHP is not the Granger cause of LNLP	2.36	0.50
Sample 2	LNLP is not the Granger cause of LNHP	8.86^{**}	0.03
	LNHP is not the Granger cause of LNLP	0.71	0.87
Sample 3	LNLP is not the Granger cause of LNHP	2.40	0.49
	LNHP is not the Granger cause of LNLP	0.48	0.92

Note: ***, **,*denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

The test results show that, for sample 1 and 2, we should reject the null hypothesis that "LNLP is not the Granger cause of LNHP", as the statistic values are different from zero at the 5% significance level. It indicates that, in the first two sub-periods, land prices are the Granger cause of housing prices, and the change of land prices will lead to the change of housing prices in the short run, showing that the mean information of land market can be transmitted to housing market and be reflected in the housing prices. However, for sample 3, this null hypothesis cannot be rejected, indicating that land prices are not the Granger cause of housing prices. Meanwhile, it can be found that although the null hypothesis is rejected for both sample 1 and 2, the statistic of sample 1 is 24.26, larger than that of sample 2. It also shows that the significance of the effect of land prices on housing prices is weakened in the second sub-period.

The null hypothesis "LNHP is not the Granger cause of LNLP" is rejected for all the three-samples. It shows that no matter whether the IAL system and HPR are implemented or not, the housing prices cannot affect the land prices, and the mean information of housing market is not transmitted to land market. However, on the other hand, before the implementation of IAL system and HPR, land prices can affect housing prices, indicating that there is information transmission from land market to housing market. After the implementation of IAL system and before the carrying out of HPR, this effect still exists, but the significance decrease. After the implementation of HPR, we cannot observe an effect of land prices on housing prices. It means that, the mean information of land market cannot be transmitted to housing market anymore.

Therefore, we can conclude that, the implementation of IAL system and HPR reduces the information transmission efficiency between Chinese housing market and land market. The carrying out of HPR even cuts off the transmission of mean information between the two markets. It shows that, for the mean information, the administrative policy reduces the transmission channel.

5.3.1.4 Results of impulse responses tests

To further examine the effect of IAL system and HPR on the information transmission speed between housing market and land market and the information efficiency in the two markets, we conduct the impulse responses analysis based on the PVAR model. The analysis results for the three samples are shown in Figure 5-3, 5-4 and 5-5, respectively. Every figure contains (a), (b), (c) and (d) four parts, showing the responses of housing prices to housing prices shock, responses of housing prices to land prices shock, responses of land prices to land prices shock and responses of land prices to housing prices shock, respectively.

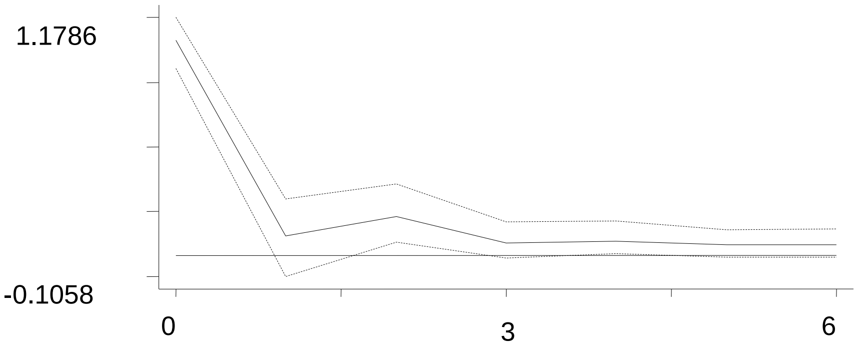
Similar to Figure 4-4, the solid lines in the middle of these figures show the responses to the impulse in every period, and the two dotted lines show the confidence interval at the 95% level obtained by the Monte Carlo simulation method. The observation window contains 6 periods.

Figure 5-3 presents the responses of housing price and land price in the first sub-period. Part (a) shows the responses of housing price to the unit shock of itself. As the figure indicates, the unit shock at period 0 will lead to an increase of housing prices, and this effect will level off after period 2. Part (b) shows the responses of housing price to the unit shock of land price. It can be found that there is one period lag for the effect of the shock. This effect is zero at period 0, and levels off at period 2. Seen from the confidence interval, the effect of the shock of land price on housing price is merely 0.28. Part (c) exhibits the responses of land price to the unit shock of housing price. The figure shows that the effect is very small, and merely zero. Part (d) presents the responses of land price to the unit shock of itself. We can find that this response is positive, but also very small compared with the responses of housing price to the shock of itself , as shown in Part (a).

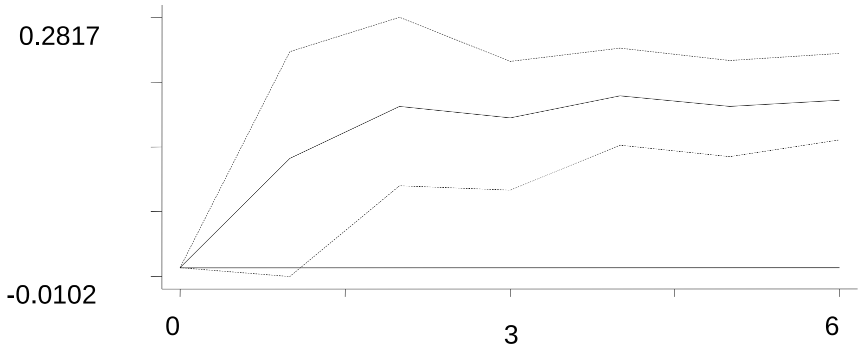
Figure 5-4 presents the responses of housing price and land price in the second sub-period. As part (a), (b), (c) and (d) show, the maximum responses are 1.1721, 0.1728, 0.0354 and 0.1570 respectively, all lower than the corresponding values of Figure 5-3. It indicates that after the carrying out of IAL system, the responses of housing price and land price to the shock of themselves and each other all become smaller. Seen from the sustaining period of the responses, the housing price needs one period to absorb the shock from itself, and needs four periods to totally reflect the shock from land price. There are also no obvious responses of land price to the shock of housing price, and the reaction period of land price to the shock of itself is four. Therefore, we find that the reaction time become a little longer after the implementation of IAL system.

Figure 5-5 shows the responses of housing price and land price in the third sub-period. It can be seen obviously that only the responses of housing price to the shock of itself are significant, as presented in part (a), and the reaction time is two or three periods. The other responses presented in part (b), (c) and (d) are all very small, there is no significant change of the response curve, and the confidence intervals are even diverging. These all indicate that the housing market cannot absorb the land information, the land market also does not respond to the information from housing market. The results show that after the implementation of HPR, the information efficiencies of housing market and land market have a further decrease. The specific manifestation is that the responses to new information become smaller and slower.

