Rent to Price Ratio and Housing Bubble in Urban China

Weida Kuang

(School of Business, Renmin University of China)

Abstract: China' housing bubble issue is worldwide and heatedly discussed recently. Based on consumption demand and investment demand, this paper contributes to develop a theoretical model to combine rental market and ownership market and derive both equilibrium rent to price ratio with bubble and benchmark rent to price ratio without bubble. Thus, we are able to measure housing bubble by comparing real rent to price ratio to benchmark rent to price ratio. Using the rental market and ownership market datasets of China's 35 large and medium-size cities over the period 1996-2011, we finds 15 cities (e.g. Beijing, Shanghai, Guangzhou, Shenzhen, Hangzhou, Xiamen, Tsingdao, Shenyang, Ningbo) exist distinct housing bubble. The housing price in other 15 cities (e.g. Tianjin, Dalian, Jinan, Harbin, Chongqing, Chengdu), however, is undervalued, which indicates there is no housing bubble in these 15 cities. Hence, housing bubble varies across cities. Second, we find the future housing price negatively and most significantly impacts rent to price ratio, which implies the expectation of housing price appreciation can cause housing bubble. By contrast, interest rates of mortgage loan and development loan have no significant impacts on rent to price ratio. For this reason, the interest rate policy has no effects to curb housing price bubble in urban China. Third, the mortgage loan has less effects in rent to price ratio. Therefore, mortgage lending is not the main cause of housing bubble formation in China, which is converse to the existing literature. Fourth, housing stock significantly and negatively impacts rent to price ratio, which implies that overbuilding causes housing bubble. Finally, the land price has less effect in rent to price ratio. Accordingly, land price is also not the majority cause of housing bubble formation in urban China.

Key words: rental market, ownership market, rent to price ratio, housing bubble

Weida Kuang
Professor of Real Estate Finance and Economics
Department of Finance, School of Business, Renmin University of China (RUC),
Associate Director, Center for Real Estate Research, RUC
59 Zhongguancun Street, Haidian District, Beijing, 100872, P.R.China
Email:weidakuang@gmail.com
Tel: 86-10-8250-0473 (O)

1.Introduction

1.1 Background

It is known that both the financial crisis of Southeast Asian in 1998 and the global financial crisis in 2008 stem from the burst of housing bubble. Housing bubble occurred in many countries not only leads to a great deal of mortgage default, but also gives rise to bank bankruptcy due to capital inadequacy in many countries such as the United States, Great Britain, Spain, Iceland, Ireland, Hungary (Reinhart and Rogoff, 2009). For this reason, housing bubble is taken as a precursor of financial crisis, and housing prices are typically regarded as an important indicator of financial fragility by policymakers (BIS and IMF, 2005; Koetter and Poghosyan, 2010). In fact, rent to price ratio is typically lower in the presence of housing bubble. Himmelberg et al. (2005) compare the ratios of rent to price in 12 American cities and find that the ratio of rent to price significantly decline since 2000. Davis (2008) finds that the rent to price ratio of the United States varies from 5% to 5.5% during the period 1960-1995, while it declines since 1995 and reaches historic record at 3.5% in 2006. Using the American dataset of housing market from 1960 to 2011, Nneji et al. (2013) adopt Markov regime-switching model to regress rent to price ratio and find that there exists intrinsic bubble prior to 2000 and periodically collapsing rational speculative bubbles since 2000. A strand of literature investigates variations and the determinants of rent to price ratio. Using housing market databases of American 23 metropolis, four regions, and a country during the period of 1975 to 2007, Campbell et al. (2009) take dynamic Gordon growth model and variance decomposition to find that housing premia have a significant explanatory power in the fluctuations of rent to price ratio at both national level and local level, while the covariance of rent growth rates, actual interest rates and housing premia might significantly smooth out fluctuations of rent to price ratio. Simulating the database of the booming housing market in the United States over the period 1995-2006, Sommer et al. (2013) find that low interest rates, low down payment ratio and high income dramatically increase equilibrium prices of rational expectations, while have less effects on equilibrium rent, which drawfs rent to price ratios. Unfortunately, the extant literature on rent to price ratios is merely empirical research and has not provided a baseline rent to price ratio without bubble, which makes it tough to justify a housing bubble. In sum, a study on rent to price ratio is essential to measure and expound housing bubble at both theoretical side and empirical side.

During the period of 1992-1993, the housing bubble of Hainan and the North Sea in China engender the local banking system crash. Since 2005, housing prices keep running-up in China’s many cities. As a consequence, housing bubble issue has been heatedly discussed again. To prevent housing bubble, China’s central government carries out various measures like monetary policy (e.g. interest rate policy), credit policy (e.g. down payment restriction, credit quota), regulatory policy (e.g. purchasing number restrictions), to curb soaring housing prices. Unfortunately, the effects of these policies are trivial. According to the communiqué of national economy and social development issued by the National Bureau of Statistics of China, the housing sale prices of China's 70 large and medium-sized cities grew at 7.6%, 5.5%, 7.6%, 6.5%, 1.5%, 6.4%, 5.0% and 2.4%, respectively over the period 2005-2012. In terms of year-on-year price variations of newly-built commodity dwellings reported by National Bureau of Statistics in November 2013, only the dwelling price of Wenzhou was falling while the dwelling prices of other 69 cities were rising with the maximum of 21.9% and the minimum of 1.2% in China’s 70 large and medium-sized cities. In addition, the year on year prices of second-hand dwelling exhibit

the similar trend as newly-built commodity dwellings, only the second-hand dwelling price of Wenzhou was falling, while the second-hand dwelling prices of the other 69 cities were rising with the maximum of 20.1% and the minimum of 5.7%. On the other hand, the housing prices of "ghost city" such as Kangbashi in Erdos city, Zhengdong new district in Zhengzhou city, Chenggong in Yunnan province, Shiyan in Hubei province, Yingkou in Liaoning province, Changzhou in Jiangsu province, Hebi new district in Henan province) precipitated due to higher vacancy rates. A survey of China's 70 cities conducted by National Development and Reform Commission in 2008, demonstrated that the rent to price ratio of China was approximately 1:400 in the first half year, even though the average ratio of Beijing with great rental demand reached 1:325 lower than the international alarming-floor ratio of 1:300. Thus, housing bubble is prevailing across China's cities in recent years. More importantly, what is the rational of alarming-floor ratio of 1:300. In other words, how to define rent to price ratio with or without bubble. Furthermore, what determines rent to price ratio.

From the perspective of expectation, the existing literature measures housing bubble in the light of definitions of rational bubble and irrational bubble. A rational bubble consists of fundamental value and bubble component. General speaking, There are four approaches to measure housing bubble. The first approach defines housing bubble as the discrepancy of housing prices far exceed present value of expected cash flow (Smith and Smith, 2006). The second approach views equilibrium price as fundamental value and takes the deviation of actual housing price from equilibrium price as bubble (Abraham and Hendershott, 1994; Goodman and Thibodeau, 2008; Costello et al., 2011; Ren et al., 2012). By virtue of econometric skills, the third approach employs economic fundamental factors to estimate housing fundamental value, and takes the residuals of estimation as bubble (Muellbauer and Murphy, 1997). The fourth approach regards housing prices determined by consumption demand as fundamental value and takes the differential between housing price determined by investment demand and that of consumption demand as bubble (Clayton, 1996; Himmelberg et al., 2005; Wheaton and Nechayev, 2008). Unfortunately, none of the four approaches of rational bubble is able to measure fundamental value accurately. Using the dividend discount model (DDM), the first approach is incapable to predict future rents precisely. The second approach takes equilibrium price as fundamental value, while equilibrium price contains expectation factors as well as bubble component. As for the third method, due to missing explanatory variables, the residual comprises of both bubble component and non-bubble components. Although the fourth approach measures housing bubble from the perspective of housing feature, it fails to rigorously differentiate consumption demand. Since housing has dual properties of consumption and investment, the former determines fundamental value of housing, and the latter determines bubble component of housing. As a result, consumption demand determines long-term fluctuation of housing prices, while investment demand determines short-term volatility of housing prices. Although Clayton (1996) distinguishes consumption demand from investment demand, he does not explore their effects of housing price both in the long-run and in the short-run. Himmelberg et al. (2005) compare the ratios of rent to price in American 46 cities, but they do not provide theoretical evidence to take historical ratio of rent to price as fundamental value. Wheaton and Nechayev (2008) distinguish owner-occupied dwelling (the first dwelling) and investment housing (two dwellings and above). Nevertheless, they neglect rental demand and do not differentiate rental housing from ownership housing. As a matter of fact, rental demand is the genuine demand for consumption. Hence, fundamental value of housing is determined by rental market, while housing bubble is determined by ownership market.

