Under the general equilibrium perspective of house price decision model: An empirical research of the effect of the property tax of China

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Abstract:

China has been facing an intractable problem which is the extremely high house price especially in the recent 10 years. The average house price of China has increased about 3 times in ten years. The situation in the major cities of China such as Shanghai is more serious. Such high house prices has severely harmed the society welfare in China, and the inequality is worse and worse at the same time. China has been considering to introduce the property tax which never exists in China before as a way to reduce the house price and increase the government revenue.

The house price is always a popular topic in economics. In this paper, I try to analyze the possible influencing factors of house price from the micro sight. From the maximization of utility of households and maximization of profit of real-estate developers, the total demand curve and supply curve can be estimated, and then, a theoretical house price model is established under the general equilibrium perspective. With the theory support, the empirical research can be reasonably performed. Beijing and Shanghai, as two major cities in China, together with China as a whole, are modeled in the empirical study for the investigation of the house price of China. After estimating these three house price model, the property tax simulation are performed for each house price model. Each equation of the empirical house price decision model is estimated with the time series data from 2005 to 2016 of Beijing, Shanghai and the whole China. The result of the simulation of the 5% property tax rate in each model shows that the property tax is indeed enable to decrease the high house price.

1. Introduction

China has been facing many economic problems since the global finance crisis in 2008. After the central bank of China decided to release 4 thousand billion Yuan(Chinese currency) to enhance the disappointing employment rate caused by the global finance crisis, the CPI and the price of almost every asset in China have been increased in different extent. One of the most explicit increase is the house price.

From 2008 to 2018, the average house price of first-tier city in China such as Shanghai increased about 10 times, which is the biggest increase around the world in the same period. House price is a frequently discussed topic in any place of China. People with property or real estate wish the price of their property stay strong or even rush higher while people who hoping to buy a new house wondering if there is any possibility that the house price would decrease. House price is highly correlated with human life and their happiness, now days the high house price has become to a hard symptom affecting the development and people's life in China.

What drives the house dynamic? What makes the house price of China soar up with such astonishing speed in these recent years? It is a pervasive researched topic in the academic circle. Several factors are considered as the important determinants of the house price. For the theory part, it is pervasively accepted among the house prices academic researchers that monetary liquidity, land price and demographic factors are part of the most important determinants for the house price. For the empirical part, many empirical researches shows the significance of the above three factors to the house price. The mainstream house market researcher tend to believe that the demographic factors decide the long-run house price moving while land price influence the house price in mid-term and the monetary liquidity especially for house loan determine the short-term house prices.

As the scholars analyzing the house price dynamics days and nights, Chinese government also try to solve the high house price problem with empirical actions. The government has been considering to enact different bills for instance house restrictions and property tax. Shanghai and Chongqing are the first two cities that introduced the property tax. Property tax is a very common fiscal tools of governments almost in every country. As one of the international common taxes, the history of property tax can be traced back to 15 century in the Britain. In 1601, the property tax is imposed as the name of British domestic taxes. After that, the property tax can be found in many places although the name of such tax may be not the property tax, the nature of such tax is the same— the taxation aimed to households based on the value of the real-estate owned by these households in unit time. The American property tax also has a long history, the U.S federal constitution set in 1787 authorized the united government to impose the property tax directly to the household. While the western country have had a lot of experience to impose the property tax or other similar kind of this tax, China is still naive to deal with the taxation in this regard. For the strong will of the government and people of China to solve the high house price problem, the government ultimately set some new policies on the agenda, one of these is the property tax. But the result of these new act will still be forecasted by the researchers and the testified by the reality.

Many papers studied about the house market or the newly coming acts of China. Jing Wu, Joseph Gyourko and Yongheng Deng(2012) evaluated the conditions of major Chinese house market, they found that the land value has increased about 8 times since 2003 and the big rise of the land value is one of the major reason that Chinese house price increase such rapidly. Timothy Yang Bian and Pedro Get(2015) used vector autoregression to study several potential drivers of the housing dynamics of China. They found the dominant drivers of house price of China can generally be concluded as 3 factors: saving glut, productivity and policy stimulus. They also found when the sample is near to 2014, the housing preference and credit shocks played a lager role of house price and volume. Zaichao Du, Lin Zhang(2015) went farther, they modified the method of Hsiao, Ching and Wan (2012) by using the leave-n_v-out cross-validation criterion to find the best policy choice of the decision of each city they studied. They found the house restriction can reduce the house price growth rate of Beijing by nearly 8 percent, the property tax of Shanghai plays no role on the house price while the property tax of Chongqing reduced the house price slightly.

Section 2 of this paper reviews the theoretical and empirical literatures to this regard and also provide some background knowledge of China house market. Section 3 provides a whole theoretical house price determination model in the general equilibrium perspective. In this part, several assumptions will be introduced to this model for simplification, but the logic behind the dynamic of the interaction of the demand and supply side of the house is the same. Section 4 will introduce the data source and perform an empirical econometric house price model using error correction model with the time series data of Shanghai Beijing and China as a whole and estimate the result of this model. The house market of Beijing and Shanghai is very representative to the whole China house market, the city level data is also more accurate and tendency of it is more evident. The model result of the China as a whole provides more intuitive explanation of the China house market. Section 5 will do the simulation with the estimated model to find to what extent the property tax will influence the house price of Shanghai and then shed light on the whole China house market. Section6 concludes.

2. Literature reviews and China house market background

2.1 Literature reviews

The economic theory for the house price always start with the demand and the supply side of the house market(HM treasury 2003).

$$D^h = F\left(p^{h^e}, y, r, p^c, A_0, n, X\right)$$

$$S^h = F\left(p^{h^e}, p^l, p^b, p^c, X\right)$$

For the demand side, the house demand should determined by the expectation of house demand(p^{h^e}) with positive effect, disposable income(y) with positive effect, interest rate(r) with negative effect, normal consumption price(p^c) with possibly both side effect, initial wealth(A_0) with positive effect, population with positive effect and vectors of other possible factors such as tax policies.

For the supply side, the house supply determined by the expectation of house demand(p^{h^e}) with positive effect, land price(p^l) with positive effect, construction cost of real-estate firms(p^b) with positive effect, normal consumption price(p^c) with possibly both side effect and vectors of other possible factors.

The house price is just like other kind of prices determined directly by the supply and demand of the market. For instance, when the central bank tighten the liquidity of the market, it would be difficult for the individuals or households to borrow money and buy the house. The market would be cool off and the house price will decrease because the demand shock. The conduction mechanism is very intuitive but still we need a more specific model to quantify this conduction process. And this is what section 3 will do.

The empirical researches is in greater numbers compared to the theoretical researches in this regard. Ponte P. Bucci and Cosenza(2013) examined the key drivers of house prices among seven countries with the data from 1970 to 2010. A special multivariate unobserved component model introduced by Harvey was used by the researchers to model the house price fluctuations. The empirical results shows that besides some common important drivers such as long-run interest rate, disposable income and inflation, the latent factors such as changing in preference and structural changes in market also play an important role.

Eloisa T. Glindro, Tientip Subhanij, Jessica Szeto, and Haibin Zhud(2008) investigated the house price dynamics in 9 Asia- Pacific economies from 1993 to 2006. They found the house price tend to be more volatile when the supply elasticity is low and business environment is flexible. They also found an important result that there is evidence that the house price bubbles does exist in some market.

Joachim Zietz, Emily N. Zietz and G. Stacy Sirmans (2007) started with a micro perspective in regard to the house market. They try to identify the micro-determinants of house prices with the method of quantile regression. They found that purchasers of high-priced house svalue some house characteristic such as square footage differently from the purchasers of low-priced houses. This paper start with the micro perspective, although not offer the general house prices determinants, but remind us that house prices may vary in very specific house characteristics. H Hirata, MA Kose, C Otrok and ME Terrones(2013) studied the global house price moving determinats, they use a wide range of FAVAR models and found that house prices are synchronized across countries. The rise of global interest rate tend to decrease the house price while the decreasing international monetary base does not have significant effect on the house price. Égert, Balázs; Mihaljek, Dubravko (2007) studied several conventional determinants of house prices in the Eastern Europe and compared them with the result of 19 OECD countries. The result it all of the conventional determinants such as GDP per capita, real interest rates, housing credit and demographic factors determined the house prices to a great extent. This papers shows that the pervasively theoretical assumptive underlying determinants of house prices truly make sense.