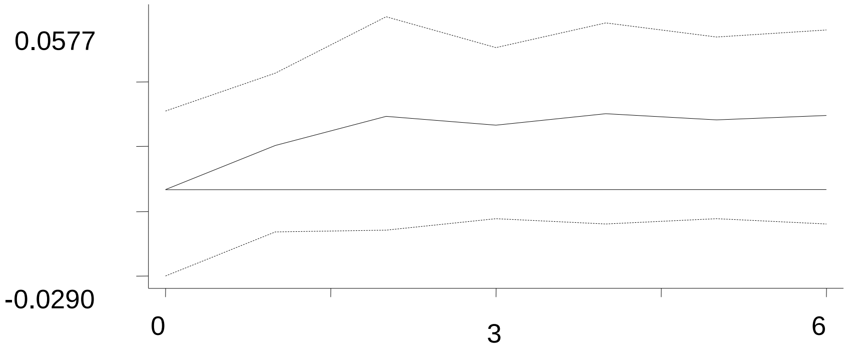
Sample1



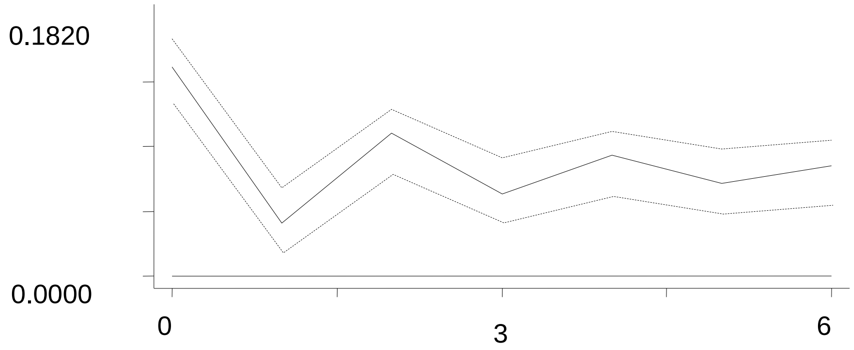
(a) responses of LNHP to LNHP shock



(b) responses of LNHP to LNLP shock



(d) responses of LNLP to LNHP shock

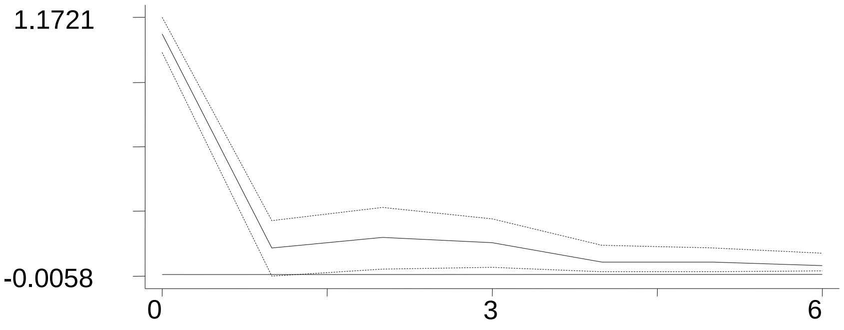


(c) responses of LNLP to LNLP shock

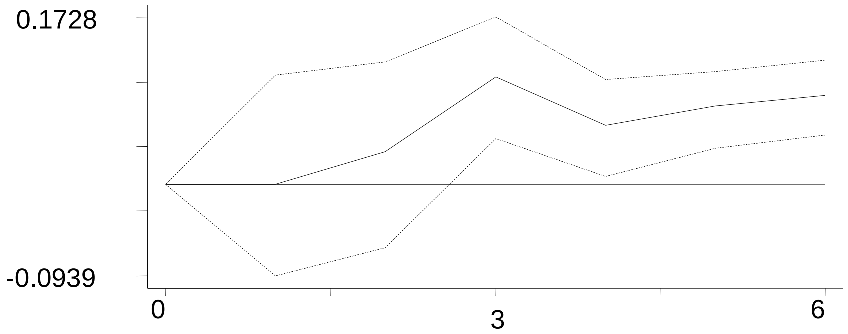
Figure 5- 3 Results of impulse response analysis for sample 1

Source: estimated by the author.

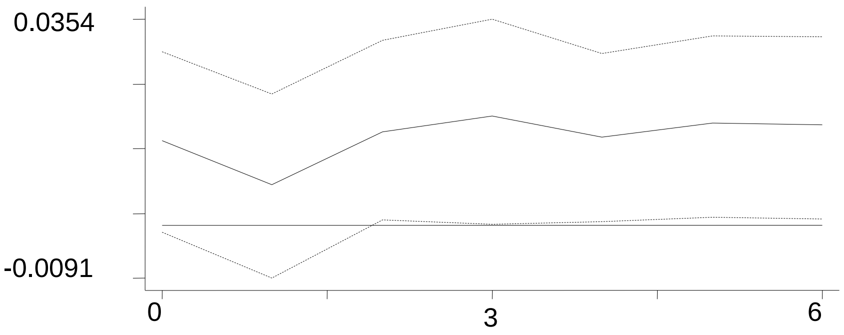
Sample2



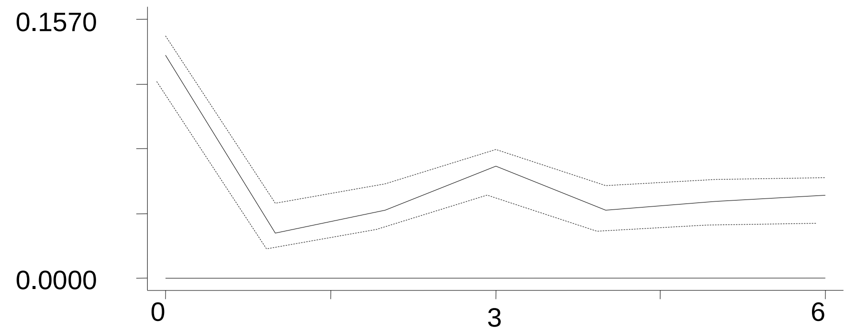
(a) responses of LNHP to LNHP shock



(b) responses of LNHP to LNLP shock



(c) responses of LNLP to LNHP shock

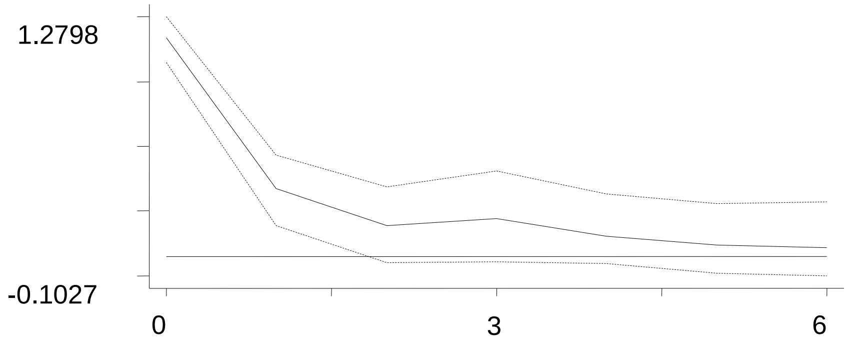


(d) responses of LNLP to LNLP shock

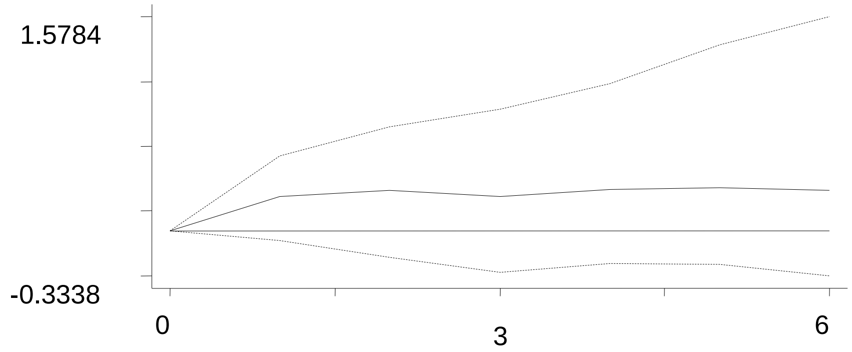
Figure 5- 4 Results of impulse response analysis for sample 2

Source: estimated by the author.

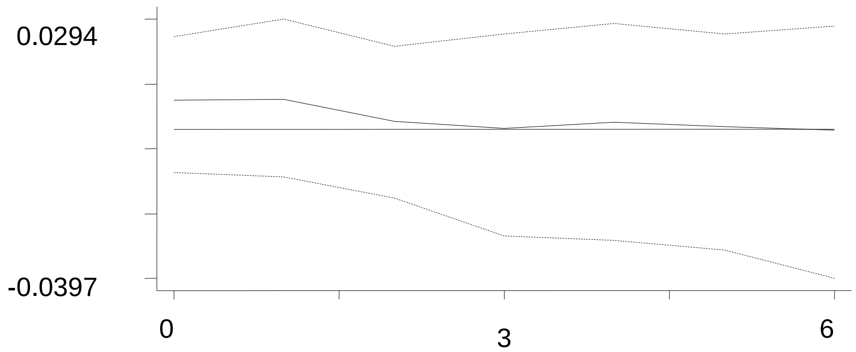
Sample3



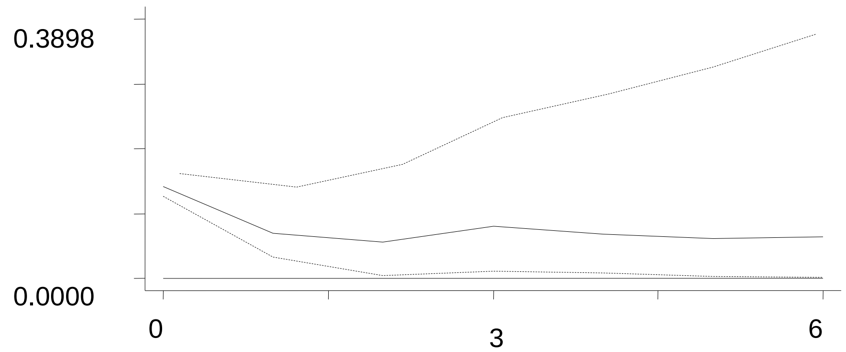
(a) responses of LNHP to LNHP shock



(b) responses of LNHP to LNLP shock



(c) responses of LNLP to LNHP shock



(d) responses of LNLP to LNLP shock

Figure 5- 5 Results of impulse response analysis for sample 3

Source: estimated by the author.