Accordingly, a family of the literature uses rent to price ratio to measure housing bubble. For instance, employing six-month databases of housing price index and rental index in 23 American metropolitan statistical area (MSA) from 1978 to 2006, Mikhed and Zemˇcík (2009) find that housing bubble exists at the late 1980s, early 1990s and since the late 1990s by stationary tests and the Granger causality tests. Lastly, irrational bubbles measure housing bubble by growth rate of housing prices (Case and Shiller, 2003; Hendershott et al., 2003). Nevertheless, irrational bubble does not consider housing fundamental value, which is not able to measure housing bubble precisely. In other words, even though the growth rate of housing prices is higher, housing price is lower than fundamental value, there is also no housing bubble. On the other hand, if housing price is higher than fundamental value, there is a housing bubble even though the growth rate of housing price is declining.

Finally, there are four kinds of research works on causes of housing bubble. The first category of research works believes the interaction of mortgage loan and housing price produces housing bubble (Herring and Wachter, 2002; Oikarinen, 2009; Gimeno and Martinez-Carrascal, 2010; Sommervoll et al., 2010; Park, et al., 2010; Hott, 2011; Brueckner, et al., 2012). In other words, mortgage loan elevates housing price, while expectation of housing price appreciation expands mortgage loans, which consequently cause housing bubble. The second category of literature document that expectation and speculation leads to housing bubble (Herring and Wachter, 2002; Case, et al., 2012). The third category of research works verify that supply inelasticity causes housing shortage and speculation, which creates housing bubble (Roehner, 1999; Malpezzi and Wachter, 2005; Glaeser, etc., 2008; Bourassa, etc., 2009; Huang and Tang, 2012). The fourth category of research works believe that the heterogeneity of developers and investors give rise to housing bubble (Wong, 2001; Wong, 2005).

In conclusion, the extant research either does not strictly differentiate between consumption demand and investment demand (Wheaton and Nechayev, 2008) or lack of rigorously rational (Clayton, 1996; Himmelberg, et al., 2005). Hence, the remainder of the paper is organized as follows: firstly, based on consumption demand and investment demand, we build a theoretical model of rent to price ratio and provide a baseline ratio of rent to price; secondly, using housing market dataset of China's 35 large and medium-sized cities, we measure housing bubble and examine the determinants of housing bubble; Finally, we conclude the paper and present policy implications.

2. The model

To fill the gap of existing literature, this paper regards rental demand as consumption demand and ownership demand as investment demand. The former determines fundamental value of housing, and the latter determines bubble component of housing. As rental market determines equilibrium rent, and ownership market determines equilibrium housing price, this paper combines rental market and ownership market, and constructs a theoretical model of housing bubble to measure

and expound housing bubble .

2.1 Rental market equilibrium

As mentioned above, housing fundamental value is determined by rental market. According to the extent literatures, rental demand (consumption demand) is determined by rent, income, and demographic factors. Hence, rental demand equation can be written as:

$$D_{it}^{r} = \alpha_0 + \alpha_1 R_{it} + \alpha_2 y_{it}^{r} + \alpha_3 Dem_{it}^{r} \quad (\alpha_1 < 0, \alpha_2 > 0, \alpha_3 > 0) \tag{1}$$

Secondly, rental supply is determined by rent and housing stock. Thus, rental supply function can be expressed as:

$$S_{it}^{r} = \beta_0 + \beta_1 R_{it} + \beta_2 H_{it} \quad (\beta_1 > 0, \ \beta_2 > 0) \tag{2}$$

In equations 1 and 2, R_{it} and y_{it}^{r} denote rent and household income of tenant in region i at time t, respectively; Dem_{it}^{r} denotes population size, household number and household structure of demographic factors; H_{it} is housing stock in region i at time t.

In terms of equations 1 and 2, when rental market realizes equilibrium, we can obtain equilibrium rent:

$$R_{it}^{E} = \frac{\alpha_0 - \beta_0 + \alpha_2 y_{it}^{r} + \alpha_3 Dem_{it}^{r} - \beta_2 H_{it}}{\beta_0 - \alpha_1} \tag{3}$$

It is noteworthy that equilibrium rent（R_{it}^{E}）does not contain bubble component in that it is determined by consumption demand, which is referred to as housing price without bubble.

2.2 Ownership market equilibrium

As mentioned above, as bubble component of housing is determined by investment demand, housing bubble is determined by ownership market. In terms of the existing literature, housing investment demand (purchasing demand) is determined by housing price and its growth expectations, income, demographics, credit factors and so on. Because it is hard to distinguish investment demand from speculative demand in reality, we refer them to as investment demand. Therefore, housing investment demand equation can be written as:

$$D_{it}^{o} = \phi_0 + \phi_1 P_{it} + \phi_2 P_{it+1}^{e} + \phi_3 y_{it}^{o} + \phi_4 Dem_{it}^{o} + \phi_5 i_{it} + \phi_6 L_{it}^{d} \quad (\phi_1, \phi_5 < 0, \ \phi_2, \phi_3, \phi_4, \phi_6 > 0) \quad (4)$$

In equation 4, P_{it} and P_{it+1}^{e} stand for housing price in region i at time t and expected housing price in region i at time $t+1$, respectively; y_{it}^{o} is household income of homebuyer; Dem_{it}^{o} is demographic factor of homebuyer; i_{it} and L_{it}^{d} are mortgage rate and loans amount, which reflect the effects of mortgage loan on investment demand.

Current housing supply is composed of lagged housing stock and new supply. According to the extant literature, new supply is determined by expectation of current housing price, lagged development costs, housing development regulation and credit factors. A housing can be developed provided that expected housing price is higher than development costs. In the light of the lag of development, we assume that development period is solely lagged one, housing supply equation can be expressed as:

$$S_{it}^{o} = H_{it-1} + NS_{it} = H_{it-1} + \eta_1 P_{it}^{e} + \eta_2 C_{it-1} + \eta_3 Z_{it-1} + \eta_4 i_{it-1} + \eta_5 L_{it-1}^{s}$$

$$(\eta_1, \eta_5 > 0, \ \eta_2, \eta_3, \eta_4 < 0) \quad (5)$$

In equation 5, NS_{it} denotes new supply, P_{it}^{e} represents developers' expectation for housing price of t time at $t-1$ in region i; C_{it-1} is the lagged development costs, consisting of land cost and construction cost, Z_{it-1} is lagged housing development regulation, which reflects the effects of regulations on housing supply, i_{it-1} and L_{it-1}^{s} represent lagged interest rates and amount of housing development loans, respectively, which reflects the effects of loans on housing supply.

If we assume that homebuyers and suppliers have rational expectations, thus $P_{it}^{e} = P_{it}$, $P_{it+1}^{e} = P_{it+1}$. In terms of equations 4 and 5, while ownership market equilibriums, we can get equilibrium housing price:

$$P_{it}^{E} = \frac{\phi_0 - H_{it-1} + \phi_2 P_{it+1} + \phi_3 y_{it}^{o} + \phi_4 Dem_{it}^{o} + \phi_5 i_{it} + \phi_6 L_{it}^{d} - \eta_2 C_{it-1} - \eta_3 Z_{it-1} - \eta_4 i_{it-1} - \eta_5 L_{it-1}^{s}}{\eta_1 - \phi_1} \quad (6)$$

It is worth noting that equilibrium housing price (P_{it}^{E}) contains bubble component because it is

determined by investment demand.