Eleonora Granziera n, Sharon Kozicki(2015) started in another way that they treated houses as a financial asset. They use a fascinating asset pricing model to identify the effect of expectations to the house market and the price-rent ratio of the U.S. The aim is to find a much sound model to explain those things. The rational expectations is not good enough for the high coefficient of risk aversion. The extrapolative expectations performed a little bit better but still cannot match the moments of the data and have a sound explanation. Only the near rational bubble solution is good enough that can replicate the economic trend of the history datas. It provided a solution of real-estate cycle. The result is good but the near rational bubble is hard to identify in the real life. For the purpose of the introduction of other important variables to the house price model, the rational expectation is still usually applied in many house price determinants articles such as in this paper. Edward L. Glaesera, Charles G. Nathanson (2017) studied very specifically for the momentum and mean reversion of the house price dynamics. They extend the research results of Barberis(2015) using an extrapolative model of house price dynamics. In this model, buyers are partially rational. In this situation, buyers forecast the future house price partly based on the historical house price. The empirical of this papers focus on the price autocorrelations with the AR model. The methodology of this paper lead the future research to the directions that exploring the implications of the inference for the naive consumption. The autocorrelation of the house price gives guidance for this paper. However, this paper considered little about the supply side of the house market which will be discuss a lot in the following paragraph.

After reviewing some literatures regarding the house market studying containing effective market and the rational expectation, the house price determinants should still be payed much attention.Charles Ka Yui Leung (2014) set up a dynamic stochastic general equilibrium(DSGE) model with the error-correction terms in the model. The result shows that the house prices are mostly correlated with the relative income, or, called the ratio of house price and income. This paper also test the relationships between house price and income and find that this two factors are cointegrated with each other in long run. Such integration test will be performed in my paper as well but I will introduce more variables to explore the long run relationship between house price and other variables. This paper is a further try of Malpezzi (1999) and Capozza et al. (2004). This model also has shortcomings in some aspects. For instance, this model did not consider the household production. Davis and Martin(2009) shows in their article that household production is very important and the introduction of that to the model can enhance the model accuracy. But still, the methodology of this paper gives us much thoughts of handling the time series data of the house market. Another highlight of this paper is the using of the micro perspective data. From the micro sight, the empirical research can be well explained by the theoretical researches.

Man Cho (1996) summarized a series of literature that regarding the theoretical issue and empirical issue of the house price dynamics. For the theory part, many literatures proved that the market is not totally efficient. The abnormal returns always exist in the market. Future research should pay more attention on market efficiency, speculative bubbles and mean reversion. And also transaction fees and other middle variables is also important. However, to the opinion of my paper, the market which is not efficient is hard to quantified in an economic model. The efficient market is always a guidance of the theoretical research of the house price and house market. Man Cho also proposed that improving the measurement of the variables such as house price and land price is important. It truly make sense, for the accuracy of the model in this paper, I use the house price index of Beijing and Shanghai that already handled by the National Statistics Bureau.

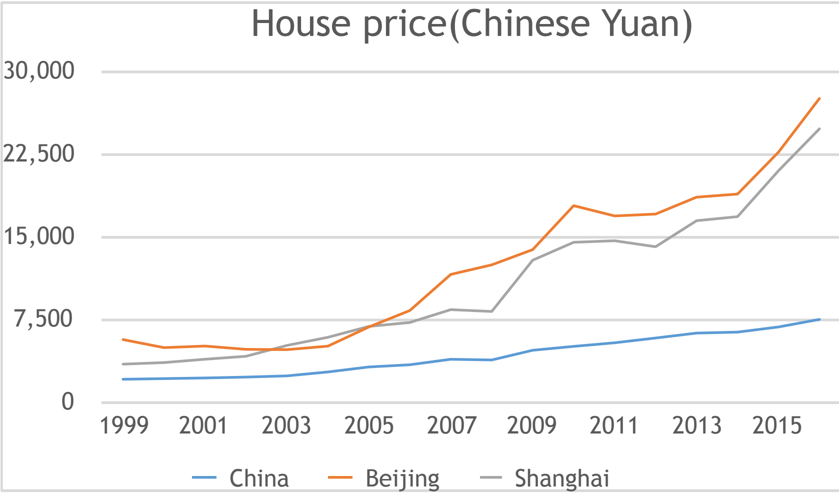
The economics theory is truly supported by the empirical studies. The real interest rate, household disposable income and demographic factors are some of the basic determinants of the house prices. To manage these factors into a theoretical general equilibrium model is the work that section 3 will do.

2.2 China house market background

The commercial house market of China start up in a very late date approximately in 1998. In 1998, in order to deal with the Asian financial crisis, the reform of the house consumption demand started. The government abolished the house allocation policy and start the revolution of the monetization, housing credit, land auction and so on. From that day, the house market of China has been truly established. The following 20 years experienced a huge increase of house price which is very mere compared to other countries within the same period. From 2002 to 2007, the house market of China tend to overheated, the government successively introduced some policies such as adjustment of land supply, reform of the credit structure and transaction taxation. From 2008 to 2009, the international financial crisis erupted, the economic policy tend to stimulus the consumption of houses, at the same time, the investment demand of house has appeared to a large extent. Many people buy houses not for residence but for waiting the capital gain of such investment. From 2014 to 2016, for the purpose of stabilization of the economy of China, the government start a new round of stimulus policy, containing the relaxation of restrictions on purchase and loan, the strengthening of credit support and tax relief. The house price in this two years experienced another round of increase. After September of 2016, the policy turned to the aim of risk-prevention, but the the result is not as the government expected, the house market is still overheated.

Under this situation, the property tax has been introduced to China. In 2010, the State Council and the Ministry of Finance issued documents three times to promote the reform of individual housing and real estate tax. Shanghai and Chongqing will be the first two cities which introduced trial property taxation. But the result of it said that the trial property tax did not make good deal of government income and did not adjust the house market satisfactorily. After that time, the individual trial property tax stagnate. The pervasive effect of property tax of China should still be testified both by theoretical research and empirical experiments.

Graph 1: House price of China



Much literatures did lots of works on the China house market. Yu REN, Cong XIONG, Yufei YUAN(2012) applied the rational expectation bubbles to the Chinese housing market with the method of Blanchard and Watson(1983). The theory of Blanchard and Watson indicates that it is less possible that the house price would decrease if the bubbles exists. The results is interesting, they found that some local basic factors such as GDP growth, population growth, and unemployment rate cannot influence the local house returns. Hence, the cash flow from rich districts to poor districts should be the major dynamics that lead the house price of poor district increase. The authors proposed that the deposit rates as the opportunity cost of capital should be enhanced for the fact that in this way the investment on house or real-estate will decrease. However it may not a good way, China market is doing such things now days but we should remind ourselves that the interest rate will affect many many of important factors to the economy. The whole economy would be cool down in this way not only the house market. The authors also suggest that the government should block such capital flow from rich district to poor district. However, it may not be the best solution. Firstly, the capital flow is hard to controlled by the governments. Moreover, the capital flow reflects the rational expectation of people and will eliminate the arbitrage of the market. Capital flow is good for economics but high house price is not. We know that the Chinese house market is already with much bubbles. The point should focus at how to eliminate the bubbles with the smallest cost. The property tax and selling restriction are two good method that already applied in several cities such as Shanghai, the model will study the property tax in the later paragraph.

Yanbing Zhang, Xiuping Hua and Liang Zhao(2012) combined the house price decision model with the China market. They performed a Nonlinear Auto Regressive Moving Average with exogenous inputs (NARMAX) combined with the Vector Error Correction Model (VECM) trying to find the important determinants of the house price with the data from 1999 to 2010. They found the significance of mortgage rate, house developer cost, credit supply and exchange rate while some of the important economic variables such as household income is not significant in the model.

Specifically, the authors used both linear and non-linear estimation to identify several possible important determinants on the list. The results of this two method with error correction term comes differently when it is in-sample prediction and out-of-sample prediction. The most important found is the importance of the monetary policy toward the house price while the income seems not influenced the final price. The result is interesting but I am a bit skeptical about that. That is why I conduct a similar empirical research of that in the following paragraph of this paper.

3. Economics basis of the model

3.1 Rent discounting model of house price

What determines the property price? It is a pervasively discussed topic since maybe the currency and transaction are born. Some people think the growth of population is the key point, while other factors such as fluidity, land price, inflation decide the house price.The house price is also a kind of price, hence we should start to treat it as the way we model a price in order to find a better theoretical prove of it.

Before the starting of the modeling, I will firstly introduce a rent discounting model of house price:

$$houseprice = \sum_{t=1}^{\infty} \beta_t \left(\mathbf{E}\left(\mathbf{Re}_t\right) - \mathbf{E}\left(De_t\right)\right) \tag{1}$$

E(Re) is the expected rent of a certain house while E(De) is the expected depreciation of this house. β is the discounting factor which is equal to $\frac{1}{1+\mathbf{E}(r)}$. E(r) is the expected interest rate in the following each year.

As we know, price is determined by the supply and demand. The price of every consumption necessities can be easily modeled and calculated by this. For instance, the price of bread is determined by the demand and supply of bread, when the supply curve and demand curve are crossed, we can calculate the amount and price. This is the simplest application of Alfred Marshall Theory of Demand. But what decides the price of durable goods? We know that when people buy a house, they will live in this house for a long period indicating that they will not come into the house market again when we do not consider other factors. It would be problematic if we considering the price of a durable goods like the way we consider the consumptive necessities. Total demands of such consumption goods can be added up by each household’s demand, but the durable goods can not be treated like that, we do not know which household need a house, and how many people want to buy a house. Hence, I transfer the calculation way of the house from the durable perspective to the instant necessities perspective. The logic is as follow.