5.3.1.5 Robustness check

Similar to Chapter 4, to make sure the conclusions above are credible, the thesis uses the quarterly average housing prices and land prices to conduct the robustness check. Although the sample period of quarterly data is short, the panel structure can increase the amount of data, and can support the estimation of PVAR model.

(1) Stationary test

Firstly, the stationary test is conducted for the housing prices and land prices for three sub-periods, as shown in Table 5-7. The results show that the level values of LNHP and LNLP in all the three sub-periods are not stationary, and their first differences are stationary. It indicates that the quarterly housing prices and land prices are integrated of order1. For the variables integrated of the same order, we should examine whether there is cointegration relationship between them.

Table 5- 7 Stationary test for quarterly data during sub-periods

Sample	Variable	Statistic	P value	I(d)	
Sample 1	LNHP	0.082	0.533	Not stationary	I(1)
	ΔLNHP	-7.046^{***}	0.000	Stationary	
	LNLP	1.166	0.878	Not stationary	I(1)
	ΔLNLP	-74.320^{***}	0.000	Stationary	
Sample 2	LNHP	0.987	0.838	Not stationary	I(1)
	ΔLNHP	-8.678^{***}	0.000	Stationary	
	LNLP	2.991	0.999	Not stationary	I(1)
	ΔLNLP	-10.980^{***}	0.000	Stationary	
Sample 3	LNHP	1.809	0.986	Not stationary	I(1)
	ΔLNHP	-9.537^{***}	0.000	Stationary	
	LNLP	4.191	1.000	Not stationary	I(1)
	ΔLNLP	-4.314^{***}	0.000	Stationary	

Note: ***, **, *denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

(2) Cointegration test

Johansen Fisher method (Johansen, 1995; Fisher, 1934) is used to examine the cointegration relationship between housing prices and land prices during three sub-periods. The results are shown in Table 5-8.

In the first sub-period, the null hypothesis “none” and “at most 1” both are rejected, indicating that there is at least one cointegration relationship between housing prices and land prices for sample 1. While in the second and third sub-periods, the statistic rejects the null hypothesis “none” and accept the null hypothesis “at most 1”, which shows that there is only one cointegration relationship for sample 2 and 3. Overall speaking, housing prices and land prices are integrated for all the sub-samples, implying a long run stable and equilibrium relationship between them. If they deviate from the equilibrium in the short run, the market will correct the error immediately.

Table 5- 8 Cointegration test for quarterly data during sub-periods

Sample	The number of cointegration relationships	Statistic	P value
Sample 1	None	27.62^{***}	0.0006
	At most 1	13.58^{*}	0.0933
Sample 2	None	18.52^{**}	0.0177
	At most 1	8.078	0.4258
Sample 3	None	32.09^{***}	0.0001
	At most 1	12.26	0.1401

Note: ***, **, *denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

(3) Estimate the vector error correction model

As the housing prices and land prices are integrated of same order and cointegrated for three sub-samples, the error correction model should be used to study the mean information transmission between the two prices. Models are specified as (3-6) and (3-7).

Firstly, we run the regressions of LNHP and LNLP on each other for every sample, and get the error terms of the two regressions, named them ecm^{HP} and ecm^{LP}, respectively, which are the error correction terms of model (3-6) and (3-7). The stationary test shows that all the error terms are stationary, and can be added into model directly. The lag orders of these models are decided by AIC, BIC and HQIC. The regression results are shown in Table 5-9, 5-10 and 5-11.

Table 5-9 contains the estimation results for sample 1. The optimal lag structure for model (3-6) contains one lagged LNHP and three lagged LNLP, while the optimal structure for model (3-7) contains four lagged LNHP and four lagged LNLP. Wald statistic of HP model is 2.825, different from zero at the 5% significance level, showing that in the first sub-period, land prices are the Granger cause of housing prices, implying that the historical values of land prices can explain the current housing prices significantly, and the mean information of land market has been transmitted to housing market. On the contrary, Wald statistic of LP model is 1.909 and not significant, indicating that housing prices are not the Granger cause of land prices, and the mean information of housing market has not been transmitted to land market.

Table 5- 9 Estimation results of VECM for sample 1

Model	HP model			LP model		
Variable	Coefficient	T value	Variable	Coefficient	T value	Variable
c	0.049^{***}	4.461	0.000	0.013	1.503	0.140
△LNHP (-1)	-0.291^{**}	-2.609	0.012	-0.100	-1.654	0.106
△LNHP (-2)				-0.101	-1.580	0.121
△LNHP (-3)				-0.026	-0.399	0.692
△LNHP (-4)				0.065	1.232	0.225
△LNLP (-1)	-0.031	-1.123	0.267	-0.002	-0.016	0.987
△LNLP (-2)	-0.057^{*}	-1.823	0.074	-0.066	-0.583	0.563
△LNLP (-3)	-0.082^{***}	-2.909	0.005	-0.138	-1.324	0.193
△LNLP (-4)				0.795^{***}	8.030	0.000
$ecm^{HP}(-1)$	-0.292^{***}	-3.156	0.003			
$ecm^{LP}(-1)$				-0.279^{***}	-2.808	0.008
Wald test	2.825^{**}		0.048	1.909		0.126

Note: ***, **, *denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

The coefficients of the error correction term of HP model and LP model are –0.292 and -0.279, which are significant different from zero at the 1% level. It indicates that the deviation of housing prices from the equilibrium will be corrected 29.2% in the next period. That of land prices will be corrected 27.9%, showing that housing prices react more quickly to market disparity than do land prices. The housing market is more informationally efficient than the land market, which is also consistent with the results obtained with the monthly data.

Therefore, we can conclude that before the implementation of IAL, there is unidirectional mean information transmission from land market to housing market, and the land market is the information center. Meanwhile, the housing market has higher internal information efficiency. These conclusions are consistent with the results obtained with the monthly data.

Table 5- 10 Estimation results of VECM for sample 2

Model	HP model			LP model		
Variable	Coefficient	T value	Variable	Coefficient	T value	Variable
c	0.062^{***}	3.819	0.000	0.079^{***}	3.032	0.003
△LNHP (-1)	-0.166	-1.475	0.144	-0.043	-0.256	0.798
△LNHP (-2)	-0.126	-1.156	0.251	-0.308^{*}	-1.880	0.064
△LNLP (-1)	-0.122^{***}	-2.619	0.010	-0.374^{**}	-2.557	0.012
△LNLP (-2)	-0.095^{**}	-2.417	0.018	-0.365^{***}	-2.790	0.007
△LNLP (-3)				-0.323^{***}	-2.851	0.006
△LNLP (-4)				0.337^{***}	3.760	0.000
ecm^{HP}(-1)	-0.247^{***}	-3.269	0.002			
ecm^{LP}(-1)				-0.233^{**}	-2.028	0.046
Wald test	4.107^{***}		0.020	1.830		0.167

Note: ***, **, *denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

Table 5-10 contains the estimation results of sample 2. The optimal lag structure for model (3-6) contains two lagged LNHP and two lagged LNLP, while the optimal structure for model (3-7) contains two lagged LNHP and four lagged LNLP. Wald statistics of HP model and LP model are 4.107 and 1.830, respectively. The former is significant different from zero at the 1% level, while the latter is not statistically significant. It also indicates that land prices cause the change of housing prices, but the reverse does not hold. The coefficients of the error correction terms of HP model and LP models are -0.247 and -0.233, significant at the 1% level. It shows that after the implementation of IAL system, the markets still correct the errors of housing prices and land prices, but the adjustment speeds decrease to 24.7% and 23.3%. Housing market still reacts faster to the disequilibrium than land market. Meanwhile, we can also find that the correction speed of housing market and land markets both lower than that before the implementation of IAL system, showing that the internal information transmission efficiencies of housing market and land market are reduced by the IAL system.