2.3 Coequlibria of rental market and ownership market: rent to price ratio without bubble

As mentioned above, housing has dual property of consumption and investment, consumers resolve their shelters by renting a house or purchasing a housing. That is why the first home is regarded as consumption demand and the second home or above are viewed as investment demand in some sense (Wheaton and Nechayev，2008). According to tenure choice theory, there is no difference between renting and owning a house in the event that rent price is equal to housing user cost. Thus, both rental market and ownership market realize equilibria under this circumstance (Clayton, 1996; Himmelberg et al., 2005). Namely,

$$R_{it} = UC_{it} = P_{it} uc_{it} = P_{it}(i_{it} + \tau_{it} + m_{it} + d_{it} - g^{e}_{it}) \tag{7}$$

In equation 7, UC denotes user cost of unit housing price, and comprises of interest rate, property taxe, maintenance cost, housing depreciation and expected growth rate of housing price (Hendershott and Slemrod, 1983; Himmelberg et al., 2005). The co-equilibria housing price of both rental market and ownership market reflects fundamental factors, which is referred to as housing price without bubble. Thus, rent to price rate without bubble (baseline ratio) can be obtained:

$$\frac{R^{*}_{it}}{P^{*}_{it}} = uc_{it} = i_{it} + \tau_{it} + m_{it} + d_{it} - g^{e}_{it} \tag{8}$$

From equation 8, we can get Proposition 1.

Proposition 1: if the assumptions above hold, then $\partial(\frac{R^{*}_{it}}{P^{*}_{it}}) / \partial i_{it} > 0$, $\partial(\frac{R^{*}_{it}}{P^{*}_{it}}) / \partial \tau_{it} > 0$, $\partial(\frac{R^{*}_{it}}{P^{*}_{it}}) / \partial m_{it} > 0$, $\partial(\frac{R^{*}_{it}}{P^{*}_{it}}) / \partial d_{it} > 0$, $\partial(\frac{R^{*}_{it}}{P^{*}_{it}}) / \partial g^{e}_{it} < 0$

Proposition 1 demonstrates that when rental market and ownership market are equilibrium simultaneously, mortgage rate, property tax, maintenance rate and housing depreciation rate are negatively associated with likelihood of housing bubble due to higher housing cost and baseline rent to price ratio. However, expected growth rate of housing price is positively associated with likelihood of housing bubble due to lower housing user cost and baseline rent to price ratio.

2.4 Non-coequilibriua of rental market and ownership market: rent to price ratio with bubble

When ownership market primarily reflects investment demand rather than consumption demand, rental market and ownership market realize their equilibria respectively. Equilibrium housing price of ownership market contains bubble component, because it is determined by investment demand. In terms of equations 3 and 6, we can obtain equilibrium rent to price ratio with housing bubble:

$$\frac{R_{it}^E}{P_{it}^E}=\frac{(\eta_1-\phi_1)(\alpha_0-\beta_0+\alpha_2 y_{it}^r+\alpha_3 Dem_{it}^r-\beta_2 H_{it})}{(\beta_0-\alpha_1)(\phi_0-H_{it-1}+\phi_2 P_{it+1}+\phi_3 y_{it}^o+\phi_4 Dem_{it}^o+\phi_5 i_{it}+\phi_6 L_{it}^d-\eta_2 C_{it-1}-\eta_3 Z_{it-1}-\eta_4 i_{it-1}-\eta_5 L_{it-1}^s)} \quad (9)$$

From equation 9, we can derive Proposition 2.

Proposition 2: if the assumptions above hold, then $\partial(\frac{R_{it}^E}{P_{it}^E})/\partial P_{it+1}<0$, $\partial(\frac{R_{it}^E}{P_{it}^E})/\partial y_{it}^r>0$, $\partial(\frac{R_{it}^E}{P_{it}^E})/\partial y_{it}^o<0$, $\partial(\frac{R_{it}^E}{P_{it}^E})/\partial H_{it}<0$, $\partial(\frac{R_{it}^E}{P_{it}^E})/\partial H_{it-1}>0$, $\partial(\frac{R_{it}^E}{P_{it}^E})/\partial L_{it}^d<0$, $\partial(\frac{R_{it}^E}{P_{it}^E})/\partial L_{it}^s>0$, $\partial(\frac{R_{it}^E}{P_{it}^E})/\partial i_{it}>0$, $\partial(\frac{R_{it}^E}{P_{it}^E})/\partial i_{it-1}<0$, $\partial(\frac{R_{it}^E}{P_{it}^E})/\partial C_{it-1}<0$

Proposition 2 indicates that the higher the expectation price is, the larger the current housing demand is, the lower rent to price ratio is, and the more likely housing bubble occurs. The higher the tenant income is, the higher the rental price is, the higher rent to price ratio is, and the less likelihood of housing bubble. While the higher homebuyer's income is, the higher the housing price is, and the lower rent to price ratio is, and the greater the likelihood of housing bubble is. The larger current housing stock is, the lower the rental price is, the lower rent to price ratio is, and the more likelihood of housing bubble is; the greater the lagged housing stock is, the grater the current housing supply is, the lower the housing price is, and the higher the rent to price ration is, and the more likelihood of housing bubble is. The larger the homebuyer's loans is, the higher the housing prices is, the lower the rent to price ratio is, and the more likelihood of housing bubble is; the higher homebuyer's mortgage rate is, the less the housing demand is, the higher the rent to price ratio is, and the less likelihood of housing bubble is. The larger the development loan is, the greater new supply is, the higher the rent to price ratio is, and the less likelihood of housing bubble is. The higher the interest rate of development loan and the greater development cost are, the less the new supply is, the lower the rent to price ratio is, and the more likelihood of housing bubble is.

3. Measurement of housing bubble

3.1Indicators of housing bubble

Apparently, in terms of equations 7 and 8, if $\frac{R_{it}^E}{P_{it}^E}=\frac{R_{it}^*}{P_{it}^*}$, then there is no housing bubble; if

$\frac{R_{it}^E}{P_{it}^E} > \frac{R_{it}^*}{P_{it}^*}$, then housing price is undervalued; if $\frac{R_{it}^E}{P_{it}^E} < \frac{R_{it}^*}{P_{it}^*}$, then housing price is overvalued, and housing bubble exists. Thus, by comparison of $\frac{R_{it}^E}{P_{it}^E}$ and $\frac{R_{it}^*}{P_{it}^*}$, we can measure the degree of housing bubble and generate housing bubble index as follow :

$$HB_{it} = \frac{R_{it}^E}{P_{it}^E} / \frac{R_{it}^*}{P_{it}^*}$$

In the equation above, HB_{it} denotes the degree of housing bubble. For convenience, we categorize degrees of housing bubble as Table 1.

Table 1 Category of Housing Bubble

HB	Degree
<0.7	Severe
0.7-0.9	Slight
0.9-1.1	None
>1.1	undervalued

3.2Assumptions of user cost measurement

To measure the housing bubble, we need to measure rent to price ration without bubble. According to equation 8, rent to price ratio without bubble could be measured by user cost of unit housing price. Even though housing user cost is widely used, it is necessary to make relevant assumptions to reduce difficulties encountered in measurement. In terms of Himmelberg (2005), we assume that: (1) baseline interest rate of five years and above is taken as the mortgage rate, albeit central bank allows loan rates of commercial banks to fluctuate with limitation around baseline interest rate; (2)According to the tentative implementations of property tax of Shanghai and Chongqing in 2011, property tax rate is set at 0.5%; (3) in terms of the ordinances of residential special maintenance funds management issued by Ministry of Housing and Ministry of Finance in 1998 and in 2008, maintenance rate is set as 2%; (4) According to code for residential design published by Ministry of Housing and General Administration of Quality Supervision in 2011, we depreciate housing capital in 50 years and use straight-line depreciation method with the salvage value rate 5%; (5) the expected growth rate of housing price is constant in each city, geometric growth of housing price in sample period(1996-2011) is taken as the expected growth rate.

