Housing prices dynamics in China

A case study of Shanghai, Tianjin and Hefei
Abstract

This paper studies the fundamental determinants of housing prices in three different developed cities in China. The main question addressed is whether fluctuations in the fundamental determinants of housing prices around the world have an impact on housing prices in China. The theoretical framework shows that housing prices in China are determined to a large extent by stipulated factors that affect other big cities. They are: income per capita, interest rate, land price, construction cost and population and stock price.

We use a linear regression model in our article. The empirical testing shows that these six determinants used in Western countries are also applicable to Chinese real estate market. Most of them succeed in explaining the dynamics of housing prices. However, the results of the empirical testing are different among the three cities, so specific economic environment of the three cities are necessary to understand the results.

In our opinion, although some of the determinants fail to explain the fluctuations of housing prices, it is early to say there are bubbles due to the short history of Chinese real estate market. However, if policies are not implemented to calm down the overheating market in some first-tier cities, the consequences are hard to identify.
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1 Introduction

In the last few years, a hot issue in China has been the incredibly soaring housing prices and the dramatic increase in sales of commercial houses in some big cities.

In 2009, the total sales of commercial houses amounted to 4,400 billion yuan, up by 75.5 percent year-on-year, of which the sales of commercial residential buildings surged 80 percent. (National Bureau of Statistics of People's Republic of China, 2009) The investment in real estate development was 3,623 billion yuan, up by 16.1 percent in 2009. (National Economic and Social Development, 2009) As shown in Figure 1-1, the percentage of sales of commercial houses in GDP has increased in the last decade; the contribution of commercial housing market to GDP is increasingly important. In 2009, the sales of commercial houses as a proportion of GDP is 13.12%, more than doubled of the number in 2002, which is only 5.89%. It proves that real estate market in China has developed significantly in last decade.

![Figure 1-1 Sales of Commercial Houses/GDP](image)

Source: Made by the author, data from National Bureau of Statistics

Furthermore, the average price of new homes rose about 25.1% last year. This is largely due to the boom of housing prices in some well-developed cities, especially in the four first-tier cities. In the fourth quarter of 2009, the average price of new homes in urban Shanghai, Beijing, Shenzhen and Guangzhou surged 86.9%, 63.0%, 65.7% and 39.5% year on year to RMB31,314, RMB22,571, RMB20,893 and RMB 17,268 per sq m, respectively. (Knight Frank, 2010)

The drastic increase symbolizes an occurrence which China has never experienced before. It has raised concerns amongst policy-makers about the inherent instability that this asset price increase will cause. One characteristic of instability is that fundamental determinants, the basic macroeconomic factors which influence either supply or demand in the real estate market, fail to explain the fluctuations of housing prices. In this thesis, we analyze whether six fundamental determinants applicable to Western countries could explain the dynamics of housing prices in Chinese real estate market.
“If the reason the price is high today is only because investors believe that the selling price will be high tomorrow when ‘fundamental’ factors do not seem to justify such a price then a bubble exists”

---- Joseph Stiglitz

Although the increase of housing prices in China has caught the attention of many scholars, almost all analysis on housing prices has focused on the studies of either individual metropolitan housing markets or the country-level housing market. However, analysis of an individual market has less power to reflect economic fluctuations and the country-level analysis based on the aggregate statistics fails to capture the swings in some specific regions. (McCarthy & Peach, 2004) Therefore, to make the analysis capture more information, we analyze the housing prices dynamics in three cities which are different in the level of economic development. These three cities are Shanghai, Tianjin and Hefei.

In this article, the behaviour of housing prices, disposable income per capita, interest rate, stock price, population growth, construction cost and land price is studied within the context of a simple linear regression model. The empirical framework permits us to identify the response of housing prices to changes in a small set of key determinants. (Tsatsaronis & Zhu, 2004)

Although the housing prices in first-tier cities have soared up last year, it is still early to say that there are bubbles in the market. This is largely due to the short history of Chinese real estate market. Chinese real estate market became an open market since 1998. Therefore, the observation of the market only covers the period between 1998 and 2009. It is a relatively short period in the timeline. Then even the price appears an upward trending recently, it is hard to identify whether in the long run, it is the peak of the wave. In another word, if the market has a long history, maybe it is just a soft fluctuation.

Our main result is that, overall, disposable income per capita, interest rate, population, stock price, land price and construction cost are important determinants of housing prices in the three cities, although not all six determinants are statistically significant in affecting housing prices in each city. Taking all the determinants into account, we believe that fundamental determinants are to some extent strong enough to explain the dynamics of housing prices in China. And the linear regression output suggests that most of results are consistent with previous empirical analysis of Western countries.

1.1 Purpose

The purpose of this thesis is to analyze whether disposable income per capita, interest rate, stock price, land price, construction cost and population have played a role in the observed housing prices dynamics in China. These six factors are the basic determinants of market supply and demand. To be more concrete, since we use linear regression model in our article, we basically analyze whether the housing prices are linearly related to these six determinants by using data from 2003:q1 to 2009:q4 of three different developed-level cities. It should be noticed that the determinants of housing prices in our model draw on the standard variables used in the previous literatures. Our task here is to investigate whether these six determinants used by other scholars in analyzing Western housing market can also explain the housing prices dynamics of China.
1.2 Outline

The outline of the paper is as follows. Section 2 provides a brief background of markets and policies that are useful in this article. The next section supplies an overview of the previous literatures on the determinants of housing prices and introduces theoretically how each determinant applied in this article affect the housing prices. The subsequent section presents our empirical model, describes techniques of estimation, introduces the data deficiencies and shows the results of empirical testing. The following section analyzes the potential reasons of the results. Finally, the last section draws concluding remarks.
2 Background

In this section, we introduce the development of Chinese real estate market first. (Section 2.1) It gives the readers a brief background of Chinese real estate market’s route of development. Then we introduce government’s land policies and regional division used in Chinese real estate market.

2.1 The development of real estate market

In section 2.1, we present the development of real estate market after 1998 and introduce the major policies which have promoted the development of real estate market.

Chinese real estate market became an open market since 1998. Before 1998, the houses were welfare oriented distributed. Government assigned funds to public institutions and enterprise units. These two types of institutions then built and allocated houses to their employees. The eligibility of allocation was dependent on employees’ length of working, age, generations in the family, number of family members and working achievements. The rents paid by the employees were much lower than the sum of construction, protection and maintenance costs of the houses.