Table 5- 11 Estimation results of VECM for sample 3

Model	HP model			LP model		
Variable	Coefficient	T value	Variable	Coefficient	T value	Variable
c	0.019	1.048	0.300	0.019^{***}	2.692	0.010
ΔLNHP (-1)	-0.392	-2.981	0.005	-0.015	-0.310	0.758
ΔLNLP (-1)	-0.377	-1.020	0.313	0.132	0.906	0.369
$ecm^{HP}(-1)$	-0.134^{*}	-1.655	0.104			
$ecm^{LP}(-1)$				-0.227^{**}	-2.108	0.040
Wald test	1.040		0.313	0.187		0.668

Note: ***, **, *denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

Table 5-11 contains the estimation results of sample 3. The optimal lag structure for model (3-6) and (3-7) both contains one lagged LNHP and one lagged LNLP. Wald statistics of HP model and LP model are 1.040 and 0.187, respectively, which both are not significant, indicating that housing prices and land prices are independently in the short term, and the information of housing market and land market are not transmitted to the opposite market.

The coefficients of the error correction terms of HP model and LP models are -0.134 and -0.227, significant at the 10% level. It shows that after the implementation of HPR, the markets still correct the errors of housing prices and land prices, but the adjustment speed decreases significantly. Especially for the housing market, the correction proportion decreases from 24.7% in sample 2 to 13.4% in sample 3. The correction speed of land market also decreases, but the descend range is less than that of housing market. Therefore, we can conclude that: firstly, after the carrying out of HPR, there is no information transmission between housing and land market, and the unidirectional transmission from land market to housing market was cut off; secondly, HPR decreases the internal information efficiency of both housing market and land market, especially for the housing market. That may be because the information is transmitted and revealed by transactions, but HPR reduces the trading volume of housing greatly, causing the information cannot be revealed widely and diffuses fast, so that the information efficiency of housing market decreases significantly.

5.3.2 Effect on the volatility information transmission efficiency

Similar to the researches of financial market, this thesis uses the time-series data to study the volatility transmission, which means that the information transmission efficiency should be examined separately for each city. We can strictly divide the sample according to the implementing time of HPR. Therefore, the time ranges of the sub-samples for Beijing are 2002M3-2004M8, 2004M9-2010M4 and 2010M5-2014M6, for Tianjin they are 2002M3-2004M8, 2004M9-2010M9 and 2010M10-2014M6, for Shanghai they are 2002M3-2004M8, 2004M9-2010M9 and 2010M10-2014M6, and for Chongqing they are 2002M3-2004M8, 2004M9-2010M12 and 2011M1-2014M6. Then, the BEKK-GARCH model is used to study the volatility information transmission. The specific model are (3-15) and (3-16). We conduct the estimations for 12 times for three sub-samples and four cities. The results are presented in Table 5-12, 5-13, 5-14, 5-15.

5.3.2.1 Changes of the volatility transmission efficiency for Beijing

Table 5-12 contains the estimation results of BEKK-GARCH model for three sub-samples for Beijing. It can be seen that the coefficients a_{11} and a_{22} are significant for the three sub-samples, indicating that no matter whether the IAL system and HPR are introduced or not, the housing returns and land returns of Beijing have volatility clustering. The coefficients b_{11} and b_{22} are significant except b_{11} of sample 3, which shows that housing returns and land returns of Beijing also have volatility persistence. a_{12} and a_{21} measures the volatility spillover between housing market and land market. It can be found that in sample 1, the coefficients of a_{12} and a_{21} are both negative, and significant different from zero at the 5% level, showing that before the implementation of IAL system, there are bidirectional volatility information transmission between housing market and land market, and their volatilities can help to stabilize the variation of each other. In sample 2 and 3, the coefficient of a_{12} is not significant any more, indicating that after the carrying out of IAL system, the formation mechanism of land prices has been greatly changed, which leads that the volatility information of housing market cannot be transmitted to land market, and while the reverse still holds. Therefore, we can conclude that after the implementation of IAL system, the bidirectional volatility transmissions between Beijing housing market and land market become unidirectional transmission from land market to housing market. The land market still is the information center.

5.3.2.2 Changes of the volatility transmission efficiency for Tianjin

Table 5-13 contains the estimation results of BEKK-GARCH model for three sub-samples for Tianjin. It can be seen that the coefficients a_{11} and a_{22} are significant for the three sub-samples except a_{11} in sample 1, indicating that the housing returns and land returns of Tianjin have volatility clustering. The coefficients b_{11} and b_{22} are significant except b_{22} of sample 3, showing that the housing returns and land returns of Tianjin also have volatility persistence.

The statistic significance of coefficients a_{12} and a_{21} is similar to that of Beijing. Both the two are significant in sample 1, and a_{12} is not significant anymore in sample 2 and 3. Therefore, we can obtain the same conclusions with Beijing, which is that after the implementation of IAL system, the bidirectional volatility transmissions between Tianjin housing and land markets become unidirectional transmission from land market to the housing market. The land market is the information center.

5.3.2.3 Changes of the volatility transmission efficiency for Shanghai

Table 5-14 contains the estimation results of BEKK-GARCH model for three sub-samples of Shanghai. It can be seen that the coefficients a_{11} and a_{22} are significant in the first two samples except the a_{11} in sample 1, indicating that the housing returns and land returns of Shanghai have volatility clustering. Both the two coefficients are not significant in sample 3, which presents that after the introducing of HPR, there is no volatility clustering anymore. The coefficients b_{11} and b_{22} are not significant in all the three sub-samples, showing that there is no volatility persistence in the housing returns and land returns of Shanghai.

For the coefficients a_{12} and a_{21}, a_{12} is not significant and a_{21} is significant in sample 1, showing that before the implementation of IAL system, there is unidirectional volatility transmission from land market to housing market. This relationship still exists in sample 2. The difference is that the coefficient a_{21} is negative in sample 1, but positive in sample 2. It indicates that before IAL system, the volatility of land returns can help to stabilize the volatility of housing returns, but will increase the volatility after that. The reason may lie in that, after 2004, there are more speculators in housing market, and the volatility of land prices increases the transactions of housing, and therefore increases the variation of housing prices. In sample 3, the two coefficients both are not significant, which indicates that after the introducing of HPR, the volatility transmission between housing market and land markets disappears.

Therefore, all the findings show that, after the implementation of HPR, the unidirectional volatility transmission between housing market and land market of Shanghai disappears.

5.3.2.4 Changes of the volatility transmission efficiency for Chongqing

Table 5-15 contains the estimation results of BEKK-GARCH model for three sub-samples for Chongqing. It can be seen that the coefficients a_{11} and a_{22} are significant in the three sub-samples, indicating that the housing returns and land returns of Chongqing have volatility clustering. The coefficients b_{11} and b_{22} are significant in sample 1 and 3, showing that there is no volatility persistence in the housing and land returns of Chongqing after the implementation of IAL system.

In sample 1, both the coefficients a_{12} and a_{21} are significant different from zero at the 1% level, showing that before the implementation of IAL system, there are bidirectional transmissions between Chongqing housing market and land market. In sample 2 and 3, a_{12} is not significant anymore, indicating that after the carrying out of IAL system, there is only unidirectional volatility transmission from land market to housing market.

We can have the conclusion that the implementation of IAL system decreases the information transmission efficiency between Chongqing housing market and land market, and the land market is the volatility information center.