Although we can not treat it like the household buy the commodity “house” in every period, but actually we can treated as they “consume” the commodity “house ”in every period. Considering a household do not buy a house to live instead of rent it, the rent they pay in each period can be treated as a current consumption of the house. Suppose the household is in no difference(same utility) that they buy a house or they rent a house(Assumption 1)when other factors is the same. Hence we can consider that buying a house is just like renting a house forever, the utility a household buy or rent forever is the same so the cost should be the same as well. Therefore, the house price should just equal to the present value of rents they pay in each period and minus the present value of the depreciation in each period. We can also treat this process like an investment i.e. a person buy a house and then rent it out. The price he pay can be considered as the first period investment, and the cash flow of the rent of following period is the return. The net present value(NPV) of this whole process should be zero when we assume this is in a ideal world. The depreciation also matters this process, it can be analogize to the corporate investment decision.

After invert the house price into the format of house rent, we can research on our model targeted on the house rent. To some extent, the house rent can be treated identically as the house price.

In the above paragraph that we have already have the assumption 1 which is the household is indifferent with rent a house or buy a house. For the theory part we need more assumptions to make the theoretical model well established.

Assumption 2: The house the household buy or rent is homogeneous, the only difference is the size of the house. This assumption is important to the model, the house is homogeneous means that there is only one kind of goods in the house market. The “amount” of house the household need is expressed as the size the household need. Hence the rent of the house is showed as the rent of $1m^2$ in one unit of time. In this way we can simplify our model while not influence the feasibility of the model to the real world. In the real world, house price can be influenced by the size of room, the location of the house, the region the house in, the safety of the neighborhood etc. In this paper, I care about the factors influenced the house price under the macroeconomic perspective, therefore the detail of the house is not be studied in this model. The research target is the entire house price trend. Hence, homogenous house in this model will not influence the result.

Assumption 3: The household and people are homogenous. This assumption is somewhat similar as assumption 2 and will also not influence the feasibility of the model. In the real world we can separate the household or people to rich one or poor one, the number of people of each household may also be different, the house size each household need may also be different, however, when we study the general income or other factors under aggregate perspective, this assumption will not influence the result. Also this assumption has limitation somewhat, when we want to study the specific factors such as the influence of the income inequality, age structure, household structure and marriage to the house price, this assumption can not be adapted. Another way of the treatment to household is to assume the household income uniformly distributed, but for the simplification, I adapt the first one.

Assumption 4: The land price is exogenous. In reality, the land price and house price can influence each other. But when we set up a economic model, we should control one of these two factors. For a certain period, a static land price can make it easier to arrive to a exact house price.

3.2 Theoretical model from supply and demand perspective

After established several assumptions and introduced the rent discounting model of house price, we can now enter the ideal world model. Let's start at the demand part of the house. The demand of house can be separated into two parts, living demand and investment demand. The living demand is a kind of rigid demand, no matter who should have a place to live, such demand is highly correlated with demography statistics. The investment demand is much more flexible compared to the living demand. Under different conditions, the investment demand would be totally different. The investment demand is always correlated with the expectation of the house price, we can analyze this field with behavior economics. This part is more complex i.e. for a certain house, some people think its price will rise in the future while others think it would decrease. In my model, I would like to investigate the intrinsic value of a house hence I set the assumption 5: This is a complete market, nobody can earn an extra return in the house market. This assumption is sound and feasible to the model. As we know, the price will always fluctuate with the value whatever the commodity is. I treat the investment demand of house as a noise to the market. Such noise always exist in almost every market, but for the long run, the price will always be close to the true value.By the way, the investment demand as I referred to refers to the the chase of extra return of the house stemmed from the Erroneous pricing of the house but not the average expected rent return. It can be analogized as the stock market, in this model, α does not exist, and because the house is homogenous in the model hence the β is all the same equals to 1in the house market, the average return of the house is just the rent benefit which is consistent with the assumption (more details can be found in Investment of Zvi bodie). In this model, if household X would like to buy a house and plan to rent it out to household Y, such demand of the house will be considered as living demand not the investment demand. The reason is that the "investment demand" of household X is just the living demand of household Y. In general, for a region with certain population, the living demand is constant in this model.

In this model, the house rent is a proxy of the house price. Suppose a household maximize its utility, and the household is only care about the daily consumption and the house they live. c is the number of consumption and h is the size one household choose to live. μ is the time preference of utility.

$$\text{MAX.} \qquad \sum_{t=1}^{\infty} \mu_t U\left(c_t, h_t\right) \tag{2}$$

$$\text{H.B.C} \qquad \sum_{t=1}^{\infty} \beta_t \left(p_t^h \cdot h_t + p_t^c \cdot c_t\right) = \sum_{t=1}^{\infty} \beta_t \cdot y_t + A_o \tag{3}$$

Equation 3 is the household budget. p^h is the price of $1m^2$ in one time unit and p^c is the price of the normal consumption in this period. y is the income of household and A_0 is the initial wealth of the household. β is the discounting factor which is equal to $\frac{1}{1+\mathbf{E}(r)}$.

Use Lagrange method to solve this maximization questions, we can have:

$$\sum_{t=1}^{\infty} \mu_t \cdot U_c'(c,h) + \lambda \cdot \sum_{t=1}^{\infty} \beta_t \cdot p_t^c = 0 \tag{4}$$

$$\sum_{t=1}^{\infty} \mu_t \cdot U_h'(c,h) + \lambda \cdot \sum_{t=1}^{\infty} \beta_t \cdot p_t^h = 0 \tag{5}$$

$$\sum_{t=1}^{\infty} \beta_t \left(p_t^h \cdot h_t + p_t^c \cdot c_t\right) = \sum_{t=1}^{\infty} \beta_t \cdot y_t + A_o \tag{3}$$

Solve the Lagrange equation we have:

$$\frac{\sum_{t=1}^{\infty} \mu_t \cdot U_c'(c_t,h_t)}{\sum_{t=1}^{\infty} \beta_t \cdot p_t^c} = \frac{\sum_{t=1}^{\infty} \mu_t \cdot U_h'(c_t,h_t)}{\sum_{t=1}^{\infty} \beta_t \cdot p_t^h} \tag{6}$$

Put equation (3) into equation (6) we can solve for a certain household, the house demand(the house size this household need) can be expressed as:

$$h\left(p^c, p^h; A_0, \beta, \mu\right) \tag{7}$$

After calculating the first derivative of equation (7), we can conclude that the house size the household demand is monotonically decreasing with the rent of the house. Considering the format of the utility function of households, usually the house demand of households is monotonically increasing under the assumptions above. A, β and μ are the parameter of the function.

Suppose the original number of the households is n_1, consider the assumption (3), hence the total house demand can be written as:

$$H\left(p^h\right) = n_1 \cdot h\left(p^c, p^h; A_0, \beta, \mu\right) \tag{8}$$

The specific aggregate house demand function depends on the utility function. Consider the most simple format of the house demand. When the utility function is in logarithm and ignore the time preference and discounting factors, the aggregate house demand will not be influenced by the price of consumption. Suppose it only have one period and ignore the initial wealth and the utility function is in the format of equation(9) in which θ is used to represent the comparative preference of house, the relationship between consumption and housing can be expressed as equation (10). The equation (11) shows the household budget. After calculation, the total house demand can be expressed as equation (12).

$$U = \ln c + \theta \cdot \ln h \tag{9}$$

$$h = \theta \cdot \frac{p^c \cdot c}{p^h} \tag{10}$$

$$p^h \cdot h + p^c \cdot c = y \tag{11}$$

$$H = \frac{n_1 \cdot \theta \cdot y}{1+\theta} \cdot \frac{1}{p_h} \tag{12}$$

Now we have already get the demand part of the model. For the supply part, we also need an ideal simulation of it. In the real world, we know that different market have different situation. For a mature market, it may be close to perfect competition market. In most industries, monopoly is very common. In the real world, the house market of some certain local market is more close to oligopoly, several big real-estate firms rule the market. But in some region especially in the big cities in which suppliers of house is in great numbers, the situation is more close to perfect competition.