3.3 Data

This paper utilizes the databases of ownership market and rental market in China's 35 large and medium-sized cities during the period of 1996 to 2011. The dataset of ownership market includes housing prices, urban household disposable income, housing stock, housing sales and residential development costs (comprising land costs and the construction costs), residential development loan, CPI and loan interest rates. Because the database of tenants is not available, the dataset of rental market solely contains rent price and rental price indices. It is noteworthy that housing development costs are the sum of land costs and construction costs. In addition, housing stock

could be obtained by urban dwelling size per capita and urban population (urban dwelling size per capita multiplies urban population).

First, the data of rents in 2011 are from Xitai website of real estate database (http://www.cityre.cn/), the rental prices during 1996-2010 are calculated by rental price indices, which are assembled from *Prices Yearbook of China*. Second, housing prices, household disposable income, housing sales, urban population, dwelling area per capita and CPI are collected from *Statistical Yearbook* of corresponding cities. Third, land costs are represented by land prices (land price=residential land revenue/residential land sale area). The data of land revenue and land sale area are from *China Land and Resources Statistical Yearbook*. Fourth, housing construction costs = value of housing completion / housing completion, value of housing completion and housing completion are from *China Real Estate Statistics Yearbook*. Fifth, baseline interest rates of five-years and above are from the central bank website (http://www.pbc.gov.cn) , which are adjusted by days. Sixth, to eliminate inflation, we take Year 1996 as base year and convert housing prices, rents, household disposable income, housing sales, land costs, construction costs and residential development loan into real terms by city CPIs.

3.4 Descriptive analysis

According to assumptions of user cost measurement, we reckon real rent to price ratio, rent to price ratio without bubble and degrees of housing bubble for China's 35 large and medium-sized cities over the period 1996-2011. Table 2 shows that as the governments only charged symbolically few rents for public housing before the housing reform in 1998, a plenty of cities had housing bubbles during 1996-1997. Since the housing reform, the cities with housing bubbles have changed constantly. The number of cities with severe housing bubble arrived at 3 in 2010, and cities with slight housing bubble increased from 2 in 1999 to 7 in 2010. The cities with housing prices undervalued decreased from 32 to 21 in1999 and in 2010.

Table 2 Distribution of housing bubble in China's 35 large and medium-sized cities during 1996-2011

Year	$HB < 0.7$	$0.7 < HB < 0.9$	$0.9 < HB < 1.1$	$HB > 1.1$
1996	17	4	0	8
1997	4	4	5	19
1998	3	0	5	27
1999	0	2	1	32
2000	0	1	0	34
2001	0	1	0	34
2002	0	0	1	34
2003	0	0	1	34
2004	0	1	0	34
2005	0	1	0	34
2006	0	1	2	32
2007	2	3	8	22
2008	2	6	5	22
2009	0	5	5	25

2010	3	7	4	21
2011	1	5	2	27

Table 3 China’s 15 cities with severe or slight housing bubble during 1996-2011.

City	Indicators	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Beijing	RTP	0.04	0.04	0.04	0.04	0.06	0.08	0.08	0.09	0.09	0.07	0.06	0.04	0.04	0.03	0.03	0.04
	UC	0.12	0.10	0.07	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.05	0.05	0.04	0.04	0.03
	HB	0.32	0.37	0.53	0.80	1.60	1.95	2.39	2.65	2.51	1.84	1.45	0.85	0.77	0.96	0.83	1.26
Shanghai	RTP	0.08	0.15	0.11	0.11	0.11	0.11	0.09	0.08	0.07	0.06	0.06	0.06	0.06	0.04	0.04	0.04
	UC	0.13	0.11	0.08	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.05	0.05	0.04
	HB	0.58	1.34	1.39	1.87	2.08	2.09	2.02	1.68	1.51	1.27	1.17	0.91	0.94	0.82	0.75	0.98
Guangzhou	RTP	0.07	0.09	0.07	0.07	0.07	0.07	0.07	0.06	0.07	0.06	0.05	0.04	0.04	0.04	0.03	0.04
	UC	0.12	0.10	0.07	0.04	0.04	0.04	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.04	0.04	0.03
	HB	0.57	0.93	1.02	1.54	1.83	1.80	2.02	1.84	2.02	1.64	1.27	0.78	0.73	0.98	0.86	1.20
Shenzhen	RTP	0.08	0.08	0.07	0.07	0.07	0.06	0.07	0.06	0.06	0.05	0.04	0.03	0.03	0.03	0.02	0.02
	UC	0.11	0.09	0.06	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.05	0.05	0.03	0.03	0.03
	HB	0.68	0.90	1.12	1.65	1.92	1.85	2.12	2.09	1.85	1.54	1.17	0.65	0.67	0.89	0.70	0.86
Hangzhou	RTP	—	0.13	0.13	0.12	0.12	0.11	0.09	0.09	0.09	0.06	0.06	0.05	0.05	0.03	0.03	0.03
	UC	—	0.05	0.02	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.01	-0.01	-0.01	-0.02
	HB	—	2.48	5.39	-193.43	-17.67	-17.13	-8.86	-7.94	-8.66	-8.50	-14.61	10.49	7.36	-3.56	-3.14	-2.00
Ningbo	RTP	—	0.15	0.14	0.13	0.12	0.11	0.09	0.09	0.08	0.06	0.05	0.04	0.04	0.03	0.02	0.03
	UC	—	0.04	0.01	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.02	-0.02	-0.01	-0.01	-0.02	-0.02	-0.03
	HB	—	4.07	17.21	-8.61	-5.49	-5.03	-3.40	-3.49	-3.18	-2.46	-2.60	-4.14	-4.60	-1.28	-1.05	-0.88
Xiamen	RTP	—	—	0.12	0.11	0.11	0.10	0.09	0.09	0.07	0.06	0.04	0.03	0.03	0.04	0.03	0.03
	UC	—	—	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	-0.01
	HB	—	—	3.66	14.61	67.46	61.12	-42.58	-31.28	-36.17	71.11	10.11	2.60	2.38	-34.92	-50.03	-3.64
Tsingdao	RTP	0.12	0.13	0.12	0.12	0.11	0.12	0.10	0.09	0.07	0.06	0.05	0.04	0.05	0.04	0.04	0.03
	UC	0.08	0.06	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.00	0.00	-0.01
	HB	1.46	2.01	3.42	11.51	26.75	27.77	254.07	-340.93	137.80	16.64	7.41	2.86	2.87	29.06	19.22	-6.62
Hefei	RTP	0.06	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.05	0.05	0.05	0.04	0.04	0.03	0.03
	UC	0.19	0.06	0.04	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.00	0.00	0.00
	HB	0.34	1.16	2.02	6.16	12.19	11.89	32.52	43.45	22.97	8.89	5.77	2.74	2.34	10.89	7.39	-8.44
Wuhan	RTP	—	—	0.15	0.13	0.13	0.11	0.10	0.10	0.08	0.07	0.06	0.05	0.05	0.05	0.04	0.04
	UC	—	—	0.04	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.00	0.00	0.00
	HB	—	—	4.13	11.26	20.98	18.64	47.56	64.29	35.20	13.23	6.93	2.75	2.66	13.87	11.54	-10.59
Shenyang	RTP	0.06	0.06	0.06	0.05	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04
	UC	0.14	0.12	0.09	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.08	0.06	0.06	0.05
	HB	0.41	0.51	0.66	0.78	0.90	0.89	0.95	0.95	0.89	0.84	0.80	0.68	0.61	0.71	0.62	0.68

Shijiazhuang	RTP	0.05	0.07	0.06	0.07	0.07	0.07	0.08	0.08	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.04
	UC	0.14	0.12	0.09	0.07	0.06	0.06	0.06	0.05	0.06	0.06	0.06	0.07	0.07	0.06	0.06	0.05
	HB	0.38	0.56	0.71	1.01	1.18	1.19	1.36	1.39	1.53	1.33	1.07	0.80	0.72	0.71	0.69	0.80
Taiyuan	RTP	0.15	0.07	0.07	0.07	0.08	0.09	0.09	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.03	0.03
	UC	0.19	0.10	0.07	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.04	0.04	0.03
	HB	0.82	0.71	1.05	1.62	2.01	2.30	2.44	2.52	2.15	1.72	1.46	1.08	1.04	1.24	0.78	1.07
Yinchuan	RTP	—	—	0.05	0.06	0.07	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.06	0.05	0.04	0.04
	UC	—	—	0.09	0.06	0.06	0.06	0.05	0.05	0.05	0.06	0.06	0.07	0.07	0.05	0.06	0.05
	HB	—	—	0.60	0.92	1.16	1.19	1.29	1.47	1.38	1.24	1.10	0.95	0.81	0.85	0.80	0.90
Urumqi	RTP	0.07	0.08	0.07	0.07	0.07	0.07	0.06	0.05	0.07	0.06	0.07	0.06	0.05	0.05	0.03	0.03
	UC	0.14	0.11	0.08	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.05	0.05	0.04
	HB	0.50	0.73	0.90	1.20	1.31	1.35	1.23	1.18	1.40	1.24	1.32	0.92	0.76	0.95	0.73	0.79

Note: RTP denotes actual rent to price ratio, UC denotes user cost of housing, HB=RTP/UC (hereinafter).