Table 5- 12 Results of volatility spillover for sub- samples for Beijing

Sample 1			
Parameter	**Coefficient**	**T value**	**P value**
c_{11}	0.039	1.558	0.119
c_{12}	0.552	1.529	0.126
c_{22}	0.000	0.000	1.000
a_{11}	1.406***	10.736	0.000
a_{12}	-2.681**	-2.235	0.025
a_{21}	-0.094***	-5.902	0.000
a_{22}	0.532***	4.318	0.000
b_{11}	0.194**	2.320	0.020
b_{12}	1.483	1.470	0.142
b_{21}	0.041***	2.895	0.004
b_{22}	0.682***	3.313	0.001
Sample 2			
Parameter	**Coefficient**	**T value**	**P value**
c_{11}	0.073***	3.087	0.002
c_{12}	-0.301	-0.866	0.387
c_{22}	0.000	0.000	1.000
a_{11}	0.608***	4.313	0.000
a_{12}	-1.781	-1.259	0.208
a_{21}	0.029*	1.720	0.085
a_{22}	0.463***	3.521	0.000
b_{11}	0.508**	2.183	0.029
b_{12}	3.925**	2.322	0.020
b_{21}	-0.010	-0.764	0.445
b_{22}	0.730***	3.940	0.000
Sample 3			

Parameter	Coefficient	T value	P value
c_{11}	0.064^{**}	2.472	0.013
c_{12}	0.465^{***}	4.950	0.000
c_{22}	0.000	0.000	1.000
a_{11}	-0.415^{**}	-2.505	0.012
a_{12}	-0.864	-1.114	0.265
a_{21}	0.099^{*}	2.422	0.015
a_{22}	0.875^{***}	4.416	0.000
b_{11}	0.305	1.487	0.137
b_{12}	-1.234	-1.241	0.215
b_{21}	0.114^{***}	2.902	0.004
b_{22}	-0.260^{*}	-1.711	0.087

Note: ***, **, *denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

Table 5- 13 Results of volatility spillover for sub-samples for Tianjin

Sample 1			
Parameter	**Coefficient**	**T value**	**P value**
c_{11}	0.211^{***}	14.819	0.000
c_{12}	-0.465^{***}	-14.763	0.000
c_{22}	0.000	-0.146	0.884
a_{11}	0.104	0.588	0.556
a_{12}	9.813^{***}	28.552	0.000
a_{21}	0.004^{**}	2.139	0.032
a_{22}	0.584^{***}	63.288	0.000
b_{11}	-0.416^{***}	-23.767	0.000
b_{12}	0.915^{***}	24.656	0.000
b_{21}	0.008^{***}	2.956	0.003
b_{22}	-0.017^{***}	-2.993	0.003
Sample 2			
Parameter	**Coefficient**	**T value**	**P value**
c_{11}	0.000	0.000	1.000
c_{12}	0.000	0.000	1.000
c_{22}	0.000	0.000	1.000
a_{11}	0.572^{***}	4.440	0.000
a_{12}	1.812	1.178	0.239
a_{21}	0.017^{**}	2.339	0.019
a_{22}	0.314^{***}	2.768	0.006
b_{11}	0.659^{***}	9.015	0.000
b_{12}	-7.033^{***}	-7.295	0.000
b_{21}	0.037^{***}	6.374	0.000
b_{22}	0.787^{***}	9.314	0.000
Sample 3			

Parameter	Coefficient	T value	P value
c_{11}	0.082^{***}	2.892	0.004
c_{12}	0.687	1.226	0.220
c_{22}	0.000	0.000	1.000
a_{11}	0.433^{***}	3.208	0.001
a_{12}	3.381	1.536	0.124
a_{21}	-0.023^{*}	-1.822	0.069
a_{22}	0.861^{***}	3.985	0.000
b_{11}	0.476^{*}	1.869	0.062
b_{12}	-9.816^{***}	-3.517	0.000
b_{21}	0.016	0.777	0.437
b_{22}	-0.113	-0.267	0.790

Note: ***, **, *denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

Table 5- 14 Results of volatility spillover for sub-samples for Shanghai

Sample 1			
Parameter	**Coefficient**	**T value**	**P value**
c_{11}	0.000	0.404	0.686
c_{12}	-0.716^{***}	-3.093	0.002
c_{22}	0.861^{***}	7.840	0.000
a_{11}	0.173^{***}	272.439	0.000
a_{12}	1.812	1.582	0.114
a_{21}	-0.172^{***}	-247.221	0.000
a_{22}	0.303	1.436	0.151
b_{11}	0.000	0.025	0.980
b_{12}	1.103	0.764	0.445
b_{21}	0.000	-0.008	0.993
b_{22}	-0.028	-0.145	0.885
Sample 2			
Parameter	**Coefficient**	**T value**	**P value**
c_{11}	0.001	0.921	0.357
c_{12}	1.041^{***}	3.170	0.002
c_{22}	0.000	0.000	1.000
a_{11}	1.627^{***}	6.659	0.000
a_{12}	-0.586	-0.285	0.776
a_{21}	0.017^{***}	4.759	0.000
a_{22}	0.390^{*}	1.838	0.066
b_{11}	0.477^{***}	6.447	0.000
b_{12}	0.088	0.164	0.869
b_{21}	0.000	-0.069	0.945
b_{22}	0.440	0.834	0.404
Sample 3			

Parameter	Coefficient	T value	P value
c_{11}	0.052	0.815	0.415
c_{12}	0.936***	4.694	0.000
c_{22}	0.000	0.000	1.000
a_{11}	-0.397	-1.507	0.132
a_{12}	2.056	1.391	0.164
a_{21}	-0.041	-1.193	0.233
a_{22}	0.247	1.086	0.277
b_{11}	-0.458	-1.559	0.119
b_{12}	-1.204	-0.783	0.434
b_{21}	-0.090**	-1.983	0.047
b_{22}	-0.253	-0.820	0.412

Note: ***, **,*denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

Table 5- 15 Results of volatility spillover for sub-samples for Chongqing

Sample 1			
Parameter	**Coefficient**	**T value**	**P value**
c_{11}	0.086***	92.987	0.000
c_{12}	0.432***	83.925	0.000
c_{22}	0.000	-0.072	0.943
a_{11}	0.631***	7.781	0.000
a_{12}	-0.894***	-3.707	0.000
a_{21}	-0.229***	-7.097	0.000
a_{22}	0.707***	6.837	0.000
b_{11}	-0.041***	-7.307	0.000
b_{12}	-0.206***	-7.158	0.000
b_{21}	-0.045***	-112.584	0.000
b_{22}	-0.223***	-103.509	0.000
Sample 2			
Parameter	**Coefficient**	**T value**	**P value**
c_{11}	0.066	0.939	0.348
c_{12}	0.620***	3.266	0.001
c_{22}	0.000	0.000	1.000
a_{11}	0.315**	2.208	0.027
a_{12}	0.649	0.820	0.412
a_{21}	-0.079*	-1.836	0.066
a_{22}	0.420**	2.044	0.041
b_{11}	-0.184	-0.376	0.707
b_{12}	0.103	0.046	0.963
b_{21}	-0.133*	-1.811	0.070
b_{22}	0.389	0.749	0.454
Sample 3			

Parameter	Coefficient	T value	P value
c_{11}	0.000	0.000	1.000
c_{12}	0.000	0.000	1.000
c_{22}	0.000	0.000	1.000
a_{11}	-0.395^{***}	-2.758	0.006
a_{12}	0.195	0.086	0.932
a_{21}	-0.025^{*}	-1.824	0.068
a_{22}	0.349^{*}	1.813	0.070
b_{11}	0.857^{***}	9.599	0.000
b_{12}	4.381^{***}	3.489	0.000
b_{21}	-0.020^{*}	-1.805	0.071
b_{22}	0.805^{***}	8.559	0.000

Note: ***, **, *denote that the statistic is statistically significant different from zero at the 1%, 5% and 10% level.
Source: estimated by the author.

Chpater6: Findings and Suggestions

6.1 Main Findings and innovations

Firstly, this thesis empirically studies the information transmission efficiency of Chinese real estate market by taking Beijing, Tianjin, Shanghai and Chongqing as the research objects, which are the only four municipalities under the direct administration of Chinese central government. The results show that no matter for the mean information and volatility information, there is only unidirectional transmission from land market to housing market and land market is the information center. The information of land market will be transmitted to housing market in the next period. It indicates that Chinese real estate market is not completely efficient, no matter from the perspective of information transmission direction or transmission speed. Meanwhile, it can be found that the housing market is much more informationally efficient, as it responds to new information faster. The reason may lie in that the information is transmitted and revealed by transactions, the trading activity in housing market is more frequent. Therefore, the information efficiency of that is higher.

Secondly, this thesis empirically studies the effect of IAL system and HPR on the mean and volatility information transmission between Chinese housing market and land market. The two policies are administrative command attracting widespread concerns from industry and academia, due to their persistence, universality and the fundamental impacts on the market supply and demand structure. The results show that, for the mean and volatility information, both IAL system and HPR decrease the transmission efficiency. Firstly, the mean information transmission channels change from one to zero after the implementation of IAL system. Secondly, the mean information efficiencies inner housing and land markets also reduce, and it needs longer time for the two markets to respond to the new information. Thirdly, after the implementation of the two policies, the bidirectional volatility transmissions between housing market and land market change to unidirectional transmission from land market to housing market, or the unidirectional transmission becomes no transmission.