Assumption 7: the house market in this model is perfect competition, the real-estate firms is homogenous in the market. This assumption indicates that no house supplier can earn a extra benefit of selling a house. This is an ideal situation however do not influence the validity of the model. In the perfect competition market, for the purpose of maximize the total profit, the firms will let the marginal benefit equals to the marginal cost. In the firm theory of microeconomics, we know that under this condition, the price of the house should equal to the marginal benefits so as equal to the marginal costs. According to microeconomics, the supply curve of the firm is the marginal cost curve where marginal cost is higher than the average cost. To make the model valid, I refer to the usual assumption in the firm theory in microeconomics: Assumption 8: the real-estate firms in the market has decreasing returns to scale. In this case the firms would have quadratic cost function. Suppose the cost function of each firm is:

$$\mathbf{C} = \mathbf{C}\left(h, p^l, p^b\right) \tag{13}$$

In this cost function, h is the size of the house that supplier wish to sell, p^l is a proxy of the land price, p^b is the constructing cost of building 1 unit house. The marginal cost which equals to the supply function is:

$$\mathbf{C}_h^{'}\left(h, p^b, p^l\right) \tag{14}$$

Suppose the specific cost function of the whole market is

$$\mathbf{C} = p^b \cdot H^2 + p^l \cdot H \tag{15}$$

Hence, the supply function would be:

$$p^h = 2p^b \cdot H + p^l \tag{16}$$

Put equation (12) and equation (16) together we can solve for the current house price(house rent in this period).

$$p^h = p^l + \sqrt{\left(p^l\right)^2 + \frac{8n_1 \cdot \theta \cdot y \cdot p^b}{1+\theta}} \tag{17}$$

When we consider for only one period and simultaneously simplify the cost function of firms and the utility function of the household, we can refer to the result of equation (17). When more time units are in consideration, the interest rate and time preference also matters. We can use more advanced mathematical tools to calculate the house rent per period if the utility functions and cost functions of firms are more complex and close to reality. After obtained house rents of all the period, we can use equation (1) to get a final house price in this moment.

4. Data source and the econometric model

4.1 Data source

The data comes from the China Data Online, Wind Database of China and the National Bureau of Statistics of China. The range of these Time series data is from 2003 to 2018. Containing the annual basis interest rate, per capita income, average land price and population growth rate of Shanghai, Beijing and China as a whole etc. The average house price of Shanghai and Beijing has already handled by the Wind Database in index form while the average house price of China is the real price. The data is in season level. Because China start the commercial house market since 1998, the data before has no value of reference for the model. The shortage of the data constitute the shortage of the model. But it can still have a sound result.

The interest rate data I used in the model is the five-year basic lending interest rate decided by the People's Bank of China. China has not yet entered the interest rate marketization, the basic interest rate is officially decided by the central bank. The lending interest rate is better than deposit interest rate in this model because lending interest rate is a closer indicator of the fluidity among people. The monetary cost of lending money to buy a house is decided by lending interest rate. The cost of real-estate firm is also partly constituted by lending interest rate. The population growth data is the natural population growth which is estimated by National Bureau of Statistics of China by several Census. The land price indicator is more specific, it refers to the average price of land only traded by real-estate developer. Such data is more suitable with this model because the purpose of the model is to study the house price, data only concerned with house or real estate should be used in the model. The disposable income per capita is used to show the income of people, the data used in this model is under the new statistical caliber of National Bureau of Statistics of China.

4.2 Methodology of the empirical econometric model

Section 3 is the analysis under the economics theory perspective. The supply and demand of the house market interact with each other and arrive to a temporary final market cleaning price. This whole procedure can be quantified as one equation as following:

$$\pi_h = \pi_h^e + \beta\left(i - i^e\right) + \gamma\left(g - g^e\right) + \alpha\left(\Delta \ln p^l - \Delta \ln p^{l^e}\right)$$
$$+\eta\left(\Delta \ln y - \Delta \ln y^e\right) + \epsilon + \phi ECM \qquad (18)$$

Before explaining the equation, I will set up another assumption to illustrate the equation more specifically.

Assumption 8: People have adaptive expectation in the model. This assumption are more close to the reality. In the real world, people usually regard the price of current term as the price of last term. Or, people regard the price growth rate of the current term as the price growth rate of last term. In the model I adapt the last one. People are more visible than usual that they consider the inflation in every market and field. However, they are not rational enough to have a rational expectation. Economic decision are made by people, hence, the mental factors must be considered. The assumptions above in section 2 set up for the economics model are more ideal, ideal model is more representative and easier to be expressed by economic terms. But after understanding the economic intuition of this house market, the empirical research require us to be more realistic.

Look back into equation (18), the assumption 8 is applied in almost every terms. The shocks of the house price is stemmed from the factors that our of people's consideration. π_h is the first difference of the house price i.e. house price growth rate in the current period while π_h^e is the expectation of house price growth rate. The interest rate is represented as i. In section 2, it can be concluded that the interest rate influence the house price mainly in demand side. To simplify the model, the shocks from the credit and liquidity are all expressed by interest rate. After studying the historical time series data, we can found that the basic interest rate, monetary supply, government bond rate and other monetary factors are highly correlated and cointegrated in the long run. p^l is the price of land per unit and p^{l^e} is the expectation of it. This term represents a main supply shocks. In the model, the land price is considered as an exogenous variables that effect the house supply. The population growth rate is represented by g and g^e is the expectation of it. The population shocks is the main shock of house in the demand side. Another primary shock in the demand side of the house is the average household income represented by y and y^e is its expectation. All the other impact is represented as other shocks "ϵ". The change of property policy constitute the main shock in economy.The transaction tax is the most influential impact of the shock. It will set a tax wedge between the supply curve and demand curve and influence the both the supply and demand of house. For the empirical data, the transaction tax of house does not change much since the marketization of house market 1998. Other policy factors is even less influential than the change of transaction tax such as transaction restrictions and down payment ratio.

Equation (18) is the transformation of equation (17) in the economics model in section 3 to some extent. The intuition is the same, intuitively the demand and supply influence the final house price. The cost of building a house which is mainly constituted by land price is the primary supply shocks, according to the China Real estate research center of National Development Research Institute, until 2016, the land price constitute nearly 70% cost of the house. The population and the monetary policy is the major influencing factors of the demand side. The absolute value of the household income matters the absolute value of the house price.Government policies such as tax, purchase restriction and down payment rate can be seen as exogenous shock affect both supply side and demand side.

In the model, suppose every factors are consistent with what people expected, the growth rate would just right equals to the expected growth rate. Consider the equation (1), the house price can be expressed by the house rent, people who want to earn a benefit of buying a house and then rent it out would have an average expected return in the long run. Because people have adaptive expectation, the house price growth rate would be the same as the price growth rate of last term.For further explanation of this stuff, see equation (19) and (20).

$$R = \beta\left(r - r_o\right) + r_0 \tag{19}$$

$$R = \frac{\mathbf{Re}_t}{P_t^h} + \frac{p_{t+1}^h - p_t^h}{p_t^h} \tag{20}$$

Equation (19) refers to a house price capital asset pricing model(CAPM). R represents the return rate in one term that buying a house. $\mathbf{Re}_t$ is the rent in period t and p_t^h is the house price in period t. r is the standard risk asset return rate, and β is the relative risk parameter which is correlated with the standard error of the return of investing a house or liquidity of this house. r_o is the risk-free interest rate which can be regard as same as the basic interest rate. In equation (20), by decomposing the return rate of investment of a house to two parts, rental yield and yield from price increase. In this model, as the result of adaptive expectation of households, when there is no shocks outside and rent is constant, the house price growth rate $\frac{p_{t+1}^h - p_t^h}{p_t^h}$ would be the same as last term's house price growth rate.

Moreover, for the purpose of gaining a more accurate house price decision estimation of equation (18), the error correction term is used. For the time series data in the model, some is unstable time series, error correction term is used in the equation to show the long term relationships between house price and other influence factors. With the error correction model, first difference may eliminate the possible trend factors so that avoid the possible fake regression. The apply of first difference in the ECM may also eliminate the possible multiple collinearity. Also, because the stationarity of the error correction term, the model can be estimated the classic OLS. The result will show a more accurate long-run relationship between house price and it determinants.

4.3 Model results

In this section, the paper will analyze three house price decision model of Shanghai, Beijing and China as a whole. Before estimating a final house price determination model. It is necessary to test the stationarity of each variables in the model. With the unit root test in Eviews, the result is consistent as the common sense that interest rate and population growth is in I(0) while the logarithm of house price, land price and income is in I(1). Then use Eviews do the Johansen Cointegration test. When testing cointegration between house price, interest rate and income, the cointegration relationship is significant and sound. The cointegration result of the three separate mode is showed in the appendix. The specific cointegration relationships of the model of China as a whole is showed in Table 1. The specific cointegration relationships of Shanghai and Beijing can be found in the appendix.

Table 1: Cointegration relationships of China

LOG(PH)	LOG(Y)	INT	G
1.000000	-0.844027	0.024984	-0.001674
	(0.01330)	(0.00677)	(0.00823)
Adjustment coefficients (standard error in parentheses)			
D(LOG(PH))	D(LOG(Y))	D(INT)	D(G)
-0.775432	0.276089	6.891396	-7.058299
(0.40199)	(0.14126)	(4.83749)	(1.40658)

The cointegration relationship make sense when we see the signs of each coefficients. From table 1, the normalized coefficient of disposable income per capita (Y)is negative which means that the income has positive effect on house price. The normalized coefficient of interest rate(INT) is positive means that a higher interest rate will decrease the house price which is also consistent with the estimation. Higher interest rate indicates tighter fluidity which always accompany with increasing asset price. The normalized coefficient of natural population growth(G) is negative which means that a higher population growth rate will lead to a higher house price because the overall demand is increased as the paper discussed above.