Table 3 illustrates that as values of HB are between 0.7 and 0.9 in Beijing, Guangzhou from 2007 to 2010, Shanghai from 2009 to 2010, Shenzhen 2009 and 2011, Shenyang from2004 to 2006, Shijiazhuang 2007 and 2011, Yinchuan and Urumqi from 2008 to 2011, there exists slight housing bubble in these cities. Since values of HB are less than 0.7 in Shenzhen from 2007 to 2008 and in 2010, Shenyang from 2007 to 2011, Shijiazhuang from 2008 to 2010, severe housing bubble exists in those cities. It is worth noting that due to the higher growth of housing price in Hangzhou, Ningbo, Xiamen, Qingdao, Wuhan and Hefei, their user costs are negative, which results in the negative HB value in Hangzhou, Ningbo and Xiamen during the period 1999-2011 and in Qingdao, Wuhan and Hefei in 2011. As a result, the above 6 cities exist severe housing bubble. Hence, housing bubble not only occurred in the eastern cities, but also in the middle and western cities. Therefore, the governments should pay great attention on the issues of housing bubble in above 15 cities. It is necessary to point out that real RTPs tends to decline over the period of 1996-2011, the growth rate of housing price is greater than that of rental price. Similarly, as the rapid growth of housing prices over the period of 1996-2011, the user costs (UC) are going down while principally between 0.04 and 0.06.

Table 4 China's 5 cities without bubble during 1996-2011

City	Indicators	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Nanjing	RTP	—	—	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.06	0.06	0.06	0.04	0.03	0.04
	UC	—	—	0.07	0.04	0.04	0.04	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.03	0.04	0.03
	HB	—	—	1.15	1.75	2.01	2.09	2.29	2.05	2.17	1.83	1.61	1.15	1.19	1.15	0.92	1.33
Haikou	RTP	0.15	0.12	0.14	0.13	0.12	0.12	0.10	0.09	0.09	0.08	0.08	0.07	0.05	0.04	0.03	0.04
	UC	0.12	0.10	0.07	0.05	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.05	0.05	0.04	0.04	0.03
	HB	1.22	1.27	2.02	2.86	3.12	3.07	2.95	2.68	2.55	2.05	1.88	1.32	0.99	1.21	0.87	1.40
Zhengzhou	RTP	0.08	0.10	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.04
	UC	0.12	0.10	0.07	0.04	0.04	0.04	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.03	0.03	0.03
	HB	0.69	1.07	1.03	1.55	1.86	2.00	2.22	2.23	2.14	1.71	1.52	1.08	0.98	1.27	1.13	1.42

Lanzhou	RTP	—	—	0.11	0.10	0.10	0.10	0.10	0.10	0.08	0.07	0.06	0.06	0.05	0.04	0.05	0.05
	UC	—	—	0.08	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.06	0.06	0.04	0.04	0.04
	HB	—	—	1.44	1.98	2.22	2.23	2.45	2.38	1.83	1.54	1.34	1.00	0.94	1.04	1.07	1.36
Xining	RTP	0.09	0.08	0.08	0.08	0.09	0.10	0.10	0.09	0.09	0.08	0.07	0.06	0.05	0.05	0.05	0.05
	UC	0.13	0.11	0.08	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.05	0.05	0.04
	HB	0.65	0.73	0.95	1.33	1.68	1.93	2.13	1.97	1.90	1.60	1.33	0.96	0.79	1.06	0.99	1.25

Table 4 exhibits that, except for 1996 and 1997, values of HB are between 0.9-1.1 in Nanjing in 2010, Haikou in 2008 and 2010, Zhengzhou in 2007 and 2008, Lanzhou from 2007 to 2010 and Xining from 2007 to 2010. Thus, there are no obvious housing bubble in the above five cities, while housing prices in other years are undervalued. The governments also should highly care about the issues of housing bubble in the above five cities.

Table 5 China’s 15 undervalued cities during 1996 and 2011

City	Indicators	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Tianjin	RTP	0.07	0.09	0.09	0.09	0.09	0.11	0.11	0.10	0.09	0.07	0.06	0.05	0.05	0.04	0.04	0.03
	UC	0.12	0.09	0.07	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.04	0.05	0.05	0.03	0.03	0.03
	HB	0.58	0.96	1.39	2.28	2.53	3.01	3.39	3.38	2.84	1.96	1.53	1.04	1.01	1.29	1.11	1.33
Dalian	RTP	—	0.13	0.11	0.10	0.11	0.11	0.10	0.10	0.10	0.08	0.07	0.06	0.05	0.05	0.05	0.04
	UC	—	0.08	0.06	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.02	0.02	0.02
	HB	—	1.49	1.95	3.13	4.01	4.06	4.50	4.60	4.18	3.13	2.37	1.48	1.39	2.12	2.06	2.58
Foochow	RTP	—	—	0.09	0.10	0.11	0.10	0.09	0.08	0.05	0.05	0.05	0.05	0.04	0.03	0.03	0.03
	UC	—	—	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.00
	HB	—	—	2.36	6.60	10.93	10.71	15.38	14.88	9.17	5.85	4.00	2.28	2.00	4.41	4.46	307.11
Jinan	RTP	0.09	0.14	0.10	0.10	0.10	0.10	0.09	0.08	0.07	0.07	0.06	0.06	0.05	0.04	0.03	0.03
	UC	0.11	0.09	0.06	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.05	0.03	0.03	0.02
	HB	0.83	1.54	1.60	2.55	3.00	3.01	3.29	2.99	2.36	2.17	1.78	1.29	1.12	1.49	1.16	1.50
Changchun	RTP	0.07	0.07	0.07	0.07	0.07	0.08	0.07	0.08	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04
	UC	0.19	0.09	0.06	0.04	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.04	0.04	0.03	0.03	0.02
	HB	0.36	0.78	1.16	1.96	2.32	2.61	2.95	3.16	3.34	2.78	2.33	1.42	1.31	1.72	1.34	1.95
Harbin	RTP	0.13	0.16	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.10	0.09	0.07	0.07	0.06	0.06
	UC	0.19	0.10	0.07	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.04	0.04	0.03
	HB	0.70	1.64	1.77	2.60	2.98	2.96	3.31	3.38	3.19	2.76	2.42	1.72	1.43	1.78	1.48	1.98
Nanchang	RTP	0.06	0.10	0.07	0.08	0.09	0.08	0.08	0.06	0.05	0.05	0.05	0.04	0.05	0.04	0.04	0.03
	UC	0.19	0.08	0.05	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.01
	HB	0.31	1.25	1.41	2.97	4.35	4.32	4.91	4.15	3.42	2.92	2.08	1.39	1.40	2.13	2.15	3.17
Chan	RTP	0.07	0.09	0.10	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.04	0.04
	UC	0.19	0.09	0.07	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.04	0.05	0.05	0.03	0.03	0.03