There are three main innovations and contributions of this thesis. The first is studying the information transmission efficiency of Chinese real estate market from the perspective of macro-control, which can provide useful suggestions for Chinese central government to make the regulating policies. The second is studying the mean and volatility information transmission between Chinese housing market and land market systematically, which includes the information transmission direction and speed, filling in the bland of existing researches. The third is studying the effect of administrative policies on the information transmission efficiency, inducing the IAL system and HPR two policies.

6.2 Policy suggestions

According to the empirical results of Chapter 4 and 5, we learn about the current situation of information transmission efficiency of Chinese real estate market. Therefore, this thesis provides the below suggestions for Chinese government to make the macro-control policies.

Firstly, Chinese government should reduce or cancel the administrative macro-control policies, especially the housing purchase restriction. The administrative regulation tools have greatly changed the forming mechanism of housing prices and land prices and the nature of this mechanism is a process that the information accumulated and revealed through trading. Therefore, the change of price generation mechanism will certainly change the transmission and reveal process of information, and change the efficiency of information transmission. It can be found from the empirical results that, since the implementation of IAL system, the information efficiencies inner housing market and land market decrease significantly, the response times of the two markets to the macro-policies such as tax and credit policies become much longer, and the timeliness of policies is reduced. Meanwhile, after that, the transmission channels of volatility information are reduced, for example the bidirectional transmissions between housing market and land markets in Beijing, Tianjin and Shanghai change to the unidirectional spillover. While after the carrying out of HPR, the unidirectional transmission of mean information between housing market and land market becomes no transmission, and the relationship between housing prices and land prices deviates from economic theory. Therefore, to improve the efficiency of macro-control policy, Chinese government should cancel the administrative regulating tools, especially HPR.

Secondly, Chinese government should pay more attention on the land policy when regulating the housing prices and land prices. The empirical results indicate that, from the points of the overall situation of the past ten years, land market is the information center of real estate market, and the mean and volatility information are mainly transmitted from it to housing market. If only considering the situation after the implementation of HPR, land market is still the information center. Although there is no mean information transmission between the two markets, there is still volatility spillover from land market to housing market. Therefore, the government should attach importance to the role of information center and use more land policy when controlling the housing prices. Because the housing prices are affected by both housing policies and land policies, but the land prices are only affected by land policies, to stabilize the housing prices, the government should focus on two dimensions. Otherwise, although many housing policies are introduced, the neglect of land policies will still bring the rise of housing prices. That may be why the dozens of Chinese housing policies are ineffectiveness in recent years.

Thirdly, the government should fully consider the response time of the market when measuring the effect of macro-control policies. The empirical results show that when the housing and land policies are introduced, the housing and land prices will be changed immediately, but the information efficiency of the market will affect how long the change lasts. When measuring the policy effect, the government should observe the market reaction for the whole response period, but not only for one or two periods. For example, the effect of housing policy should be observed for one period at least, and while the effect of land policy should be measured by observing the response of housing market and land market simultaneously. The reaction of housing market should be observed for two or three periods, and that of land market should be observed for about four periods.

Fourthly, the government should further improve the transparency of housing and land markets by working through the information transmission channels between the two markets. The empirical results of the overall sample show that the mean and volatility transmission between housing market and land market is unidirectional in the long run, and there is significant segregation between the two markets. It indicates that the information transmission efficiency between the two markets is relative lower, which decreases the efficiency of macro-policies largely. Therefore, the government should further improve the transparency of Chinese real estate market by establishing information platform, breaking up the institutional constraints, and working through the information transmission channels between the two markets.

Besides offering suggestions for Chinese central government, the results of this thesis can also provide some advices for other countries and regions the real estate market of which is similar to China. However, for most of the countries and regions, their real estate market is different from China, and the macro-control policies should be different, because the land property system of China is very special. In China, the land is owned by government and collectives, but in many other countries, the land is owned by private persons. Although the land ownership and use right are separated in Britain and some other commonwealth countries, their land property system is different from the public ownership system of China. In these countries, land is controlled by the private persons and organizations actually. Market-oriented tools are usually used to regulate their property market, and the administrative policies are less used. For example, in 2008, in order to boost the real estate market, the UK government stopped the stamp duty for the houses costing up to 175000 pounds for 1 year. As the government cannot control all the land supply, many Chinese policies is not appropriate for them.

For the countries that have the similar political system, economic system and land property system with China, the results of this thesis can provide some references for them. For example, just like China, North Korea, Cuba and Vietnam are all the socialist countries. In them, the land is public owned, and the governments have highly control on the real estate market. They usually use the non-market means to regulate the property market. For instance, before 2011, the houses transactions are prohibited in Cuba, and there is no real estate market indeed. Vietnam has strict limits on the housing purchasing qualification of foreigners. Its real estate market is opened to the foreign buyers in 2015, and the duration of houses is only 50 years. In North Korea, the housing transactions are also illegal at present, and the buyers and sellers have to trade in the black market. Among these countries, Vietnam reformed and opened since 1986, and its real estate market developed gradually, which is similar to China. Cuba and North Korea both have not conducted a market economy transition. Therefore, the development of Vietnamese real estate market can get more experiences from the development of Chinese real estate market.

In addition to the socialist countries, some capitalist countries or regions whose land is mainly publicly owned can also get some empirical evidences from this thesis. For example, the land ownership system of Singapore is hybrid. 53% of the land is owned by the government, 27% is owned by the statutory bodies and private land accounts for only 20%. The private property developer can obtain the land use rights from the government. In this context, the Singapore government has taken many similar policies with China to regulate their own real estate market. For example, to curb speculative housing demands, Singapore government restricts the purchasing frequency of citizens, and stipulates that the apartment cannot be rented wholly during a certain period after buying, cannot be sold during 5 years and cannot be used for commercial operation, and the apartment bought less than 1 year will be imposed high property tax.

For these countries, they can get some suggestions and experiences from the results of this thesis and the development history of Chinese real estate market.

Firstly, considering the negative effect of administrative policy on the market efficiency, we suggest these countries and regions not to use the not-market oriented tools, and use more market-oriented measures such as tax, credit and so on, to guide the market players changing their supply and demand behaviors, and then control the prices.

Secondly, for these countries and regions, when making macro-control policies, they should emphasis on the pertinence of the policies. At first, they should figure out the main affecting factors of housing and land prices, and their affecting approaches. The policies should work on the all key factors and key approaches. For example, if we only regulate the housing prices, and neglect the land price, the two prices will still rise, and if we only regulate the demand, but do not increase the supply, the imbalance between housing demand and supply still exists, and the prices cannot come back rationally.

Thirdly, for Cuba and North Korea, their real estate markets have not yet been opened and developed. They should get more references from the development of China, actively open their market, and reduce the limitations, to promote the development of national economy.

Bibliography

Ahmed, A. and C. Tsoukis (1998), Ricardian causal ordering and the relation between house and land prices: evidence from England, *Applied Economic Letter* 5,325-328.

Alexander, C. and M. Barrow (1994), Seasonality and cointegration of regional house prices in UK, *Urban Studies* 3(10), 1667-1689.

Banerjee, A., M. Marcellino and C. Osbat (2004), Some cautions on the use of panel methods for integrated series of macroeconomic data, *Econometrics Journal* 7,322–340.

Bhar, R. (2001), Return and volatility dynamics in the spot and futures markets in Australia: an intervention analysis in a bivariate EGARCH-X framework, *Journal of Futures Markets* 21(9), 833-850.

Bollerslev, T. (1986), Generalized autoregressive conditional heteroskedasticity, *Journal of Econometrics* 31,307-327.

Bollerslev, T. and J. M .Wooldridge (1992), Quasi-maximum likelihood estimation and inference in dynamic models with time-varying covariance, *Econometric Reviews* 11(2), 143-172.

Booth, Q., R. W. So and Y. Tse (1999), Price discovery in the German equity index derivatives markets, The *Journal of Futures Markets* 19, 619-643.

Bostic, R. W., S. D. Longhofer and C. L. Redfearn (2007), Land leverage: decomposing home price dynamics, *Real Estate Economics* 35(2), 183-208.

Breitung, J. (2005), A parametric approach to the estimation of cointegration vectors in panel data, *Econometric Reviews* 24, 1–20.

Brooks, C., I. Garrett and M. J. Hinich (1999), An alternative approach to investigating lead-lag relationships between stock and stock index futures markets, *Applied Financial Economics* 6,605-613.

Cai, M. and S. Yuan (2006), Empirical study on the effect of housing price and land price on each other in Shanghai real estate market, *Journal of Wuhan Information &Management Engineering* 28(5),146-149.