To promote marketization, government began to push the housing reform vigorously by issuing the 1998 State Council document on Further Deepening Housing Reform and Accelerating Housing Construction. The issue of this reform stopped the welfare-oriented public housing distribution system, transferred the public housing to be private properties of the employees of Danweis, and boosted the real estate industries for housing provision. This reform accelerated the privatization of public apartment. (Zhang, 2009) It formally released the nation from being the only provider of houses.

State Council Document [1998] No.23 Notice of the State Council on Further Deepening Urban Housing System Reform and Speeding Up Housing Construction advocated to implement different housing supply policies to different income level households. After the implementation of this document, government- or organization-funded houses at low rents were provided to the lowest income level households, affordable houses at moderate price were provided to moderate income level households, and commodity houses at market price were provided to high income level households. (Nie, 2004)

Although the issue of the document aimed at establishing a multilevel housing supply system, the objective of policies shifted from providing affordable houses at subsidized prices to providing commodity houses at market prices after 2003. The eagerness of government to promote the lucrative commercial housing projects was to generate an upward trending GDP and contributed extra revenue through land lease. (Yan, 2009)

2.2 Land policy

Land in China is state-owned. Government is the monopolistic supplier in the land market.

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1 Danwei, a work unit, is the name given to a place of employment

2 Notice of the Ministry of State Land and Resources on Strengthening the Land Supply Management and Promoting the Sustainable Sound Development of Real Estate Market (No.356 (2003) of the Ministry of State Land and Resources)
Chapter 10 in *the Constitution Of The People's Republic Of China* prescribed that land in the cities is owned by the state. In other words, a house purchaser has the ownership of the house which he or she bought, but he or she does not have the ownership of the land in which the house is build.

Furthermore, the buyer of a house only has the right to use the house he or she bought for 70 years. Since Chinese real estate market became an open market and private transactions of houses were allowed since 1998, we cannot predict the consequences after the right of use expired.

### 2.3 Description of regional division

In this subsection, we introduce how we divide regions and how we pick the representative cities.

China is divided into twenty-three provinces, five autonomous regions, four municipalities directly under the central government and two special administrative regions. It should be said that the formation of regional economies in Mainland China is a result of the interaction between each region’s economic development level and geographic characteristics. Because of the geographic differences and policy biases, regional disparities among cities are very large.

Besides the overall development disparities, the development level of each industry also has large gaps among different cities or provinces. Specific to real estate market, since there are 655 cities in China, Chinese real estate developers always divide cities into several groups to simplify their analysis. In our article, we concentrate on three cities. They are Shanghai, Tianjin and Hefei. These cities represent three different developed level of real estate industry in China. (The division of cities: first, second and third tier, 2010)

1. **First-tier cities:**

   Four cities are grouped into first-tier cities, which are Shanghai, Beijing, Shenzhen and Guangzhou. The development of real estate industry in these four cities is obviously ahead of other cities. Generally, they represent the highest level of Chinese real estate industry.

2. **Second-tier cities:**

   Except the four first-tier cities, cities which fulfill the following criteria are grouped into second-tier cities.

   1. Gross Domestic Product is equal to or larger than 200 billion Yuan
   2. GDP per capita is equal to or larger than 14,000 Yuan
   3. Number of permanent resident population is above one million
   4. Build-up area of the city is equal to or larger than 100 square kilometers
   5. The annual floor spaces of commercial houses sold accounts for more than 150 million square meter
   6. The average sales price of commercial housing is above 4,000 yuan/square meter
According to these criteria, secondary provincial capitals (consisting of 23 cities) are treated as second-tier cities.

3. Third-tier cities:

Cities that fail to fulfill one or several of these requirements are treated as third-tier cities. Most prefecture or county level city capitals are included in the third-tier group.

In this article, we pick one city from each of the three groups. These three cities are the leading cities in their groups. Their economic developed level is overhead other cities in their groups, but the tracks of their economic development could guide the development of other cities.

1. First-tier city: Shanghai

In the view of economic development, Shanghai is now the leading city of first-tier cities. Residential units in Shanghai are now the most expensive across China in December 2009; 14.9% of new home sales in the city were worth over RMB5 million. (Frank, 2010)

2. Second-tier city: Tianjin

In the past years, Tianjin has cemented its position as the leading second-tier city and possesses the greatest potential to become China’s fifth first-tier city. The city’s efficient transportation links make it an attractive location for the manufacturing and logistics sectors. It is the leading second-tier city that enjoys the fastest growing property market. (Jones Lang LaSalle, 2009)

3. Third-tier city: Hefei

Hefei, the provincial capital of Anhui province, is among those cities which have experienced the strongest economic growth in last few years. Its economy was growing at 17-18% in the past two years. (Jones Lang LaSalle, 2009)
3 Interpretation of fundamental determinants

This section supplies an overview of the previous literatures on each of the determinants of housing prices, highlights why each determinant is important to Chinese real estate market and introduces theoretically how each determinant affects the housing prices. (The empirical results are presented in Section 4)

3.1 Interest rate of loans

The empirical literature using interest rate of loans as a fundamental determinant of housing prices is vast. For example, Sutton (2002) in his article captures the effects of some fundamental macro variables on housing prices. He also suggests that a decline in interest rate will lead to higher housing prices.

Specific to Chinese market, the importance of financial instruments is enhanced by ongoing structural changes in the market; a downward-trending interest rate of loans, coupled with loose credit policies, has definitely played an important role in determining the fluctuation of housing prices.

In this section, why changes in mortgage rate have impact on real estate market and how this influence works are discussed theoretically.

Real estate market is significantly depending on loans from banks. From the point of view of suppliers in the housing market, as a capital-intensive industry, each phase in every real estate development requires large amount of funds to back up the operation. Enterprises are hard to sustain their investment and production if they only rely on self-raising funds without seeking for the help of loans from financial institutions. From the point of view of consumers, pay in full is unrealistic to majorities either. Thus, loans from bank are crucial source of raising funds in real estate market.

Because housing market generally requires large external financing, the cost of loans and the conditions under which the loans become available play an irreplaceable role in shaping the pattern of housing prices dynamics. (Tsatsaronis & Zhu, 2004) Basically, the cost of loans is the interest rate adjusted by the central bank.