gsha	HB	0.37	1.00	1.46	2.17	2.54	2.50	2.84	2.82	2.67	2.20	1.93	1.22	1.20	1.59	1.33	1.46
Hoht	RTP	0.15	0.11	0.09	0.09	0.09	0.09	0.10	0.10	0.09	0.08	0.07	0.06	0.07	0.05	0.05	0.04
	UC	0.11	0.08	0.07	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.04	0.04	0.03
	HB	1.38	1.30	1.28	1.97	2.21	2.21	2.62	2.65	2.42	2.00	1.55	1.21	1.20	1.32	1.18	1.38
Nanning	RTP	0.10	0.14	0.08	0.08	0.08	0.09	0.08	0.08	0.08	0.09	0.08	0.07	0.06	0.05	0.05	0.05
	UC	0.12	0.09	0.06	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.03	0.03	0.02
	HB	0.85	1.56	1.31	2.02	2.45	2.54	2.66	2.75	2.74	2.64	2.20	1.50	1.32	1.67	1.59	2.03
Chongqing	RTP	0.13	0.14	0.13	0.13	0.13	0.12	0.11	0.11	0.11	0.09	0.08	0.07	0.07	0.06	0.05	0.05
	UC	0.11	0.09	0.06	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.05	0.05	0.03	0.03	0.02
	HB	1.17	1.51	2.02	3.37	3.80	3.64	3.70	3.79	3.57	2.74	2.27	1.48	1.46	1.78	1.58	1.96
Chengdu	RTP	0.15	0.16	0.13	0.12	0.12	0.11	0.11	0.11	0.09	0.07	0.06	0.05	0.05	0.05	0.04	0.04
	UC	0.10	0.08	0.05	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.02	0.02	0.01
	HB	1.55	2.10	2.61	4.89	6.34	6.15	7.23	7.56	6.29	4.18	2.88	1.70	1.47	2.91	2.49	4.49
Guiyang	RTP	0.18	0.17	0.14	0.13	0.13	0.12	0.11	0.10	0.10	0.09	0.08	0.07	0.07	0.05	0.05	0.04
	UC	0.09	0.07	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.00
	HB	1.92	2.38	3.26	7.15	10.64	10.58	13.74	14.16	12.99	8.08	5.81	3.06	2.66	5.99	4.92	19.43
Kunming	RTP	0.12	0.08	0.09	0.08	0.08	0.09	0.09	0.08	0.08	0.08	0.07	0.06	0.06	0.07	0.05	0.12
	UC	0.10	0.07	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.04	0.04	0.03	0.10
	HB	1.18	1.11	1.79	1.95	2.00	2.25	2.28	2.11	1.96	1.69	1.31	1.09	1.54	1.69	1.69	1.18
Xi'an	RTP	0.11	0.11	0.09	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.06	0.06	0.06	0.06	0.05	0.04
	UC	0.19	0.07	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.01	0.01	0.00
	HB	0.57	1.59	2.04	4.48	6.55	6.44	9.35	9.74	7.41	5.72	3.83	2.60	2.23	5.65	4.98	12.44

Table 5 displays that the values of HB are greater than 1.1 in Tianjin, Dalian, Jinan, Fuzhou, Nanchang, Changsha, Changchun, Harbin, Hohhot, Nanning, Chongqing, Chengdu, Guiyang, Kunming and Xian from 1998 to 2011. Thus, housing prices are undervalued, there is no housing bubble, but exists better investment opportunities in the above 15 cities.

4. Empirical Tests

4.1 Econometric Model Setup

As rent to price ratio is a ratio variable, we need to construct an elastic equation. In terms of Propositions 1 and 2, we develop the logarithmic model of rent to price ratio as follow:

$$RTP_{it} = \lambda_0 + \lambda_1 \ln P_{it+1} + \lambda_2 \ln y_{it} + \lambda_3 \ln H_{it} + \lambda_3 \ln H_{it-1} + \lambda_4 i_{it} + \lambda_5 i_{it-1} + \lambda_6 \ln S_{it} + \lambda_7 \ln L^{s}_{it-1} + \lambda_8 \ln LC_{it-1} + \lambda_9 \ln CC_{it-1} + \varepsilon_{it} \quad (9)$$

In equation 9, S denotes housing sale, LC and CC represent land cost and construction cost, respectively. It is noteworthy that we employ housing sale to replace mortgage loan due to their highly correlated, albeit housing mortgage loans is not available. In addition, we utilize land costs and construction costs to represent development costs.

4.2Unit root test and cointegration test

To eliminate spurious regression, unit root tests are required to conduct. In general, unit root tests of panel data comprise of homogeneous and heterogeneous panel unit root tests. The former refers to LLC test (Levin et al., 2002), the latter includes IPS test (Im et al., 2003), Fisher-ADF and Fisher-PP tests (Maddala and Wu, 1999). This paper employs these four unit root tests. Table 6 indicates that the other variables are with exception of housing stock ($\ln H$) and land cost ($\ln LC$). Although all the difference variables are steady, a cointegration test should be conducted between dependent and independent variables. We employ panel cointegration tests proposed by Westerlund (2007) to implement the tests. Table 7 shows that two statistics of Gt and Pt reject the null hypothesis of "no cointegration", albeit Ga and Pa receive the null hypothesis. Thus, we option the level equation for estimation.

Table 6 Unit Root Test of Panel Variables

Variable	Level Equation				Difference Equation			
	Levin-Lin	IPS	Fisher-ADF	Fisher-PP	Levin-Lin	IPS	Fisher-ADF	Fisher-PP
RTP	-11.55***	-1.85**	30.18	36.22	-14.17***	-2.31***	231.60***	927.40***
	（0.06）	（0.02）	（1.00）	（0.99）	（0.00）	（0.00）	（0.00）	（0.00）
$\ln P$	-7.34***	-1.54	5.80	20.13	-18.10***	-2.74***	183.16***	451.05***
	（0.00）	（0.41）	（1.00）	（1.00）	（0.00）	（0.00）	（0.00）	（0.00）
$\ln y$	-7.84*	-1.38	11.91	15.09	-18.49***	-2.70***	230.79***	575.29***
	（0.08）	（0.76）	（1.00）	（1.00）	（0.00）	（0.00）	（0.00）	（0.00）
$\ln H$	-9.19***	-1.81**	81.29	127.77***				
	（0.00）	（0.03）	（0.16）	（1.00）				
$\ln S$	-10.49***	-1.91***	25.68	36.73	-19.44***	-2.70***	399.11***	810.71***
	（0.00）	（0.01）	（1.00）	（1.00）	（0.00）	（0.00）	（0.00）	（0.00）
i	-16.95***	-2.97***	55.67	79.44	-26.85***	-4.04***	826.42***	690.51***
	（0.00）	（0.00）	（0.89）	（0.20）	（0.00）	（0.00）	（0.00）	（0.00）
$\ln L^s$	-11.77***	-1.93***	51.62	44.10	-20.09***	-2.95***	335.57***	568.34***
	（0.00）	（0.01）	（0.95）	（0.99）	（0.00）	（0.00）	（0.00）	（0.00）
$\ln LC$	-17.55***	-2.65***	127.96***	118.67***				
	（0.00）	（0.00）	（0.00）	（0.00）				
$\ln CC$	-14.43***	-2.20***	70.05	81.76	-18.83***	-2.84***	327.27***	561.80***
	（0.00）	（0.00）	（0.47）	（0.15）	（0.00）	（0.00）	（0.00）	（0.00）

Note: (1)the numbers in parentheses are p values; (2) ***, ** and *denote the significance levels of 1%, 5% and 10% respectively (thereinafter); (3)the estimated equation contains the intercept, the lagged variables and the time trend term.

Table 7 Westerlund Cointegration tests of multivariates

Statistics	Values	Z value	P value
Gt	-2.73	-5.91	0.00
Ga	-0.37	7.03	1.00
Pt	-1.74	4.61	0.05
Pa	-0.16	3.84	0.27

Note : (1)null hypothesis is “no cointegration”; (2)the estimated equation includes the intercept, the lagged variables and the time trend term.

4.3 Results

By virtue of Hausman test（Chi2(10)= 73.01（Prob>chi2 =0.00）), we choose fixed effect model to regress equation 9. Besides, to overcome multicollinearity problems, we implement step-by-step regressions. The results of FE model are in Table 8.