Case, K. E., J. M. Quigley and R. J. Shiller (2005), Comparing wealth effects: the stock market versus the housing market, *Advances in Macroeconomics* 5(1), 1-32.

Chang, E.C., J. W. Cheng and J. M. Pinegar (1999), Dose futures trading increase stock market volatility? The case of the Nikkei stock index futures markets, *Journal of Banking & Finance* 23(5), 727-753.

Chau, K. W., S. K.Wong and C. Y. Yiu (2003), Price discovery function of the forward contracts in the real estate market: an empirical test, *Journal of Financial Management of Property and Construction* 8(3),129-137.

Chen, Y. (2006), Research on the dynamics of real estate macro control system, S*pecial Zone Economy* (8), 343-344.

Cheng, H. (2003), *Analysis of Panel Dat*a, New York: Cambridge University Press.

Clayton, J. (1996), Rational expectations, market fundamentals and house price volatility, *Real Estate Economics* (24), 441-470.

Cook, S. and C. Thomas (2003), An alternative approach to examining the ripple effect in UK house prices, *Applied Economics Letters* 10,849-851.

Cui, G. (2006), Study on the relationship among housing price, land price and rent of Shanghai, *Real Estate Market* (4), 4-6.

Dahl, R. A. and C. E. Lindblom (1953), *Politics, Economics and Welfare: Planning and Politico-Economic Systems, Resolved Into Basic Processes*, New York: Harper and Brothers.

Deng, C. (2010), *Influencing Factors and Volatility Characters of Chinese Housing Price*s, Ph.D. Thesis, School of Economics and Management, University of Electronic Science and Technology of China.

Deng, X. (1995), Grey model of urban real estate development and macro-control, *Huazhong Architecture* 13(4), 53-55.

Ding, L. and B. Li (2002), Design on flow and construction technical outline of real estate market early warning control system, *Systems Engineering Theory & Practice* (4), 58-69.

Di Pasquale, D. and W. C. Wheaton (1992), The markets for real estate assets and space: a conceptual framework, *Journal of American Real Estate and Urban Economics Association* 20 (1), 181-197.

Dolde, W. and D. Tirtiroglue(1997), Temporal and spatial information diffusion in real estate price changes and variances, *Real Estate Economics* 25, 539–565.

Du, H. and Y. Ma (2009), Study on the Granger causality relationship between Chinese housing price and rent, *Management Review* 21(1), 94-99.

Du, H., Y. Ma and Y. An (2011), The impact of land policy on the relation between housing and land prices: Evidence from China, *The Quarterly Review of Economics and Finance* 51, 19-27.

Engle, R. F. (2002), Dynamic conditional correlation: a simple class of multivariate GARCH models, *Journal of Business and Economic Statistics* 20(3), 339-350.

Engle, R. F. and C.W. J. Granger (1987), Cointegration and error correction: representation, estimation, and testing, *Econometrica* 55(2), 251-276.

Engle, R. F. and K. F. Kroner (1995), Multivariate simultaneous generalized ARCH, *Econometric Theory* 11(1), 122-150.

Engle, R. F. and V. K. Ng (1993), Measuring and testing the impact of news on volatility, *Journal of Finance* 48, 1022-1082.

Fama, E. F. (1970), Efficient Capital Markets: A review of theory and empirical work, *The Journal of Finance* 25(2), 383–417.

Fisher, J. D. (1992), Integrating research on markets for space and capital, *Journal of American Real Estate and Urban Economics Association* 20(1), 161-180.

Fisher, J.D., S. Hudson-Wilson and C. H. Wurtzebach (1993), Equilibrium in commercial real estate markets: linking space and capital markets, *Journal of Portfolio Managemen*t 19, 101-107.

Fisher, R. A. (1934), *Statistical Methods for Research Workers*, Edinburgh: Oliver & Boyd.

Gao, B. and F. Mao (2003), A Test for relationship between estate price and land price: 1999-2002, *Industrial Economics Research* (4), 19-24.

Gao, X. (2001), The fundamental relationship between land price and housing price, *Chinese and Foreign Real Estate Times* 6, 21.

Geltner, D., D. M. Bryan and M. S. Gregory (2003), Appraisal smoothing and price discovery in real estate markets, *Urban Studies* 40(5-6), 1047-1064.

Giussani, B. and G. Hadjimatheou (1991), Modeling regional house prices in UK. *Regional Science* 70(2):201-219.

Granger, C. W. J. (1969), Investigating causal relations by econometric models and cross-spectral methods, *Econometrica* 37(3), 424-438.

Greene.W. H. (2003), *Econometric Analysis*, Prentice: Prentice-Hall.

Guirguis, H. S., C. I. Giannikos and L. G. Garcia (2007), Price and volatility spillovers between large and small cities: a study of the Spanish market, *Journal of Real Estate Portfolio Management* 13(4), 311-316.

Han, L. and K. Zheng (2008), The international information transmission of copper futures market, *Management Review* 20(1), 9-25.

Hannah, L., K. H. Kim and E. S. Mills (1993), Land use controls and house prices in Korea, *Urban Studies* 30:147-156.

Harris, R.D.F. and E. Tzavalis (1999), Inference for unit roots in dynamic panels where the time dimension is fixed, *Journal of Econometrics* (91), 201-226.

Hasbrouck, J. (1995), One security, many markets, determining the contribution to price discovery, *Journal of Finance* 50(4), 1175-1199.

Heij, C. P. de Boer, P. H. Franses, T. Kloek and H. K. van Dijk (2005), *Econometric Methods With Application in Business and Economics*, New York: Oxford University Press.

Himmelberg, C., C. Mayer and T. Sinai (2005), Assessing high house prices: bubbles, fundamentals and misperceptions, *Journal of Economics Perspectives* (19), 67-92.

Ho, L., Y. Ma and D. R. Haurin (2008), Domino effects within interrelated housing markets: the influence of house price appreciation and household wealth, *Journal of Real Estate Finance and Economics* 37(4), 299-316.

Hong, T., B. Xi and B. Gao (2007), Co-movement of real estate prices and spatial diffusion of bubbles: evidence from 35 metropolises in China from 2000 to 2005, *Statistical Research* 24(8), 64-66.

Hua, R. (2005), Empirical study of dynamic relationship between spot and futures prices: based Shanghai futures exchange, *China & World Economy* (8), 32-39.

Huang F., J. Zhou and Z. Li(2009), Relationships effect among housing prices of Chinese big cities based on cointegration and vector error correction model, *China Management Studies* 4 (2), 122-143.

Huang, H. and Y.Tang (2013), Residential land use regulation and the US housing price cycle between 2000 and 2009, *Journal of Urban Economics* 71(1), 93-99.

Im, K.S., M.H. Pesaran, Y. Shin (2003), Testing for unit roots in heterogeneous panels, *Journal of Econometrics* 115, 53-74.

Jin, H. and Y. Wang (2008), Analysis on operation mechanism of Chinese real estate macro-control policies, *Journal of Engineering Management* 5, 17-20.

Johansen, S. (1995), Identifying restrictions of linear equations with applications to simultaneous equations and cointegration, *Journal of Econometrics* 69(1), 111–132.

Jong F. and T. Nijman (1997), High Frequency analysis of lead-lag relationships between financial markets, *European Finance Review* 3,337-359.

Kao, C. (1999), Spurious regression and residual-based tests for cointegration in panel data, *Journal of Econometric*s 90, 1-44.

Kim, K. H., Y. J, Park, J.D, Shilling and H. Cho (2008), Do high land values cause higher house prices, or vice versa? *Working Paper,* KAIST Business School.

Kuang, W. (2005), Study on the relationship between housing price and land price: model and test with Chinese data, *Finance & Trade Economics* (11), 56-64.

Lai, K. and M. Lai (1991), A cointegration test for market efficiency, *The Journal of Futures Markets* 11(5), 567-576.

Larsson, R., J. Lyhagen and M. Löthgren (2001), Likelihood-based cointegration tests in heterogeneous panels, *Econometrics Journa*l 4,109–142.

Lee, C. C. and M. S. Chien (2011), Empirical modeling of regional house prices and the ripple effect, *Urban Studies* 48(10), 2029-2047.

Levin, A., C. F. Lin and C.S.J. Chu (2002), Unit root tests in panel data: asymptotic and finite-sample properties, *Journal of Econometric* 108, 1-24.