We start our analysis from the point of view of suppliers in real estate market. Based on Keynes theory, enterprises’ investment is influenced by the magnitudes of marginal rate of return of assets and interest rates. When the marginal rate of return is keeping constant, a sharp increase of interest rate raises the expenses of raising funds and reduces the expected rate of return of investment. Quantity supplied in the market falls subsequently in the long run. In other cases, when the marginal rate of return of assets fluctuates (which may be caused by external economic fluctuations), the amount of loans of enterprises may still raise even if the interest rate goes up, as long as the marginal rate of return is bigger than the interest rate. (marginal revenue > marginal cost)

Now let’s consider the condition of consumers in real estate market. Generally, the consumers in the real estate market can be categorized into two groups, depending on their objectives of purchases. From consumption-inclined consumers’ view, a house is perhaps the largest single assets of most households. The costs of mortgage are therefore inevitably considered as a factor which significantly affects their willingness to purchase. To investment-inclined consumers, the value of residential real estate represents an important component in their aggregate portfolio. As a result, when interest rate goes up quantity demanded declines, no matter the consumers are investment-inclined or consumption-inclined.
Totally speaking, both quantity demanded and quantity supplied move in opposite direction to the changes of interest rate of loans. Since both curves are negative related to fluctuation of interest rate, specific economic environment and the elasticity of demand and supply will determine the trends of price.

### 3.2 Stock price

Specific to Chinese market, the development of stock market is complicated. Up to now, the market still has space to be further organized and developed. Therefore, the way it interacts with property market is unique from other countries. From the point of view of real estate development, the potential effects of fluctuations in stock price on housing prices can be summarized in three forms: (Yu & Kang, 2008)

1. **Crowding out effect:**

   Stock and real estate as two main parts in the investment portfolio are both risky assets. The proportion of risky assets in the portfolio increases when stock price goes up. In order to balance the risk, risk neutral investors have a propensity to cut down the funds in risky assets and transfer some into risk-free assets. Thus when investors reduce the funds in stock market, houses as a risky asset will also be involved in the funds-reduction scheme. Hence, crowding out effect causes the housing prices to decline.

2. **Substitution effect:**

   All else equal, when the rate of return of one asset in the portfolio changes substitution effect also plays a crucial role.

   When the rate of return in real estate market is higher than that in the stock market, parts of funds will shift into real estate market and drive the price up. By contrast, stock price goes up when the rate of return on investment in stock market is greater than that in real estate market, due to the inflow of funds from real estate market into the highly prosperous stock market. In another word, substitution effect leads the housing prices and stock price to move in opposite direction. (Yin, 2007)

3. **Wealth effect:**

   Wealth effect leads housing prices and stock price to move in the same direction. (Shiller, Case, & Quigley, 2001)

   When the value of stock portfolios rises because of escalating stock prices, investors feel more comfortable and secure about their wealth, causing them to spend more. People then choose how to deal with the funds that they gain from the bullish stock market. Investment, consumption and saving are the main options. Consequently, some of the funds gained from stock market are swarming into real estate market, driving housing prices up. Meanwhile, the stimulated housing market responds to stock market in the similar way. Therefore, the interaction accelerates the mutual flourishing of these two asset market.

### 3.3 Disposable income per capita

Intuitively, housing prices should appear an upward trend as disposable income per capita in society grows. When disposable income increases, people feel secure of their lives since they have more money in hands. The extra investment and consumption from households
will therefore accelerate the flourishing of real estate market and promote the increase of housing prices.

The impact of income growth on housing prices is a form of wealth effect. Although the magnitude of this effect remains controversial, disposable income is taken as a determinant of housing prices by almost every study about related topics, such as Égert & Mihaljek (2007), Sutton (2002), Girouard, Kennedy, Noord, & André (2006).

Theoretically, housing prices has a long run relationship with disposable income. (Fraser, Hoesli, & Mcallevey, 2009) But the responsiveness of housing prices to innovations in income varies over both time and markets. Under certain conditions, income growth on its own fails to explain the path of housing prices. For example, during the years of real estate bubble, housing prices moves essentially in line with neither income nor other fundamental determinants. Tsatsaronis & Zhu (2004) examine the housing prices fluctuations in 17 industrialized economies between 1970 and 2003 and prove that household income has a very small explanatory power over housing prices movements either. By contrast, the changes in income are strongly positively related to changes in housing prices in Central and Eastern Europe. (Égert & Mihaljek, 2007)

3.4 Population

From the paper published by Mankiw & Weil (1989), they came to the conclusion that the birth rates did play an important role on the housing prices changing. From the previous research, we are going to include the one of the major demographis factors in our model, which is population.

Supply and demand is the basic economic principle in which a product’s price is either positively or negatively affected by the availability of the product. And in the real estate market, the basic principle also can be applied. In the neo-classical economic framework, the variation of the housing prices is due to the imbalance of the supply and demand of the quantity of houses. And the volatility of housing demand will have an impact on the housing prices. To be specific, if there is an excess demand over supply of the houses in the housing market, the housing prices will be driven upwards, vice verse.

In this part, we are going to analyze how the demand side of houses influence on the housing prices. First of all, we need to figure out what cause the demand disparities. Basically, we can categorized the demand resource into two parts. One is originated from the baby boomer in 1960’s, and another one is derived from the process of the urbanization based on the situation that inequal booming of the economy in China. One point is worthnoting that due to the absence of the quarterly data set of age population, only theoritical part associated with the first part will be presented, however, regarding to the second part, both theoretical part and the simple empirical test will be presentd.

3.4.1 Baby boomer generation and housing price

Based on the researches made by scholars across the world, like USA and Japan, baby boomers generation has significant impact on the domestic housing prices. Does baby boomers generation in China share some similarities with them; are the housing prices affected by the baby boomers?

Baby boomers generation of China is defined as people who were born during the period of 1962 to 1980. And according to the National Bureau statistic of China, people who were
born during the baby boom accounts for approximately 43% of the residential citizenship, which implies that the baby boomers are becoming a part that cannot be ignored.

In the past two decades, China came into economy booming time. During this time, the consumption and the productivity will be strengthening as the growth of the economy. Houses, as a common commodity will be consumed more than ever. More importantly, people who were born in the baby boom are turning into the middle age. In the middle-aged point, people are willing to get married and live separately with their parents; hence, there is an increasing demand of the houses.