Table 8 the FE estimated results of rent to price ratio in China’s 35 large and medium cities during 1996-2011

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
$\ln P_{t+1}$	-0.06***								-0.03***
	(-28.93)								(-12.20)
$\ln y_t$		-0.05***							-0.01*
		(-20.54)							（-1.62）
$\ln H_t$			-0.05***						-0.00
			(-18.21)						（-0.02）
$\ln H_{t-1}$				-0.05***					-0.01***
				(-19.36)					(-2.91)
i_t	0.00***	0.00**	0.00	0.00	0.00***	0.00	0.00***	0.00***	0.00
	（4.62）	（2.25）	（0.98）	（0.69）	（3.44）	（0.77）	（3.91）	（8.39）	（0.68）
i_{t-1}	0.00	0.00	-0.00	-0.00***	0.00	0.00***	0.00***	-0.00***	-0.00***
	(0.20)	(0.56)	(-0.11)	(-0.26)	(1.00)	(3.56)	(4.73)	(7.48)	(-0.69)
$\ln S_t$					-0.01***				-0.00
					(-16.38)				(-0.19)
$\ln L^s_{t-1}$						-0.02***			-0.00*
						(-17.75)			(-1.72)
$\ln LC_{t-1}$							-0.01***		-0.00
							(-13.98)		(-0.70)
$\ln CC_{t-1}$								-0.01***	-0.01**
								(-7.05)	(-2.18)
Constant	0.51***	0.62***	0.50***	0.48***	0.26***	0.31***	0.12***	0.13***	0.28***
	(31.31)	(21.85)	(19.68)	(20.96)	(18.92)	(19.76)	(18.29)	(9.56)	(20.21)
F value	458.13	323.60	274.76	298.02	240.50	231.52	162.16	106.40	175.42
R-sq: within	0.75	0.67	0.63	0.65	0.61	0.64	0.56	0.42	0.84
between	0.09	0.03	0.00	0.00	0.02	0.02	0.11	0.04	0.08

overall	0.42	0.37	0.13	0.15	0.34	0.23	0.47	0.35	0.36
Mean VIF	6.67	5.96	5.79	5.77	5.42	5.45	4.58	5.86	1801.81
Obs.	477	511	512	512	491	432	420	474	380

Note (1)***, **and * denote significance levels of 1%, 5% and 10%, respectively; (2 the numbers in parentheses are t values.

Table 8 shows that there exists severe multicollinearity problem (average VIF is 1801.81) if all the explanatory variables in the regression. Multicollinearity problems, however, no longer exist should we conduct step-by-step regression (average VIFs are less than 10). Accordingly, we primarily explain the determinants of rent to price ratio in terms of models 1-9. Models 1-9 illustrate that the coefficient signs of principle explanatory variables are consistent with the theoretical propositions with exception of lagged housing stock ($\ln H_{t-1}$) and lagged development loans ($\ln L^{s}_{t-1}$) .

Table 8 indicates the expectation of housing price has the greatest impact on rent to price ratio. Model 1 demonstrates that with a one percent increase in forward housing prices, the rent to price ratio decreases by 0.06 percent, and the likelihood of housing bubble increases by 0.06 percent. Hence, shifting expectations of homebuyers play a more important role in preventing housing bubble. Second, household income significantly affects rent to price ratio. A one percent increase in household disposable income decreases rent to price ratio by 0.05 percent, and the likelihood of housing bubble increases 0.05 percent. Thus, rent to price ratios of China's 35 large and medium-sized cities reflect the fundamental factors in some extent. Third, the greater the housing stock is, the less of rent to price ratio is, and the greater likelihood of housing bubble is. Models 3 and 4 indicate a one percent increase in current and lagged housing stock decreases the rent to price ratios by 0.05 percent, while increases the likelihood of housing bubble by 0.05 percent. Indeed, the greater the housing stock is, the greater the housing supply is, the lower the rent is, the less the rent to price ratio is, and the more likelihood of housing bubble is. Accordingly, housing bubble occurs provided that overbuilding with higher housing stock and vacancy rate. A good example is referred to as "ghost city" in Ordos and Wenzhou. Fourth, mortgage rate has no significant impact on rent to price ratio. Models 1-9 indicate that the coefficient of the mortgage rate is zero, which imply that the interest rate policy of China’s central bank has trivial impact on curbing the housing bubble. Fifth, current mortgage loan and lagged development loan have significantly negative effects on rent to price ratio. Model 5 shows that with a one percent increase in the current housing sales (instrument variable of mortgage loans), the current rent to price ratio decreases by 0.01 percent, and the likelihood of the housing bubble increases by 0.01 percent. Unlike the existing literature, mortgage loans have no effects on the formation of China's housing bubble. Therefore, mortgage loans are not the majority cause of China's housing bubble over our sample period. In terms of model 6, a one percent increase in the lagged development loan decreases the current rent to price ratio by 0.02 percent, which is converse to the theoretical expectations. In fact, under inelastic supply, housing prices are still rising, and housing bubble can occur particularly for China with rapid urbanization, albeit development loans could increase

housing supply. Sixth, development cost affects rent to price ratios. Models 7 and 8 shows that with a one percent increase in the lagged land cost and the construction cost, the current rent to price ratio drops by 0.01 percent, and the likelihood of the housing bubble increases by 0.01 percent. For this reason, even though many cities appear skyscraping land bidding price (i.e. "land Kings") in recent years, the land price has less effects on the formation of housing bubble.

5. Conclusions and policy implication

It is controversial that whether China has a housing bubble. Researchers have measured and explained housing bubbles in different ways from various perspectives. This paper first constructs housing bubble indicators in theory, then measures housing bubble and explores the causes of housing bubble by using housing market database of China's 35 large and medium-sized cities over the period 1996 -2001. This paper provides theoretical and empirical evidence for China to prevent and management housing bubble.

First, based on consumption demand and investment demand, this paper combines rental market and ownership market and derived equilibrium rent to price ratio and rent to price ratio without bubble (i.e. baseline rent to price ratio). Proposition 1 shows that expected housing price, current income of homebuyer, current housing stock and mortgage loans, lagged development loan rates and development costs are negatively associated with rent to price ratio, but positively associated with the likelihood of housing bubble. By contrast, the rent to price ratio is positively associated with tenants income, lagged housing stock, mortgage rate and lagged development loans. Therefore, the likelihood of housing bubble is negatively associated with the variables above. Proposition 2 illustrates that mortgage rates, property taxes, maintenance cost and housing depreciation are positively associated with baseline rent to price ratio, while negatively associated with likelihood of housing bubble. In addition, the growth rate of forward housing price is negatively associated with baseline rent to price ratio is, while is positively associated with likelihood of housing bubble.

Second, by comparing equilibrium rent to price ratio and rent to price ratio without bubble (baseline rent to price ratio), this paper constructs indicators of housing bubble and measures the degree of housing bubble in China's 35 large and medium-sized cities over the period 1996-2001. We find that there exists slight housing bubble in Beijing and Guangzhou during 2007-2010, Shanghai from 2009 to 2010, Shenzhen in 2009 and in2011, Shenyang from 2004 to 2006, Shijiazhuang in 2007 and in 2011, and Yinchuan and Urumqi from 2008 to 2011. There exists severe housing bubble in Hangzhou, Ningbo and Xiamen during 1999-2011, Shenzhen from 2007 to 2008 and in 2010, Shenyang from 2007 to 2011, Shijiazhuang during 2008-2010 and Qingdao, Wuhan and Hefei in 2011. Hence, Chinese governments should pay great attention on housing bubbles of these cities. There are no housing bubbles in Nanjing in 2010, Haikou in 2008 and 2010, Zhengzhou from 2007 to 2008, Lanzhou during 2007-2010 and Xining during 2007-2010. The governments also should keep an alert about housing bubbles of the above five cities. From 1998 to 2011, housing prices are undervalued in 15 cities such as Tianjin, Dalian, Jinan, Fuzhou, Nanchang, Changsha, Changchun, Harbin, Hohhot, Nanning, Chongqing, Chengdu, Guiyang, Kunming and Xian. Therefore, the degree of housing bubble varies over time for the same city.