Lian, Y. and C.F. Chung (2008), Are Chinese listed firms over-investing? *Unpublished manuscript,* http://ssrn.com/abstract=1296462.

Lihara, Y. K. and T. T. Kato (1996), Intraday return dynamics between the cash and the futures markets in Japan, *Journal of Futures Markets* 16,147-162.

Liu, L. and H. Liu (2003), Economic analysis on the relationship between housing and land prices, *The Journal of Quantitative & Technical Economics* (7), 27-30.

Liu, Q. and Y. An (2011), Information transmission in informationally linked markets: evidence from US and Chinese commodity futures markets. *Journal of International Money & Finance* 30(5), 778-795.

Liu, Q., Q. Jin and R. Hua (2008), Information transmission between LME and SHFE metal futures markets, *Journal of Industrial Engineering and Engineering Management* 22(2), 155-159.

Love, I. and L. Ziccino (2006), Financial development and dynamic investment behavior: evidence from panel VAR, *Quarterly Review of Economics and Finance* 46, 190-210.

Luo, Z., C. Liu and D. Picken (2007), Housing price diffusion pattern of Australian State capital cities, *International Journal of Strategic Property Management* 11(4), *227-242.*

MacDonald, R. and M. Taylor (1993), Regional house prices in Britain: long-run relationships and short run dynamics, *Scottish Journal of Political Economy* 40(1), 43-55.

Manning, C. A. (1988), The determinants of intercity home building site price differences, *Land Economics* 64(1), 1-14.

McCoskey, S. and C. Kao (1998), A residual-based test of the null of cointegration in panel data, *Econometric Review* 17, 57-84.

Meen, G. (1999), Regional house prices and the ripple effect: a new interpretation, *Housing Studies* 14(6), 733-753.

Miles, W. (2008), Volatility clustering in U.S. home price, *The Journal of Real Estate Research* 30, 73-90.

Miller, N. and L. Peng (2006), Exploring metropolitan housing price volatility, *Journal of Real Estate Finance Economic*s (33), 5-18.

Monkkonen, P. and L. Ronconi (2013), Land use regulations, compliance and land markets in Argentina, *Urban Studies* 50 (10), 1951-1969.

Nelson, D. B. (1991), Conditional heterosdasticity in asset returns: a new approach, *Econometrica* 59,347-370.

Oikarinen, E. (2004), The diffusion of housing price movements from center to surrounding areas, *Journal of Housing Research* 15(1), 3-28.

Ozanne, L. and T. Thibodeau (1983), Explaining metropolitan housing price differences, *Journal of Urban Economics* 13, 51-66.

Payne, J. E. and A. P. Sahu (2004), Random walks, co-integration, and the transmission of shocks across global real estate and equity markets, J*ournal of Economics & Finance* 28 (2), 198-210.

Pedroni, P. (1999), Critical values for cointegration tests in heterogeneous panels with multiple regressors, *Oxford Bulletin of Economics and Statistics* 61,653–670.

Pedroni, P. (2004), Panel cointegration: asymptotic and finite sample properties of pooled time series tests, with an application to the PPP hypothesis, *Econometric Theory* 20,575–625.

Peng, L. and T. G. Thibodeau (2012). Government interference and the efficiency of the land market in China, *The Journal of Real Estate Finance and Economics* 45(4), 919-938.

Peng, R. and W. C. Wheaton (1994), Effects of restrictive land supply on housing in Hong Kong: an econometric analysis, *Journal of Housing Research* 5(2), 262-291.

Peter, R. and V. Kupke (2012), Granger causality test for the relationship between house and land prices. *Eighteenth Annual Pacific-Rim Real Estate Society Conference*, Adelaide, Australia.

Ross, S. A. (1989), Information and volatility: the no-arbitrage martingale approach to timing and resolution irrelevancy, *Journal of Finance* 44(1), 1-17.

Rutledge, R.W., K. Khondkar and R. Wang (2013), International copper futures market price linkage and information transmission: empirical evidence from the primary world copper markets, *Journal of International Business Research* 12(1), 113-131.

Ryoo, H. J. and G. Smith (2004), The impact of stock index futures on the Korean stock market, *Applied Financial Economics* 14, 243-251.

Shen, C. H. and L. R. Wang (1990), Examining the validity of a test of futures markets efficiency: A comment, *The Journal of Futures Market* 10(2), 195-196.

Shi, J.and T.Xu (2013), Price and volatility dynamics between securitized real estate spot and futures markets, *Economic Modeling* 35, 582-592.

Shi, S., M. Young and B. Hargreaves (2009), The ripple effect of local house price movements in New Zealand, *Journal of Property Research* 26(1),1-24.

Song, C. (2000), Establish an effective system of real estate macro control, *Urban and Rural Development* (3), 6-7.

Stevenson, S. (2004), House price diffusion and inter-regional and cross-border house price dynamics. *Journal of Property Research* 21(4), 301-320.

Torben, G., T. Andersen, F. X. Bollerslev, and C.V.Diebold (2007), Real-time price discovery in global stock, bond and foreign exchange markets, *Journal of International Economics* 27(2), 251-277.

Tse, Y. K. (1999), Price discovery and volatility spillovers in the DJIA index and futures markets, Journal *of Futures Markets* 19,911 -930.

Wang, S., Z.Yang and H. Liu (2008), Empirical study on the interaction of Chinese regional real estate markets, *Research on Financial and Economic Issues* 6,122-129.

Wen, H. and A. C. Goodman (2013), Relationship between urban land price and housing price: Evidence from 21 provincial capitals in China, *Habitat International* 40, 9-17.

Wong, S. K., C. Y. Yiu, K. S, Tse and K. W. Chau (2006), Do the forward sales of real estate stabilize spot price? *Journal of Real Estate Financial and Economic* 32(3), 289-304.

Wong, S. K., K. W. Chau and C. Y. Yiu(2007), Volatility transmission in the real estate spot and forward markets, *Journal of Real Estate Financial and Economics* 35(3),281-293.

Xiao, Y., D. Chen and S. Zhu (2006), Comparative research of real estate macro-control policy of Japan, America, Russia and Singapore, *Chang Jiang Forum* (3),87-90.

Xie, X. (2006), Empirical study on the relationship between housing price and land price of Shanghai, *World Economic Outlook* (12), 30-33.

Xie, Y. (2004), Study on the price of Beijing, Shanghai, Hangzhou and Shenzhen based on the ratio of housing price to rent, *Zhe Jiang Economy* (10), 25-28.

Xu, D. (2006), *Housing Price and Bubble Economy*, Beijing: Machinery Industry Press.

Xu, Y. and D. Li (2008), Research on the ripple effect of Chinese housing prices, *Statistics and Decision* (21), 15-17.

Xue, Z. (2012), *Research on the Influence of Real Estate Macro Policy Based on the Expectation Theory*, Master Thesis, University of Science and Technology of China.

Yan, M., S. Ba and B.Wu (2009), The price discovery and volatility spillover of Chine futures stock index markets, *Journal of Systems Science and Systems Engineering* 27(10), 32- 36.

Yan, S. and J.Ge (2014), Direct government control over residential land supply and its impact on real estate market: evidence from major Chinese markets. *20Th Annual Pacific-Rim Real Estate Society Conference*, Christchurch, New Zealand.

Yin, L and L. Han (2013), Exogenous shocks and information transmission in global copper futures market, *Journal of Futures Markets* 33(8), 724-751.

Yiu, C. Y., E. C. M. Hui and S. K. Wong (2005), Lead-lag relationship between the real estate spot and forward contract markets, *Journal of Financial Management of Property and Construction* 11(3), 253-262.

Zeng, X. and A. Zhang (2006), A Granger study on the relationship between land and housing prices, *China Land Science*, 20(4),57-61.

Zhang, D., W.C. Cheng and Y. K. Ng (2013), Increasing returns, land use controls and housing prices in China, *Economic Modeling* 31,789-795.

Zhang, H. (2004), *Handouts of Real Estate Economics*, Beijing: Tsinghua University Press.

Zhou, Y. (2005), A economic analysis on the relationship between current Chinese housing price and rent: an explanation from market segment theory, *Contemporary Finance & Economics* (10), 13-16.

Zhou, Z. (2007), Reference and inspiration from foreigner real estate macro-control policies, *Special Zone Economy* (1), 87-89.

Zhu, D. and M. Dong (2006), Economics analysis on land price and housing price, *China Land* (7), 20-21.