The age structure also matters on the house demand issue. We simply define the age into three groups, which are youth, middle-age and elder. It is a fact that people who are in the middle age have higher purchasing power than those who fall in the groups of youth and elders. Simply because, young people will start from the bottom due to lack of experience and other reasons, so they have the high possibility to get lower salaries compared with those who are in the golden times of their careers (middle-aged people). On the other hand, even though people who are categorized as elder might have more accumulated income, they do not have the need to buy a new house since their spatial space are decreasing or they already have a house to live. As a whole, the middle-aged group has higher purchasing power than young-aged group and higher demand for a residential house comparing with the elder people.

Therefore, we can come to the conclusion that baby boomers do play an vital role in waving up the demand of the houses, which cause the housing prices in chinese housing market to rise.

\subsection*{3.4.2 Urbanization and housing prices}

Similarly, the supply and demand curve shifts will result in the housing prices dynamics. And urbanization is also one of the factors that shift the demand curve.

Urbanization is defined as movement of people from rural to urban areas with population growth equating to urban migration. In the past decades, China has gone through an incredible high urbanization process comparing with the rest of the world. The urbanization process would have definitely some impact on the housing demand since the demand is mainly from the people who live in the area.

Next, in order to figure out the impact of the urbanization on the housing prices, we first need to find out what shifts the demand curve of houses. With the influence of the global industrialization, more and more people who live in the rural area have moved into urban area in order to have a better living and working condition. The first reason of this movement could be the result of WTO. Since 2001, China became one of the members of WTO, which brought both opportunities and challenges to Chinese economy. After the enter of WTO, China agreed to allow foreign direct investment, lower the tariffs and established the trade relationship with USA by allowing the imports of agriculture products. Does the last policy hurt the behalf of Chinese farmers? Chinese farmers are self-employed and they are highly relying on the income of retailing grains. In order to compete with foreign agriculture products, domestic producers might reduce the price and also improve the quality. Those firms who fail in the competition have to adjust and even be crowded out of the market. Since 2001, a majority of farmers who felt difficult to survive from the competition
have moved into cities in order to find a better job with relatively higher income. This movement may contribute to the increase in demand of houses in China.

Furthermore, in order to improve the rural area economy development, the government adopted the plan named rural-urban integration in the last decade, which will also shift the labour force into cities and large amount of houses will be needed. The process mentioned above also shifts the demand curve upwards and then drives up the housing prices.

### 3.5 Land price

There are vast majority of literature studying on the relationship between the land price and housing prices in China, because the land policy in China has significant differences with the western land policy. The major difference lies in the ownership of the land. As we mentioned in the background part, in China, the land is state-owned and the public or the individual sectors only have the right for some certain periods of time to utilize. The logic behind this is that profits from selling lands take a large composition of fiscal revenues of local governments.

It is necessary to introduce briefly the reform of tax policy in China. Since the reform of tax division system between local government and central government in 1994, central government has begun to control 75% of the yearly tax revenue. Land transfer fee, a one-time tax payable to the local government bodies in the area where the land is being bought are distributed to local governments as a compensation of their revenue deficits. Therefore, over these years local governments’ fiscal revenues are highly reliable to the transfer fee from selling lands to real estate developers. Actually, the proportion of land transfer fee in local governments’ fiscal revenue is around 53%. Hence, local governments as the monopolist in land market have the incentive to jack up land prices, which aggravate burdens on the shoulders of real estate developers.

Let’s take Shanghai for instance. (We failed to find the aggregate data for the whole country) Figure 3-1 describes the average percentage of costs of purchasing lands in total costs for each real estate development in Shanghai. It is observable that among all the costs of real estate development, the costs of lands occupy the largest proportion of the developers’ funds.

![Figure 3-1](image_url)
Now we are going to figure out what the theoretical reasons are based on the other literatures regarding to the land price and housing prices relationship.

As a commodity, land is a complementary commodity of the houses. As a result, their prices are tied together in the real estate market. To be specific, if the price of land goes up, so the housing prices will, vice versa. Now let’s look at the housing market from the view of its cost. It is not difficult to figure out that the cost of houses is roughly composed from the land cost, construction cost, management fees and some other taxes. However, based on the unique Chinese land market, we believe that land cost weighted most on the housing cost.

By and large, the housing prices must be tied together with the land price as the previous researches suggested. However, one thing needed to be notified is that the weights of land cost playing in the housing cost vary from different cities because of the different economic situations.

### 3.6 Construction cost

Comparing with the demand of housing studies, the studies on the supply side is less common due to lack of data collection. However, with the improvement of the technique changing and statistical completion, the studies on the supply side of the housing has increased substantially. The producers are willing to reduce the residential construction when the cost of doing it is high, vice versa. Apart from the land cost, the construction cost is also one important component of the housing cost. Since the construction cost has some significant impact on the housing supply the housing prices it is introduced by vast majority of the scholars. For instance, Somerville (1999) mainly studies on the inter-temporal behavior of construction cost by presenting quality-controlled hedonic construction cost series. He comes to the conclusion that the elasticity of housing prices with respect to construction cost is quite high, which means a small increase in construction costs will cause the housing prices to drop by a large amount. He also proves that higher construction cost reduces residential construction.

It is important to reiterate the fundamental economic theory which tells us that the equilibrium price of the residential houses is determined by the quantity of supply and demand. Hence, a shift in either supply or demand will drive up or down the housing prices. Construction cost is defined as part of the housing cost. When the construction cost goes up, the supply of the houses will decrease and consequently the housing prices will be driven up. Although the construction cost weights differently in the costs of real estate development in different housing market, the impact of changes in costs on the supply of the houses will halt the investment in the housing market as well as the developer’s profits to some extent. And the question is if this theory holds in the Chinese housing market? In the following section we are going to do the empirical testing to check if this relationship holds in the three housing markets in China.
4 Empirical testing

This section presents our empirical model, describes techniques of estimation, introduces the data deficiencies and shows the results of empirical testing.

4.1 Model of empirical testing

In this article, we apply a simple linear regression to test whether there is a significant relationship between each determinant and housing prices.

In the regression model, housing price is the dependent variable; land price, stock price, disposable income per capita, construction cost, interest rate and population are the independent variables.

We do the hypothesis testing for each coefficient at the significance level of 5% to test whether each determinant has impact on housing prices and use p value, t statistics and confidence interval to see whether the result is the same by using different methods.

If we reject the null hypothesis, this means there is some significant relationship between housing prices and the estimated determinant. If test suggests that the coefficient of the estimated determinant is insignificant, then we are going to present the possible reason of why the result is inconsistent with our prediction. (In section 5) The analysis would combine each region’s specific situation with the economic theories.