Table 2 shows the estimation results of the China house price model. The final equation for estimation is another transformation of equation (18). The final equation (21) is:

$$d\log\left(ph\right) = \beta_1 \cdot d\log\left(ph(-1)\right) + \beta_2 \cdot d\log\left(ph(-2)\right) + \beta_3 d\log\left(pl\ (-2)\right) + \beta_4 d\left(int(-1)\right) + \beta_5 d\left(g(-1)\right) + \beta_6 d\left(g(-3)\right) + \mathbf{EC}M \quad (21)$$

$$\mathbf{EC}M = LOG\left(PH(-1)\right) - 0.844027188622 * LOG(Y(-1) + 0.0249843782814 * INT(-1) - 0.0016736446959 g(-1) - 0.233540979111$$

Table 2: Estimation results of China house price model

Description	Variable	Coefficient	Std. Error	t-Statistic	Prob.
House price lag 1	DLOG(PH(-1))	0.545568	0.272321	2.003402	0.0920
House price lag 2	DLOG(PH(-2))	0.317544	0.118389	2.682218	0.0251
Land price lag 2	DLOG(PL(-2))	0.171403	0.116641	3.226953	0.0145
Interest rate lag 1	D(INT(-1))	-0.025402	0.024464	-2.559778	0.0376
Population growth lag 1	D(G(-7))	0.161701	0.060475	2.673878	0.0368
Population growth lag 3	D(G(-10))	0.116188	0.046321	2.508317	0.0460
Error correction term	Error correction	-1.182068	0.274664	-4.303686	0.0051
R-squared		0.854322	Mean dependent var		0.088728
Adjusted R-squared		0.708644	S.D. dependent var		0.060042
S.E. of regression		0.032409	Akaike info criterion		-3.717025
Sum squared resid		0.006302	Schwarz criterion		-3.412822
Log likelihood		31.16066	Hannan-Quinn criter.		-3.779553
Durbin-Watson stat		2.264032			

Within the same method, the house price model can be estimated. The estimation results of Beijing and Shanghai is showed in Table 3 and Table 4. The final equation of the Beijing model below as equation (22).

$$d\log\left(ph\right)=\beta_1\cdot d\log\left(ph\left(-1\right)\right)+\beta_2\cdot d\log\left(pl\left(-2\right)\right)+\beta_3\cdot d\left(y\left(-1\right)\right)+\beta_4\cdot d\left(y\left(-2\right)\right)$$
$$+\beta_5\cdot d\left(y\left(-3\right)\right)+\beta_6\cdot d\left(int\left(-3\right)\right)+\beta_7\cdot d\left(int\left(-4\right)\right)+\beta_8\cdot d\left(pop\left(-7\right)\right)+\mathbf{EC}M(22)$$

$$\mathbf{EC}M = LOG\left(PH\mathrm{E}\left(-1\right)\right) - 0.813373677262*LOG\left(PL\left(-1\right)\right) - 0.872840076054*LOG\left(Y\left(-1\right)\right) + 0.179848349075*INT\left(-1\right) - 0.457334386336*G\left(-1\right) - 4.11383333112$$

Table 3: Estimation results of Beijing model

Description	Variable	Coefficient	Std. Error	t-Statistic	Prob.
House price lag 1	DLOG(PH(-1))	0.653450	0.090222	7.242683	0.0000
Land price lag 2	DLOG(PL(-2))	0.3115	0.17345	1.795922	0.0817
Household income lag 1	DLOG(Y(-1))	0.26722	0.10447	2.557707	0.0153
Household income lag 2	DLOG(Y(-2))	0.20806	0.08145	2.554386	0.0154
Household income lag 3	DLOG(Y(-3))	0.22015	0.06311	3.488494	0.0014
Interest rate lag 3	D(INT(-1))	-0.016177	0.009520	-1.699160	0.0987
Interest rate lag 4	D(INT(-2))	-0.032320	0.009787	-3.302288	0.0023
Population growth lag 7	D(G(-7))	0.049726	0.018343	2.710901	0.0106
Error correction term	Error correction	-0.034358	0.014111	-2.434807	0.0205
R-squared		0.661446	Mean dependent var		0.018254
Adjusted R-squared		0.579372	S.D. dependent var		0.026763
S.E. of regression		0.017358	Akaike info criterion		-5.082171
Sum squared resid		0.009942	Schwarz criterion		-4.709813
Log likelihood		115.7256	Hannan-Quinn criter.		-4.945687
Durbin-Watson stat		2.267413			

The final equation of the Shanghai model below as equation (23).

$$
\begin{aligned}
d\log\left(ph\right) &= \beta_1 \cdot d\log\left(ph\left(-1\right)\right) + \beta_2 \cdot d\log\left(ph\left(-3\right)\right) + \beta_3 \cdot d\log\left(pl\left(-1\right)\right) \\
&\beta_4 \cdot d\log\left(pl\left(-2\right)\right) + \beta_5 \cdot d\log\left(pl\left(-3\right)\right) + \beta_6 \cdot d\log\left(pl\left(-4\right)\right) + \beta_7 \cdot d\log\left(y\left(-1\right)\right) \\
&+\beta_8 \cdot d\log\left(y\left(-2\right)\right) + \beta_8 \cdot d\log\left(y\left(-3\right)\right) + \beta_9 \cdot d\log\left(g\left(-5\right)\right) + \beta_{10} \cdot d\log\left(g\left(-7\right)\right) \\
&+\beta_{10} \cdot d\log\left(g\left(-10\right)\right) + \beta_{11} \cdot d\log\left(g\left(-12\right)\right) + \beta_{12} \cdot d\log\left(int\left(-1\right)\right) + \beta_{13} \cdot d\log\left(int\left(-2\right)\right) \\
&+\beta_{14} \cdot d\log\left(int\left(-3\right)\right) + \mathbf{EC}M \qquad (23)
\end{aligned}
$$

$$\mathbf{EC}M = LOG\left(PH\left(-1\right)\right) - 0.776344185699 * LOG\left(PL\left(-1\right)\right) - 1.62196939087 * LOG\left(\mathbf{Y}\left(-1\right)\right) - 0.00301795773857 * G\left(-1\right) + 0.171393711683 * INT\left(-1\right) + 2.4808646056$$

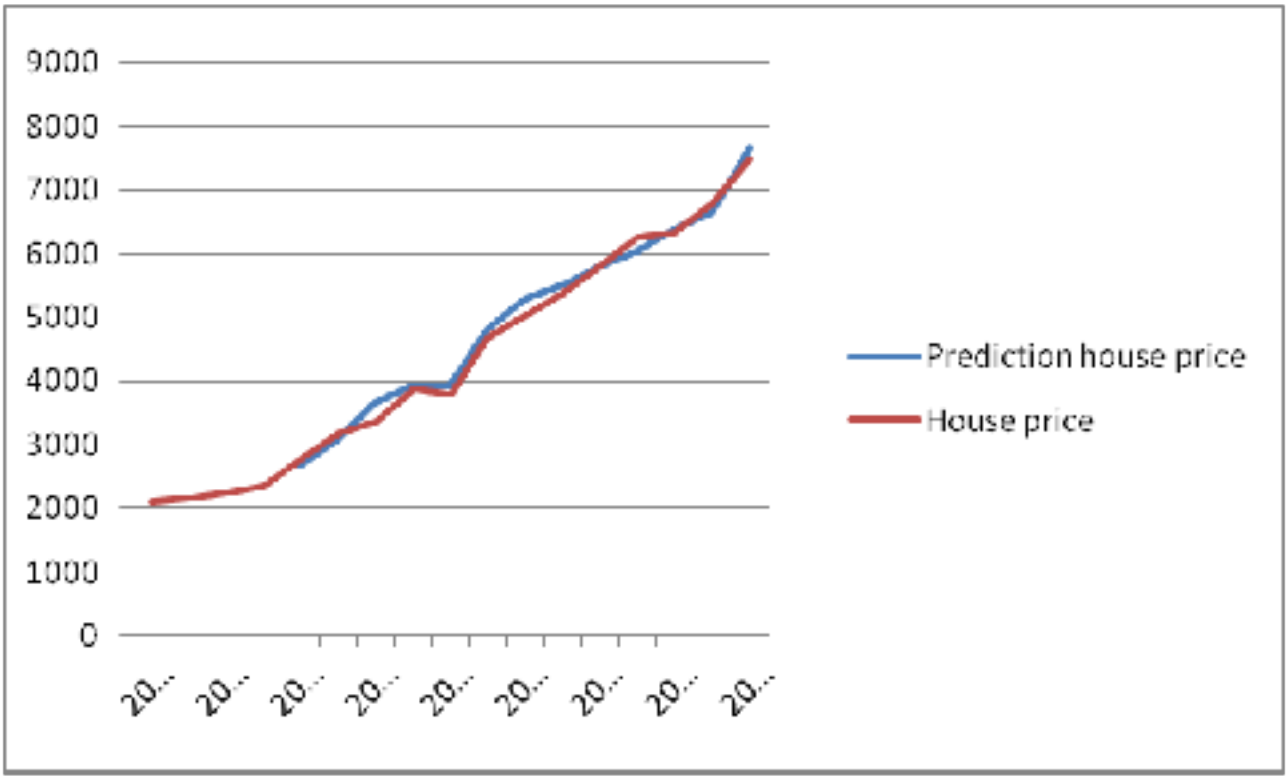
Table 4: Estimation results of Shanghai model