Finally, the results show that the expectation of housing price has the greatest impact on rent to

price ratio. Hence, expectation shift of homebuyers is crucial to prevent housing bubble. Second, household income significantly affects the rent to price ratio, which verifies that rent to price ratio could reflect the fundamental factors in some sense. Third, the greater the housing stock is, the less rent to price ratio is, and the more likely the housing bubble occurs. To prevent hosing bubble like the “ghost city” of Erdos and Wenzhou, China should alleviate overbuilding to reduce vacancy rate. Fourth, interest rates of mortgage loans have no effects on rent to price ratio, which implies that the interest policy of China’s central bank could not substantially curb housing bubble. Fifth, although mortgage loans have significantly negative impact on rent to price ratio, their coefficients are trivial, which indicates that mortgage loans are not the major cause of China's housing bubble. Sixth, even the lagged land costs have significantly negative impacts on current rent to price ratio, their coefficients are negligible. Hence, land price does not play an important role in housing bubble, albeit many cities appear "land Kings" in recent years.

References:

Abraham, J. M. and P. H. Hendershott, Bubbles in Metropolitan Housing Markets, NBER, Working Paper, No.4774, 1994.

BIS and the IMF, Real Estate Indicators and Financial Stability, Proceedings of a joint conference, Washington DC, 27-28 October 2003, April 2005.

Bourassa, S. C., D. R. Haurin, J. L. Haurin, M. Hoesli and J. Sun, House Price Changes and Idiosyncratic Risk: The Impact of Property Characteristics, *Real Estate Economics*, 2009, Vol. 372, pp.259-278.

Brueckner, J. K., P. S. Calem, L. I. Nakamura, Subprime Mortgages and the Housing Bubble, *Journal of Urban Economics*, 2012, Vol.71, pp.230-243.

Campbell, S. D., M. A. Davis, J. Gallin and R. F. Martin, What Moves Housing Markets: A Variance Decomposition of the Rent-Price Ratio, *Journal of Urban Economics*, 2009, 66, pp,90-102.

Case K. and R. J. Shiller, Is There a Bubble in the Housing Market? *Brookings Papers on Economic Activity*, 2003, Vol.2, pp.299-362.

Case, K., R. J. Shiller and A. Thompson, What Have They Been Thinking? Homebuyer Behavior in Hot and Cold Markets, *Brookings Papers on Economic Activity*, Fall 2012, pp.265-315.

Clayton, J., Rational Expectations, Market Fundamentals and Housing Price Volatility, *Journal of Real Estate Economics*, 1996, Vol.24, 4, pp.441-470.

Costello, G., P. Fraser and N. Groenewold, House prices, Non-Fundamental Components and Interstate Spillovers: The Australian Experience, *Journal of Banking & Finance*, 2011, Vol.35, pp.653-669.

Davis, M. A., The Rent-Price Ratio for The Aggregate Stock of Owner-Occupied Housing, *Review of Income and Wealth*, 2008, Vol.54, No.2, pp.279-284.

Gimeno, R. and C. Martínez-Carrascal, The Relationship between House Prices and House Purchase Loans: The Spanish case, *Journal of Banking & Finance*, 2010, Vol.34, pp.1849-1855.

Glaeser E. L., J. Gyourko and A. Saiz, Housing Supply and Housing Bubbles, NBER Working Paper, No.14193, July 2008.

Goodman, A. C. and T. G. Thibodeau, Where Are the Speculative Bubbles in US Housing Markets? *Journal of Housing Economics*, Vol.17, 2008, pp.117-137.

Hendershott, . H., R. J. Hendershott and C. R. W. Ward, Corporate Equity and Commercial Property Market ‘Bubbles’, *Urban Studies*, 2003, Vol. 40, No. 5–6, pp.993–1009.

Herring R. J. and S. Wachter, Bubbles in Real Estate Markets, Working Paper, No.402, Zell/Lurie Real Estate Center, University of Pennsylvania, 2002.

Himmelberg C., M. Christopher and T. Sinai, Assessing High House Prices: Bubbles, Fundamentals and

Misperceptions, The *Journal of Economic Perspectives*, 2005, Vol.19, pp.67-92.
Huang, H. and Y. Tang, Residential Land Use Regulation and the US Housing Price Cycle between 2000 and 2009, *Journal of Urban Economics*, 2012, Vol.71, pp.93-99.
Hui Eddie C. M. and Yue Shen, Housing Price Bubbles in Hong Kong, Beijing and Shanghai: A Comparative Study, *Journal of Real Estate Finance and Economics* , 2006, Vol.33, pp.299-327.
Hott, C., Lending Behavior and Real Estate Prices, *Journal of Banking & Finance*, 2011, Vol.35, pp.2429-2442.
Im, K. S., M. H. Pesaran and Y. Shin, Testing for Unit Roots in Heterogeneous Panels, *Journal of Econometrics*, 2003, Vol.115, pp.53-74.
Koetter M. and T. Poghosyan, Real Estate Prices and Bank Stability, *Journal of Banking & Finance*, 2010, 34, pp.1129-1138.
Levin, A., C. Lin and C. J. Chu, Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties, *Journal of Econometrics*, 2002, Vol.108, pp.1-24.
Maddala, G. S. and S. Wu, A Comparative Study of Unit Root Tests with Panel Data and A New Sample Test, *Oxford Bulletin of Economics and Statistics*, 1999, Vol.61, pp.631-651.
Marcucci J.and M. Quagliariello, Asymmetric Effects of the Business Cycle on Bank Credit Risk, *Journal of Banking & Finance*, 2009, Vol.33, pp.1624-1635.
Malpezzi S. and S. M. Wachter, The Role of Speculation in Real Estate Cycles, *Journal of Real Estate Literature*, 2005, Vol.13, pp.143-164.
Mikhed, V. and P. Zemˇcík, Testing for Bubbles in Housing Markets: A Panel Data Approach, *Journal of Real Estate Finance and Economics*, 2009, No.38, pp.366–386.
Muellbauer J. and A. Murphy, Booms and Busts in the UK Housing Market. *The Economic Journal*, Nov., 1997, Vol.107, pp. 1701-1727.
Nneji, O., C. Brooks and C. Ward, Intrinsic and Rational Speculative Bubbles in the U.S. Housing market: 1960-2011, *Journal of Real Estate Research*, 2013, Vol.35(2), pp.212-151.
Oikarinen, E., Interaction Between Housing Prices and Household Borrowing: The Finnish Case, *Journal of Banking & Finance*, 2009, Vol.33, pp.747-756.
Park, S. W., D. W. Bahng and Y. W. Park, Price Run-up in Housing Markets, Access to Bank Lending and House Prices in Korea, *Journal of Real Estate Finance and Economics*, 2010, Vol.40, pp.332-367.
Reinhart C. M. and K. S. Rogoff, The Aftermath of Financial Crises, NBER Working Papers, No.14656, 2009.
Ren,Y., C. Xiong, and Y. f. Yuan, House Price Bubbles in China, *China Economic Review*, 2012,Vol.23, pp.786-800.
Smith M. H. and G. Smith, Bubble, Bubble, Where's the Housing Bubble? *Brookings Papers on Economic Activity*, 2006, Vol.1, pp.1-67.
Sommervoll D. E., T. Borgersen and T. Wennemo, Endogenous Housing Market Cycles, *Journal of Banking & Finance*, 2010, Vol.34, pp.557-567.
Sommer, K., P. Sullivan and R. Verbrugge, The Equilibrium Effect of Fundamentals on House Prices and Rents, *Journal of Monetary Economics*, 2013, Vol. 60, pp.854–870.
Westerlund, J., Testing For Error Correction in Panel Data, *Oxford Bulletin of Economics and Statistics*, 2007, Vol.69, pp.709-748.
Wheaton W. C. and G. Nechayev, The 1998-2005 Housing "Bubble" and the Current "Correction": What's Different This Time? *The Journal of Real Estate Research*, Jan-Mar 2008, Vol.30, pp.1-26.
Wong, G., The Anatomy of a Housing Bubble, The Wharton School, University of Pennsylvania, July, 2005.
Wong, K., Housing Market Bubbles and Currency Crisis: The Case of Thailand, *Japanese Economic Review*, 2001, Vol.52, pp.382-419.