4.2 Data deficiencies

This thesis analyses the impact of fundamental determinants on housing prices in three cities during the period of 2003 to 2009. To cover this period, only quarterly data of year-on-year housing prices indices, land price indices and construction cost indices are available. Year-on-year housing prices index of this period is calculated on the base of the same period in the last year. For example, if the housing prices index in quarter 1 2009 is 103, it implies that the housing prices has increased 3% compared with its price in quarter 1 2008. (The method of calculation is also applicable to construction cost index and land price index) Consequently, in order to match the property of these three variables, we transfer the data of other determinants into year-on-year quarterly data.

There are some deficiencies of the data used in this article:

1. The National Bureau of Statistics started to supply month-on-month data in late 2007. So all the data used in this article are year-on-year growth rate. The year-on-year growth rate fails to capture the continuous changes in the determinants. This may mislead our empirical testing results. However, there are also some advantages of using year-on-year data. For instance, year-on-year data eliminate the seasonal effects. And because the property of the data is growth rate, we do not need to use the log-lin model.

2. Theoretically, there may be imperfect multicollinearity in our model. Some of the determinants are correlated with each other. For example, an adjustment of interest rate may also have impact on the level of stock price. However, the correlation matrices of the independent variables (Appendix 2) do not show obvious multicollinearity.

3. Besides the deficiencies of data, there are also limitations of our model due to the property of linear regression model. Correlation coefficient in our model is a meas-
ure of linear relationship between two variables. However, there could be non-linear relationship between the dependent variable and an independent variable. For example, the coefficient of stock price may be statistically insignificant in our model, this only means that stock price is not significantly linear related to housing prices, but in fact stock price and housing price may connect with each other in a non-linear way.

### 4.3 Empirical testing result

The table below shows the results of the empirical testing. We use quarterly data from 2003 to 2009, so the total observations in the model are around 28.

<table>
<thead>
<tr>
<th></th>
<th>Shanghai</th>
<th>Tianjin</th>
<th>Hefei</th>
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<tr>
<td>Income per capita</td>
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</tr>
<tr>
<td></td>
<td>(s.e. 0.327149)</td>
<td>(s.e. 0.157239)</td>
<td>(s.e. 0.044604)</td>
</tr>
<tr>
<td></td>
<td>(t-test 1.761522)</td>
<td>(t-test -1.051004)</td>
<td>(t-test 2.229981)</td>
</tr>
<tr>
<td></td>
<td>(p-value 0.0961)</td>
<td>(p-value 0.3089)</td>
<td>(p-value 0.0395)</td>
</tr>
<tr>
<td>Construction costs</td>
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<td>1.070842***</td>
<td>0.434591*</td>
</tr>
<tr>
<td></td>
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<td>(s.e. 0.209021)</td>
<td>(s.e. 0.105459)</td>
</tr>
<tr>
<td></td>
<td>(t-test -0.558343)</td>
<td>(t-test 5.123143)</td>
<td>(t-test 4.120941)</td>
</tr>
<tr>
<td></td>
<td>(p-value 0.5839)</td>
<td>(p-value 0.0001)</td>
<td>(p-value 0.0007)</td>
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<tr>
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<td>0.314259*</td>
</tr>
<tr>
<td></td>
<td>(s.e. 0.127364)</td>
<td>(s.e. 0.060749)</td>
<td>(s.e. 0.079858)</td>
</tr>
<tr>
<td></td>
<td>(t-test 5.988431)</td>
<td>(t-test 0.922096)</td>
<td>(t-test 3.935224)</td>
</tr>
<tr>
<td></td>
<td>(p-value 0.0000)</td>
<td>(p-value 0.3702)</td>
<td>(p-value 0.0011)</td>
</tr>
<tr>
<td>Population</td>
<td>3.545454***</td>
<td>0.830038</td>
<td>0.483506*</td>
</tr>
<tr>
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<td>(s.e. 1.114634)</td>
<td>(s.e. 0.673829)</td>
<td>(s.e. 0.203191)</td>
</tr>
<tr>
<td></td>
<td>(t-test 3.180823)</td>
<td>(t-test 1.231823)</td>
<td>(t-test 2.379563)</td>
</tr>
<tr>
<td></td>
<td>(p-value 0.0055)</td>
<td>(p-value 0.2358)</td>
<td>(p-value 0.0293)</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>0.066995</td>
<td>-4.708294***</td>
<td>0.041187</td>
</tr>
<tr>
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<td>(s.e. 0.097683)</td>
<td>(s.e. 1.206302)</td>
<td>(s.e. 0.045552)</td>
</tr>
<tr>
<td></td>
<td>(t-test 0.685842)</td>
<td>(t-test -3.903080)</td>
<td>(t-test 0.904165)</td>
</tr>
<tr>
<td></td>
<td>(p-value 0.5021)</td>
<td>(p-value 0.0013)</td>
<td>(p-value 0.3785)</td>
</tr>
<tr>
<td>Stock Price</td>
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<td>-0.023492</td>
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<tr>
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<td>(s.e. 0.013451)</td>
<td>(s.e. 0.009693)</td>
<td>(s.e. 0.006319)</td>
</tr>
<tr>
<td></td>
<td>(t-test -2.666987)</td>
<td>(t-test 3.499739)</td>
<td>(t-test -3.717382)</td>
</tr>
<tr>
<td></td>
<td>(p-value 0.0163)</td>
<td>(p-value 0.0030)</td>
<td>(p-value 0.0017)</td>
</tr>
<tr>
<td>R²</td>
<td>0.900797</td>
<td>0.755238</td>
<td>0.859206</td>
</tr>
<tr>
<td>Adjusted R²</td>
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<td>0.663452</td>
<td>0.809514</td>
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<tr>
<td>F-statistic</td>
<td>25.72757</td>
<td>8.228272</td>
<td>17.29068</td>
</tr>
</tbody>
</table>

Table 4-1 the output of linear regression model (Appendix 2)

Notes: there is a star for the significant results. If the coefficient is below 0.1, there is one star. If it is between 0.1 and 1, there are two stars. If the coefficient is above 1, there are three stars. The stars show how much the determinant affects housing prices.