Description	Variable	Coefficient	Std. Error	t-Statistic	Prob.
House price lag 1	DLOG(PH(-1))	0.537020	0.116262	4.619067	0.0002
House price lag 3	DLOG(PH(-3))	-0.193203	0.089837	-2.150591	0.0439
Land price lag 1	DLOG(PL(-1))	0.242708	0.092145	2.633977	0.0159
Land price lag 2	DLOG(PL(-2))	0.454222	0.077309	5.875428	0.0000
Land price lag 3	DLOG(PL(-3))	0.17437	0.055533	3.139955	0.0052
Land price lag 4	DLOG(PL(-4))	0.192051	0.045833	4.190244	0.0005
Household income lag 1	DLOG(Y(-1))	0.606145	0.108502	5.58647	0.0000
Household income lag 2	DLOG(Y(-2))	0.401998	0.072861	5.517336	0.0000
Household income lag 3	DLOG(Y(-3))	0.19305	0.036818	5.243386	0.0000
Population growth lag 5	D(G(-5))	-0.028603	0.014988	-1.908372	0.0708
Population growth lag 7	D(G(-7))	-0.031909	0.015772	-2.023202	0.0566
Population growth lag 10	D(G(-10))	0.045785	0.017803	2.571778	0.0182
Population growth lag 12	D(G(-12))	0.048838	0.019597	2.4921	0.0216
Interest rate lag 1	D(INT(-1))	-0.112069	0.027007	-4.149637	0.0005
Interest rate lag 2	D(INT(-2))	-0.063129	0.027036	-2.334988	0.0301
Interest rate lag 3	D(INT(-3))	-0.073933	0.021621	-3.419531	0.0027
Error correction term	Error correction	-0.504904	0.088943	-5.676703	0.0000
R-squared		0.901341	Mean dependent var		0.016738
Adjusted R-squared		0.822415	S.D. dependent var		0.028022
S.E. of regression		0.011809	Akaike info criterion		-5.736246
Sum squared resid		0.002789	Schwarz criterion		-4.996095
Log likelihood		123.1206	Hannan-Quinn criter.		-5.475308
Durbin-Watson stat		2.298845			

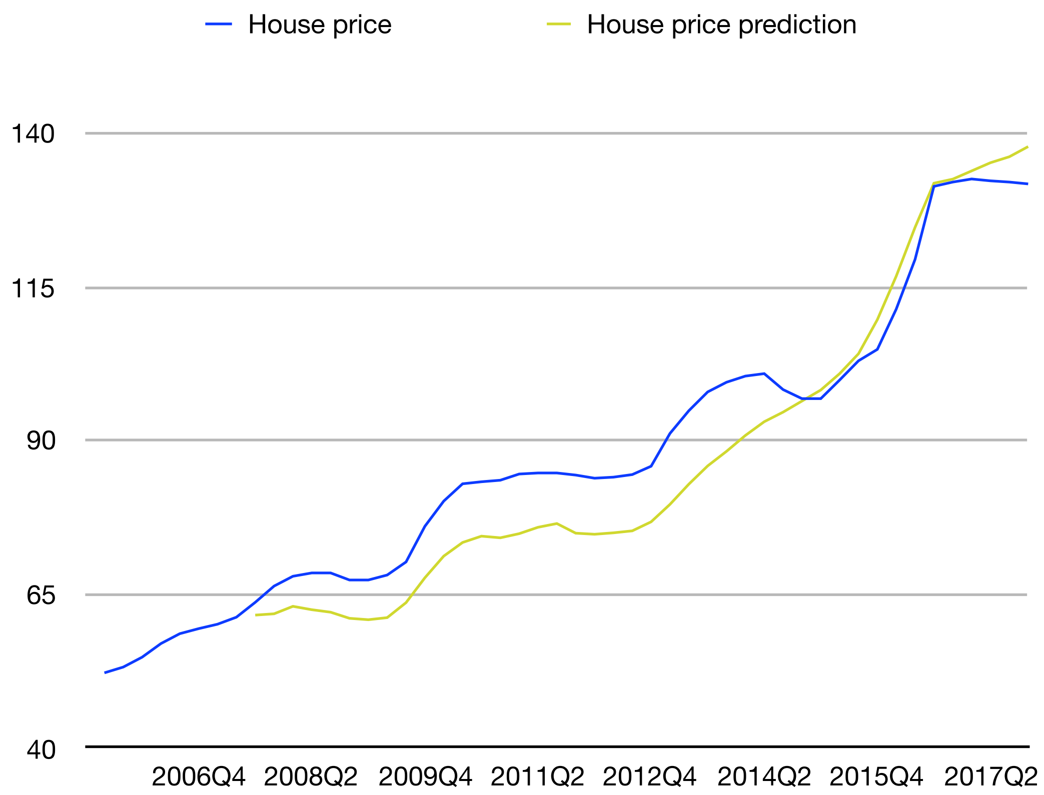
Hence, the two cities model of Beijing and Shanghai shed much light on the final China model of house price. Beijing and Shanghai are two representative cities of China which can reflect much things on China as a whole. Those three models are well estimated and the estimation results are consistent with the theory.

After getting the final estimation of the house price, we can conclude from the China house price equation and house price equation for Beijing and Shanghai. For the house price model for China as a whole. The house price is most influenced by the land price which is the main cost of the house. 1 percent increase in land price will lead to about 0.6 percent increase in house price after one year. The interest rate also matters the house price, one percent increase in interest rate will lead to about 0.08 percent increase in house price, more over, if the interest rate increase 50 percent of itself i.e. from 4% to 6%, the house price will increase 4% according the the result of the model. The household disposable income also increase the house price consistent with the theory part in section 2 of this paper. The population growth rate, which is a little bit confusing, because as the result shows the increase of population growth rate will lead house price decrease in short term, but if we consider a longer term, the sum of the coefficient of population growth rate is bigger than 1 indicating that in the relative long run, the population growth increase the house price. It is a kind of long term dynamic. The house price is also dependent with itself as the result shows, the increase of house price in the previous term also lead to the increase of the current house price. The error correction term tends the real value to the trend value, with error correction term, the equation is better estimated in the long run. Graph 1 shows the prediction house price of the model compared with the real house price.

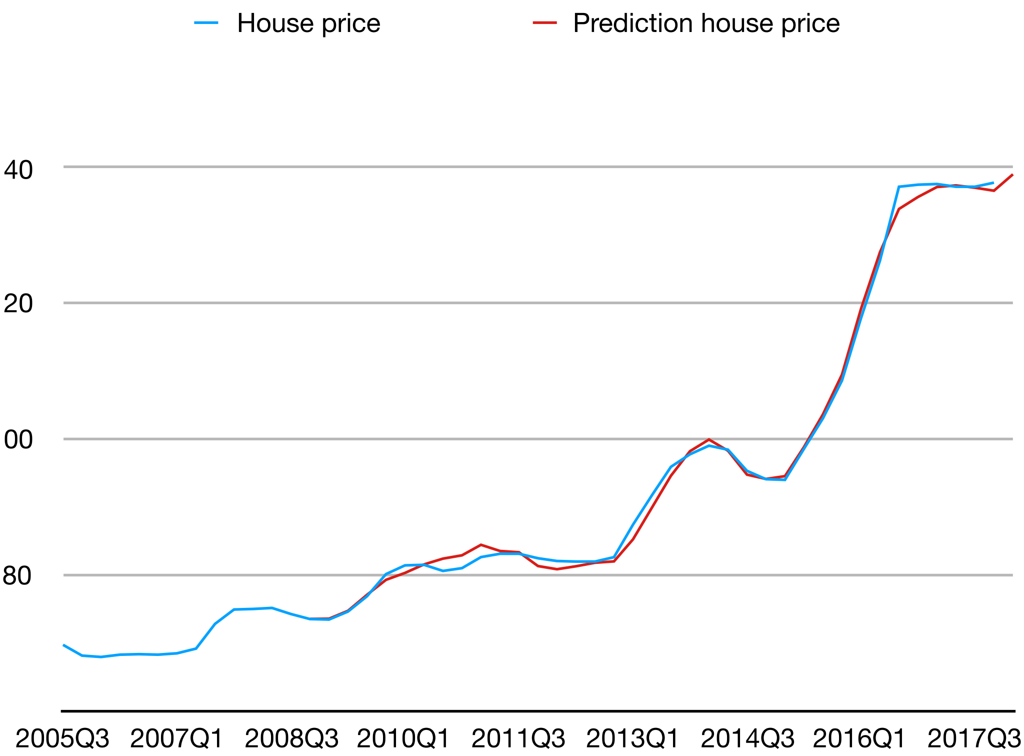
Graph 2: House price of China compared with prediction