Results:

1. The table above shows the significance of disposable income’s coefficient in Shanghai, Tianjin and Hefei. Income growth is positive related to the growth of housing prices in Hefei while in other two cities the coefficient is insignificant. Furthermore, although the coefficient is significant in Hefei a change of income per capita only influences the housing prices by a small amount (coefficient with one star)
2. Stock price’s empirical testing result is significant in all three regions, proving that there is indeed interplay between the two asset classes. However, sign of the stock price coefficient is different among the three regions. Stock price is negative correlated with housing prices in Shanghai and Hefei but positive correlated with Tianjin. Similar to the results of income per capita, changes in a small set of stock price do have an effect on housing prices but the effect is relatively slight. (coefficient with one star)

3. The result of interest rate of loans is significant only in Tianjin. In Shanghai and Hefei, empirical testing does not suggest a linear relationship between housing prices and interest rate of loans. In the case of Tianjin, interest rate is strongly negative correlated with housing prices. (coefficient with three stars)

4. The result of population coefficient proves that there is some significant relationship between housing prices and population in Shanghai and Hefei. But the p-value and t-statistic of Tianjin suggest that the coefficient of Tianjin is insignificant. Changes in a small set of population have a great impact on housing prices in Shanghai while have a relatively slighter influence on housing prices in Hefei. (coefficient with two stars and three stars respectively)

5. Land price is positive related to housing prices in both Shanghai and Hefei. But its coefficient is statistically insignificant in the case of Tianjin. And the influence of land price on housing prices is relatively strong in these two cities. (coefficient with two stars)

6. Construction cost is positive related to housing prices in both Tianjin and Hefei but statistically insignificant in the case of Shanghai. And changes in a small set of construction cost have a great impact on housing prices in Tianjin while have a relatively slighter influence on housing prices in Hefei.

7. The results of some coefficients in Shanghai and Hefei are similar, while in Tianjin the results of coefficients seem different with the other two cities. (further analysis will be done in Section 5.5)
5 Analysis of the empirical testing result

This section analyzes the potential reasons of the empirical testing results.

5.1 Disposable income per capita

The comparison of income growth and housing prices growth is made to analyze the probable reason of the income per capita’s empirical results.

The figures below indicate the growth rate of disposable income per capita and growth rate of housing prices in three regions. Due to the loose and tight credit policies, real estate market has experienced a boom and a depression in 2004 and 2008, respectively. Looking at the vertical axis, the scale of fluctuation in Shanghai is largest, followed by Tianjin; Hefei has relatively moderate fluctuations. In Shanghai and Tianjin, the growth rate of housing prices outweighed the growth rate of disposable income per capita in most of the years from 2001 to 2009. This phenomenon may be caused by the rapid economic development.

The development of Tianjin and Shanghai is reliable on the non-local investment by a large extent. In the last decade, people in growing number have swarmed into Shanghai and Tianjin, especially those possessing a great amount of funds and aiming at invest in economic booming regions. The majority of these investors do not have resident permit, which leads their income being excluded from the calculation of disposable income per capita within an area. This is probably the main reason of why the income growth fails to explain the growth of housing prices.

At the end of 2008, total number of floating population in Shanghai is 64 million, more than one-third of the number of permanent population. Up to 2009, the permanent population in Tianjin is around 123 million and the floating population is around 25 million. Furthermore, the situations of other cities which are at the same level of economic development as Shanghai or Tianjin are similar to them, since Shanghai and Tianjin are the leading city of second-tier group and third-tier group respectively.
Specific to the situation of Shanghai, income has failed to explain housing prices dynamics for several years. Figure 5-2 describes the housing prices to income ratio in Shanghai. The normal range of this ratio is between 4 and 6. According to the diagram, housing price to income ratio was above the normal level in the last decade. We believe that this phenomenon helps to explain why the coefficient of disposable income is insignificant in Shanghai.
Oppositely, Hefei as the representative third-tier city has been going through a smooth and steady economic growth. Its floating population is mainly from other cities in Anhui province (not like the situation of Shanghai and Tianjin, the floating population of these two cities are mainly from the whole country). Therefore, Hefei’s development largely depends on the local economic construction. As shown in Figure 5-1c, disposable income growth rate is higher than income growth rate in the last decade except 2003 and 2004 in Hefei.

5.2 Stock price

Taking wealth, substitution and crowding-out effects together, the net impact of a fluctuation of stock price on housing prices is hard to identify. As shown in Figure 5-3 below, when drawing the curves for aggregate housing prices and stock price, it is observable that the interplay of stock market and housing market has experienced three different periods.
1. Period 1  Before 2001

Both stock market and housing market were formed in the early 90s. Before 2001, the two new-established markets were considerably small-scaled and less-developed. The market value of stock market just reached one trillion yuan and the sum of sales and investment of real estate was only 500 billion yuan. (National Bureau of Statistics of People’s Republic of China) The mechanism of price formation had not fully marketized. The housing market therefore had no obvious interplay with stock market. In the benchmark year 2001, when bubbles in stock market burst drastically due to the lessening of state-owned shares, housing market was steadily bottoming out under the help of housing system’s reform and the implementation of a series of new policies.

2. Period 2  From 2001 to early 2006

During the period between 2001 and 2005, the two markets were in their process to maturity. The weakness of wealth effects in Chinese stock market and the scarcity of investment channels caused the sum of substitution effect and crowding-out effect to play a more important role than wealth effect, leading stock and housing prices move in contrary ways. (Hong & Gao, 2007) Thus, the correlation between housing prices and stock price was like teeterboard. (Yu & Kang, 2008)

3. Period 3  After 2006 (Yu & Kang, 2008)

Great changes took place in both stock and property markets in this period. The stock market dramatically turned around in 2007. At the end 2007, Shanghai composite index broke 5,000 points; the total market value of Shanghai and Shenzhen Exchanges was more than 30 trillion yuan.

The real estate market also changed immensely after the housing system reform. The percentage of individual purchase of houses in total housing purchases rose from 30% in 1998 to above 95%. Since the scale of real estate market expanded significantly, the financial function of houses became gradually realised by investors.
In 2007, accompanied with the boom of stock price, the housing prices in Beijing, Shanghai, Shenzhen and Guangzhou also soared up.

Data used in this paper cover periods from 2003:1 through 2009:4. The net impact of stock price on housing prices from 2003 to 2009 is hardly to identify, since two clearly-divided periods are contained in the collected data. The relationship between housing market and stock market are totally different in these two periods; from 2003 to 2006 they are negative correlated while after 2006, the two prices became moving in the same direction.