Graph 3: House price of Beijing compared with prediction



Graph 4: House price of Shanghai compared with prediction



Compared to the China model which is in the real price, the Beijing model and Shanghai model is in price index to express more intuitive price changing trend. We can see that the house price of Beijing and Shanghai roar faster than the whole country price. And the house price increase speed of Beijing is much greater than Shanghai. The house price at now days is almost similar while ten years ago the house price of Beijing is only two third of Shanghai. The prediction result of Shanghai is especially good probably due to the great number of lags of variables included. The estimator of land price of Beijing model is less significant than other that of Shanghai and it is comparably small may due to the fact that the producer's cost have already mostly been explained by the increasing household income which is highly correlated with the consumption price index and producer price index. The land price and interest rate is more influential of the house price of these two cities compared to the whole country. For the statistical results, the household income is not significant to the whole country model while this variable is statistically significant to the house price of Shanghai and Beijing. The results seems interesting, a possible explanation may be that the household income of the whole country is so widely separated that the average household income does not vary much through those years while the for the first-tiers cities of China the household income varies a lot. These interesting results remains further investigation in future.

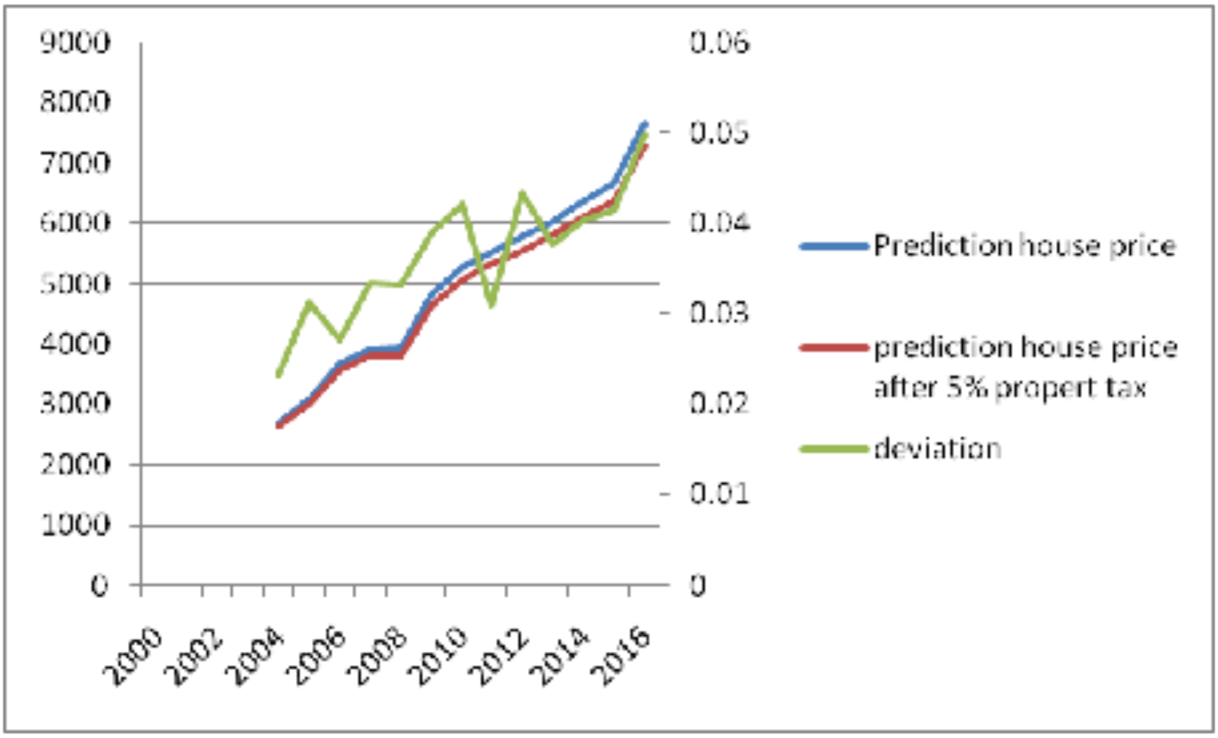
5. Simulation results of the property tax

With the well estimated equation of house price model of Shanghai, the policy simulation can be quantified. The property tax has been already experimentally started in Shanghai, the result of these experimental is still waiting to be observed and calculated. However, with the model in this paper, we can simulated the property tax in the model. The property tax is not like a house transaction tax that depends on the total transaction value of the house. The property tax is a consecutive tax that depend on the true value of the house each year. Usually, the house value should be estimated by the authorities each year to calculate a reasonable property tax. How to quantify the property tax in this model? Theoretically, we can modify the equation (1) with a new variable T representing the property tax each year. The intrinsic value of house price will decrease because of the property tax.

$$houseprice = \sum_{t=1}^{\infty} \beta_t \left(\mathbf{E}\left(\mathbf{Re}_t\right) - \mathbf{E}\left(De_t\right) - \mathbf{E}\left(T\right) \right) \tag{22}$$

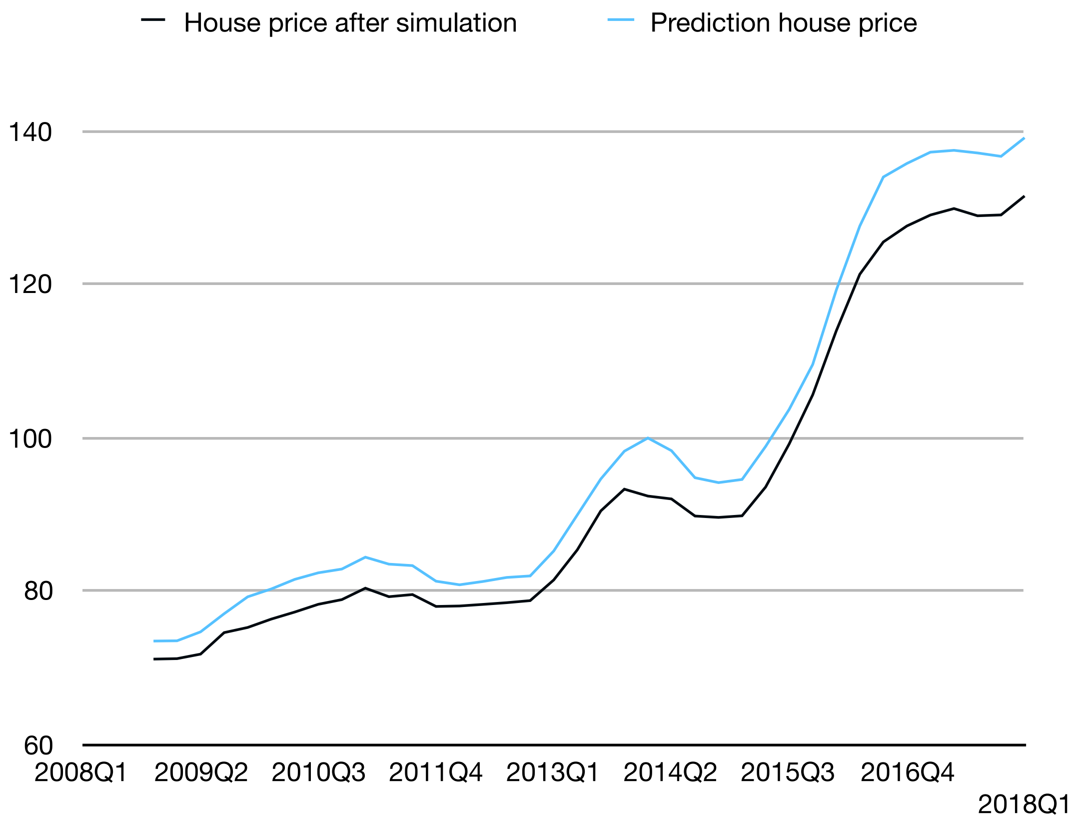
In reality, the imposing of the property tax will decrease the disposable wealth of households. Generally, the property tax would make people feel poorer than before. The shock is mostly from demand side. When property tax is higher, the money for consumption or investment is decreased. It is the same as reducing the disposable income. If the property tax is the only shock, we can assume the decrease of house price is because of the decrease of house demand which is stemmed from the decrease of people's disposable income. Assume the property tax will not influence other variables. Hence, in the model, suppose the upcoming average property tax rate of Shanghai equals to 5% compared to none property tax before, the new disposable income should equal to the original disposable income minus the per-capita housing value that each people dwelled multiplied by 5%.We can obtain this new variable per-capita housing value by using the data average house price multiplied by the per-capita living area.

Graph 5: Simulation of 5% property tax (China model)

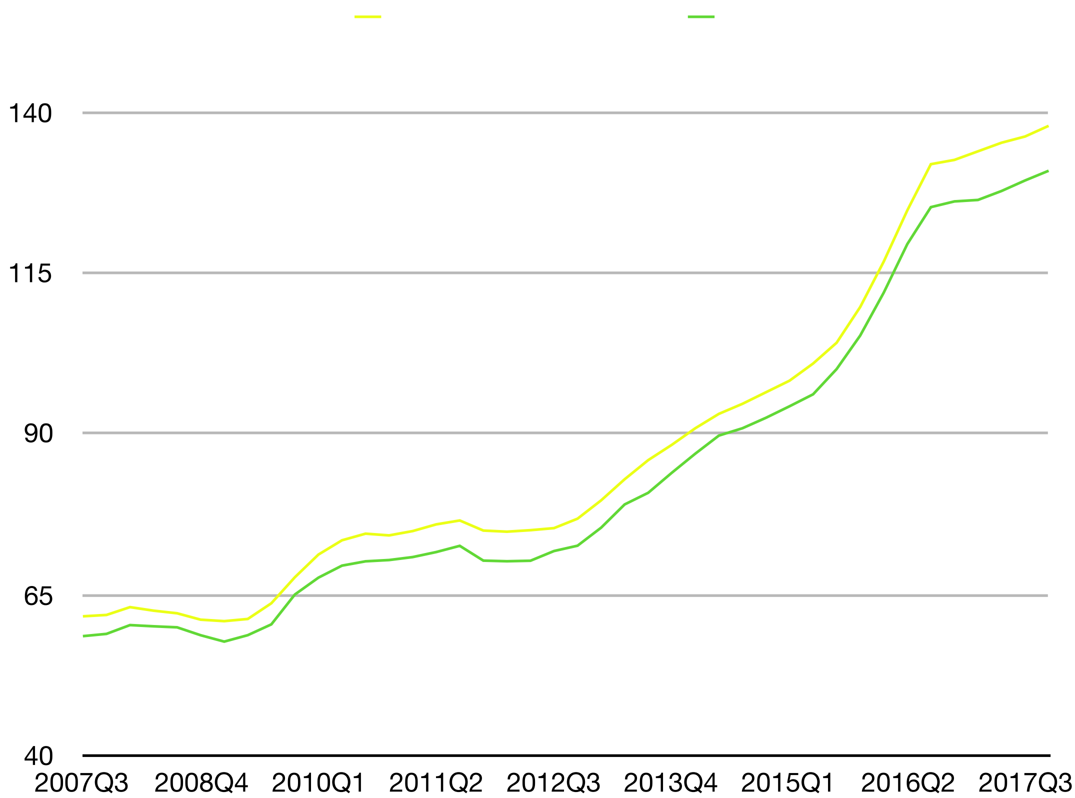


Graph 4 shows the simulation result of the house price model for the whole China. From the result, it can be concluded that the imposing of the property tax of 5% will decrease the Shanghai average house price in 2% to 5% approximately. The deviation becomes lager when the income and house price is higher. The 5 % property tax rate would induce 1.6 to 6.2 house price decrease when it is in Shanghai while the Beijing house price will decrease about 1.4 to 6.9 house price decrease among these years. It can be summarized that the effectiveness of property tax policy would be varies greatly when the absolute house price is high. Such effect would still be further investigate for the future researches. However, the effect of property tax is evident, it is indeed useful to cool down the present extremely high house price of the Chinese market. To conclude, for the purpose of decreasing the high house price in Shanghai, it is beneficial to introduce the property tax. Shanghai is representative to China in many regards, from this model, we can speculate that it is more likely that introducing property tax will slow down the high speed of house price increasing somewhat.

Graph 6: Simulation of 5% property tax (Shanghai model)



Graph 7: Simulation of 5% property tax (Beijing model)



6. Conclusion

The constitution of house price is a complex problem in economics field. This paper studied and analyzed thoroughly the possible influencing factors of house price in economics theory. Because the total amount of house demand in a period is hard to obtained, this paper find the theoretical relationships between house price and house rent and then use the house rent as a proxy to analyze the house price problem. To some extent, buying a house can be treated similarly as rent a house forever. Hence, renting a house and consumptions for other normal goods can constitute a theoretical utility function of people. The maximization of household utility function can generate a total house demand function while the maximizing the returns of real-estate firms can generate a total house supply. From economics perspective, a theoretical house price is born. The specific house price equation depends on the specific format of utility functions and profit functions. Different assumptions also matters in the house price model. However, the law is the same no matter where the market is. There is four important factors that affects the house price straightly. From the model, it can be concluded that the population growth increase the house price by increasing the total number of people, to whom it is necessary to dwell in a house. The currency and credit also matters house price the mainly in demand side. Increasing fluidity can push up the asset price because it is easy for people to borrow money to spend and easy for firms to borrow money to invest. When the total amount of houses is constant, the price of every asset will increase because the total money increases.The inflation is almost in every market. The disposable income per capita influence the house price in the similar way as the money supply or interest rate. When people are getting rich, they will be more willing to buy a house. Another important factor is the land price, this factor mainly affects the supply side of the house market because the land price constitute most cost of building a house.This model is representative to all the real-estate market in the world. The value of all the real-estate can be analyzed in this method theoretically.

The economic model is constituted and used for solving the empirical problems. There is a intractable problem affecting the economy of China which is the extremely high house price. In this paper, Shanghai is chosen as a representative city of China to be studied. After referring the theory part in section 3, an empirical model which used the empirical time series data of Shanghai from 2005 to 2016 is constitute. The house price of Shanghai can be estimated by some important variables. With this empirical model, the property tax can be simulated. The result is that an newly introducing property tax of 5% can reduce the house price about 1.6% to 6.2% depending on the absolute value of income and house price with the simulation of the historical datas. However, when we go into the nature of the house price deeply as section 3 illustrated, it can be concluded that the decrease of house price after the introducing of property tax originates from the decrease of the intrinsic value of house price. The decrease of house price does not means it becomes cheaper, it means that the house is less valuable, the gap between the prices before and after the imposing of property tax will be make up in the following time as the house owner pay the property tax in the future. Hence, the property tax can also analogized as a kind of income tax.

However, the extremely high house price has already been a disease of China, people is going irrational because they cannot generally estimated the future house price, and the social wealth is allocated unfairly because of the higher house price. The total social welfare is harmed by the wealth inequality caused by the high house price. Hence, as the result of the simulation in this model, the property tax is a good method to cool down the market, and it will turn people back to be rational and increasing the total social welfare.

7. Reference

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8. Appendix

Table 5 Variables used in the model

Item	Variables	Notation	Year
1	House price	Ph	2005-2017
2	House price index	Phe	2005-2017
3	Disposable income	Y	2005-2017
4	Land price	Pl	2005-2017
5	Interest rate	Int	2005-2017
6	Population growth rate	G	2005-2017

Table 6:Unrestricted cointegration test of China(Trace)

Hypothesised no. of CEs	Critical value	Probability
None*	29.79	0.0221
At most 1	15.49	0.1055
At most 2	3.84	0.0899

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 7:Unrestricted cointegration test of Shanghai(Trace)

Hypothesised no. of CEs	Critical value	Probability
None*	69.81889	0
At most 1	47.85613	0.3214
At most 2	29.79707	0.6005
At most 3	15.49471	0.8876
At most 4	3.841466	0.9152

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 8:Unrestricted cointegration test of Beijing (Trace)

Hypothesised no. of CEs	Critical value	Probability
None*	69.81889	0.0385
At most 1	47.85613	0.2646
At most 2	29.79707	0.3835
At most 3	15.49471	0.4245
At most 4	3.841466	0.6990

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 9: Cointegration relationships of Shanghai model

LOG(PH)	LOG(PL)	LOG(Y)	INT	G
1.000000	-0.776344	-1.621969	0.171394	-0.003018
	(0.03038)	(0.04245)	(0.01221)	(0.04592)
Adjustment coefficients (standard error in parentheses)				
D(LOG(PH))	D(LOG(PL))	D(LOG(Y))	D(LOG(INT))	D(G)
-0.029917	0.160976	2.373199	-0.227702	-0.021637
(0.01196)	(0.14209)	(0.09803)	(0.17709)	(0.10021)

Table 10: Cointegration relationships of Beijing model

LOG(PHE)	LOG(PL)	LOG(Y)	INT	G
1.000000	-0.813374	-0.87284	0.179848	-0.457334
	(0.20146)	(0.53450)	(0.06549)	(0.22192)
Adjustment coefficients (standard error in parentheses)				
D(LOG(PHE))	D(LOG(PL))	D(LOG(Y))	D(LOG(INT))	D(G)
-0.031535	0.154470	-0.354839	0.871953	-0.174161
(0.03872)	(0.37133)	(0.08633)	(0.54036)	(0.20560)