As shown in the table in section 4.3, stock price’s empirical testing result is significant in all three regions, proving that there is indeed interplay between the two asset classes. But sign of the coefficient is different among the three regions. Movements in stock price have negative influence on housing prices in Shanghai and Hefei but have a positive effect in Tianjin. The mix of two different periods within the data may be a credible explanation.

5.3 Interest rate

As we mentioned in the last section, an increase in interest rate will shift both supply and demand curve of real estate left. Therefore its net impact on housing market is hard to determine.

Some policy-makers state that interest rate as a financial tool plays an important role in adjusting the market to move in a desirable way. A close analysis of housing market in three regions, however, finds little basis for such conclusion. As shown in the Table in section 4.3, only Tianjin’s interest rate coefficient is significant. The interest rate seems have little influence on housing prices in other two cities.

First, we explain the possible reason of the significant negative result in Tianjin. In the short run, the amount of land available to develop and the funds available for construction and purchase are fixed. Thus due to the long period of real estate development and the sluggish response to changes, supply curve in real estate market is less sensitive to changes in price. By contrast, since the costs of buying houses occupy a large proportion of consumers’ total expenditure, the decision of consumption is relatively flexible. In conclusion, although a shock on interest rate has impact on both supply and demand in housing market, demand curve is more elastic in the short run. Thus an increase in interest rate shifts demand curve left by a larger scale, causing housing prices to decline. In another words, a possible reason of the significant result is that the supply curve in Tianjin is restricted, pushing up prices.

Now let’s focus on the insignificant results. The insignificant results may be caused by two reasons. First, the supply of houses in some regions appears to be inelastic, making prices there more volatile. But in some other regions where builders clearly respond to higher prices by building more the price volatility is not such great; a rise of interest rate is not likely to deteriorate the real estate market to the extent envisioned by analysts. (Case & Shiller, 2003)

The second possible reason of the insignificant results is the consequence of simultaneity: low rates stimulate the housing market, but low rates may be caused by People’s bank of China easing in response to a weak economy and housing market. (Case & Shiller, 2003) During periods of economic depression, central bank will use its financial tools to accelerate markets to revive. In another word, although the low interest rate has a potential to raise housing prices, the housing prices may still remain lower than its average standard due
to the depressively external economic environment. As a result, coefficients are plagued by simultaneity. (Case & Shiller, 2003)

<table>
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<tr>
<th>Time</th>
<th>6 months or less</th>
<th>6 months to 1 years</th>
<th>3 years or less</th>
<th>3-5 years</th>
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<td>7.74</td>
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<td>7.29</td>
<td>7.56</td>
<td>7.74</td>
</tr>
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<td>7.29</td>
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</tr>
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<td>7.20</td>
</tr>
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<td>5.67</td>
<td>5.94</td>
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</tr>
<tr>
<td>2008.12.23</td>
<td>4.86</td>
<td>5.31</td>
<td>5.40</td>
<td>5.76</td>
<td>5.94</td>
</tr>
</tbody>
</table>

Table 5-1 Interest rate adjustment in 2008

Source: Data from People’s Bank of China

Table above shows how the central bank adjusted interest rate in 2008 when financial crisis around the world hindered China’s economic development. As you can see from the table, interest rate was driven down by the central bank for 5 times. Theoretically, housing prices were expected to rise due to the lower interest rate, but actually, the housing prices still declined significantly in 2008. This may be a result of simultaneity.

5.4 Population

As the hypothesis testing suggested, the demographic factor is indeed a determinant of housing prices in Shanghai and Hefei which just matches the theoretical part we discussed in the previous part. Shanghai has become the economic centre and also most international region of China; here you can find foreign enterprises everywhere as well as the domestic companies, which provide the huge opportunities for employment and investments. So there is no doubt that demographic changes happening in Shanghai, accompanied with the booming of its local area will be one of the factors contributing to housing prices.

In China, in order to have better job opportunities, people will first consider moving into its provincial capital and then think about the municipalities. Hefei as the provincial capital of Anhui province has welcomed people from other cities or towns within the province for a long period. The consistence of Hefei’s population coefficient result with our prediction is not by accident.

In the case of Tianjin, the p-value tells us that the population expansion does not have significant impact on the housing prices. We can therefore infer that the population growth does not contribute to the demand of new urban residences. This is contradictory to the theory we mentioned before. The reason for this phenomenon could be ascribed to the aging of the population in Tianjin.

To analyze the aging of the population, the one child policy is needed to be introduced. In 1979, the one-child policy was introduced to reduce China’s burgeoning population. (One Child Policy in China, 2010) The policy limits couples to have only one child. The major objective of the implementation of one child policy is to promote the economic development. Although the policy is a controversial policy, it actually controls the birth rate signifi-
cantly. Statistically, China’s total fertility rate (the number of births per woman) is 1.7, much higher than slowly-declining Germany at 1.4 but lower than the U.S. at 2.1. (Rosenberg, 2009)

As the one child policy in China carried out, the birth rate of Tianjin has decreased moderately and which also means Tianjin did a great achievement on the policy of one child comparing with most of the second-tier cities. Since 2005, Tianjin’s population aging rate has increased by 1.3%. Intuitively, the new residences are more needed by people who are in the middle age but not the youth and elder generation. So the actual amount of people who are capable of buying the houses and are also in need are decreasing as people’s aging rate increases. This is why the demand of houses might not increase due to the population growth.

Additionally, the second reason could be ascribed to the geographic position. Tianjin is like the twin-city of Beijing where China’s capital is located. And it is natural for people who live in Tianjin to move to Beijing due to the higher income and more opportunities in Beijing. This will lead a labor mobility, which will cause the registration of the population in Tianjin to increase but not the housing demand. (People could register to be the residence of one city but actually live in another city, which will lead to disparities of the calculation of the population). The deeper and accurate reasons for the case of Tianjin are still needed to be studied on by using more precise econometric method.

### 5.5 Land price

Below, there are three charts with x axis being the time series and the y-axis being the mean value of index of both land prices and housing prices. Next, the analysis of the charts with different regions during different time periods will be given.

Figure 5-5 Housing prices & Land price

![Figure 5-5 Housing prices & Land price](image)

Figure 5-4a Housing prices & Land price in Shanghai
Based on the charts of the linear relationship between land price and housing prices for these three regions, we can easily see that the trend of land price and housing prices is almost the same, meaning that when the land price index goes up the housing prices index will also rise. But during some certain period of time, they do not go to the same direction together. For instance, in the chart for Shanghai, between year 2008 and year 2009, when the land price went up, the housing prices went down. As well as in the chart of Tianjin, it does not show any significant relationship between the land price and housing prices since year 2006. As the theory that we talked about in the previous part suggests, the dynamic behaviour of the housing prices should be explained by that of the land price. However, what makes the part we mentioned deviate from the theory? It is not difficult to figure out. Maybe we need to combine the unique Chinese land market with the facts that we obtained...
to explain the difference. Basically, the reasonable analysis could be summarized as follows apart from those we concluded from the previous parts.

1. The relevance of land cost to the cost of housing varies by location and time, as suggested by other studies on this topic. And also in the two charts of Shanghai and Tianjin, we can find the corresponding phenomena, as the shanghai chart shows that growth rate of land price and that of housing prices is closer to each other than those two in the Tianjin charts.

2. The purpose of the real estate of the developer is to maximize their profits. At some point in time, even though the land price is decreasing, it will not change the developer’s mind to decrease the housing prices. That is part of the reason contributed to the opposite direction those two factors went into in Shanghai’s chart.

### 5.6 Construction cost

Movements in construction costs fail to explain the changes of housing prices in Shanghai. This may be caused by the high amount of profits from selling houses. Due to the soaring price, the sum of construction costs is much smaller than the gains from selling houses. Even in the cases that construction costs also increase at a rapid speed, it may still be unable to catch up the increase in housing prices.

### 5.7 Further analysis

As shown in Table 4-1, the significance of the coefficients in Shanghai and Hefei are similar, while the output of Tianjin seems different with the other two cities. This may be largely due to the different patterns of housing prices dynamics in the three cities.

![Figure 5-5 Housing prices in Shanghai, Tianjin and Hefei](source: Made by the author, data from National Bureau of Statistics)

Figure 5-5 shows the housing prices fluctuations from 2002 to 2009 in Shanghai, Tianjin and Hefei. As you can see from the figure, the patterns of fluctuations are similar in Shanghai and Hefei. Although the actual numbers are different, the blue line and red line are basically moving together, or in another word, they are having a similar path of housing prices dynamics. One the other side, in Tianjin the pattern of housing prices fluctuation is different with the two cities. This can help to explain why many coefficients are significant in Shanghai and Hefei but insignificant in Tianjin or vice versa.
Furthermore, the results of the correlation between each determinant and housing prices are mainly consistent with economic theories and previous empirical analysis on Western countries. Although not all six determinants are statistically significant, fundamental determinants are to some extent strong enough to explain the path of housing prices dynamics in China. Therefore, we are not in the camp that believes there are bubbles in Chinese housing market. However, the statistically numbers indeed prove that the housing prices in some first tier cities has soared up last year. Due to the short history of Chinese real estate market, it is early to conclude anything right now. Hence, further observations are necessary to see whether the overheating market has a potential bubble inside.
6 Conclusion

The overall objective of the paper is to investigate if the determinants of the housing prices suggested by other scholars in the previous researches apply in the regional housing markets of China. And the methodology employed in this paper is mainly the linear regression model with time-series data.

Before we indicate our key findings, there are some limitations of the paper worth mentioning. First of all, the data collection presents a number of difficulties. For example, it is difficult to find quarterly data for different regions. And in some way, we simplified the methodology that is actually needed to deepen the research. There is always room for researchers to overcome these shortcomings and to make data collection more accurate.

The key findings of this paper indicate that the six determinants including stock price, population, interest rate, land price, disposable income per capita and construction cost have some significant impact on the housing prices in Shanghai, Hefei, and Tianjin. But the more important thing is that the p-value and t-statistic confirm that those determinants weighted differently from region to region. And one thing worth mentioning is that the insignificant coefficients could be biased by the data collection and the methodology we apply. More advanced methodology should be encouraged to avoid the bias.

The result of our empirical analysis is only conclusive when discussing the linear relationship between the six determinants and real estate prices. Therefore, we cannot independently generalise based on these results. This is so because a non-linear relationship might exist between the determinants and the prices but we did not test for that in this thesis. But according to the empirical testing results, at least we are able to conclude that the fundamental determinants are sufficient to explain the fluctuations of housing prices in China to some extent. So it is still early to say there are bubbles in the market.
Reference


Jones Lang LaSalle. (2009). *China 40 - The Rising Urban Stars*


Appendix

Appendix 1 The output of Linear regression model

Hefei

Dependent Variable: HOUSEPRI
Method: Least Squares
Sample (adjusted): 1 26
Included observations: 24 after adjustments

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
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<td>-1.404835</td>
<td>0.1781</td>
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<tr>
<td>INCOME</td>
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<td>0.0011</td>
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<tr>
<td>INVASSET</td>
<td>0.434591</td>
<td>0.105459</td>
<td>4.120941</td>
<td>0.0007</td>
</tr>
</tbody>
</table>

R-squared 0.859206  Mean dependent var 104.0292
Adjusted R-squared 0.809514  S.D. dependent var 3.652215
S.E. of regression 1.593997  Akaike info criterion 4.008859
Sum squared resid 43.19403  Schwarz criterion 4.352458
Log likelihood -41.10631  F-statistic 17.29068
Durbin-Watson stat 1.968593  Prob(F-statistic) 0.000002
Shanghai
Dependent Variable: HOUSEPRI
Method: Least Squares
Sample (adjusted): 1 26
Included observations: 24 after adjustments

<table>
<thead>
<tr>
<th>Variable</th>
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<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
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<td>0.066995</td>
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R-squared 0.900797  Mean dependent var 108.9458
Adjusted R-squared 0.865784  S.D. dependent var 9.921517
S.E. of regression 3.634799  Akaike info criterion 5.657478
Sum squared resid 224.6000  Schwarz criterion 6.001077
Log likelihood -60.88973  F-statistic 25.72757
Durbin-Watson stat 1.734907  Prob(F-statistic) 0.000000
Tianjin

Dependent Variable: HOUSEPRI
Method: Least Squares
Sample (adjusted): 1 26
Included observations: 23 after adjustments

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Adjusted R-squared 0.663452  S.D. dependent var 3.831500
S.E. of regression 2.222758  Akaike info criterion 4.681165
Sum squared resid 79.05046  Schwarz criterion 5.026750
Log likelihood -46.83340  F-statistic 8.228272
Durbin-Watson stat 1.941322  Prob(F-statistic) 0.000355
Appendix 2  Correlation matrix

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