Bubble or riddle? An asset-pricing approach evaluation on China's housing market ☆

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A B S T R A C T

Rapid house price growth and high price-to-income ratio in major Chinese cities have aroused a hot debate on whether there is an asset bubble in China's residential housing market. To investigate this question, we employ an equilibrium asset-pricing approach, which suggests a non-arbitrage condition on the rent-to-price ratio. This ratio should be equal to the difference between the user cost of housing capital and the expected appreciation in house prices. Using a novel micro-level data set on pair-wise matched price-to-rent ratio collected in the fourth quarter of 2013, and forecasting the expected house price appreciation based on fundamental factors, our empirical exercises do not suggest the existence of a house price bubble at the national level. However, this conclusion highly depends on the expected income growth rate and may not apply to individual markets.

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1. Introduction

In the past decade China has been experiencing a surge of house prices at an unprecedented rate. Fig. 1 plots the average residential house prices in the 35 major Chinese cities. These cities represent all municipalities, provincial capital cities and quasi-provincial capital cities in China, whose house prices have been closely watched by policy makers, researchers and investors. On average their residential house prices have steadily increased from 2426 yuan/m^2 in 2003 to 7718 yuan/m^2 in 2012. This implies a more than tripled property value in 9 years, or a 13.7% nominal compound annual growth rate. During the same period, the average CPI of these cities only rose by 30%. Fig. 2 depicts China's average residential house price-to-income ratio, a common measure of housing affordability. At the national level, this ratio has sharply increased from 6.6 in 2003 to 8.1 in 2009, and gradually declined to 7.3 in 2013 after a series of house price regulations. The 35 major Chinese cities witness an even higher price-to-income ratio, which reached 8.5 in 2013 (E-house China, 2014). By contrast, the price-to-income ratio was around 4 in the US, 5 in the UK and 6 in Australia right before the recent financial crisis (Reserve Bank of Australia, 2008). Such rampant house price growth and unusually high price-to-income ratio have aroused great interest and concern on whether China has an asset bubble in its housing market.

To assess whether the house prices are too high or too low, an equilibrium asset-pricing approach has been offered by the housing literature. According to this approach, neither accelerating house price growth nor the remarkable price level itself is the intrinsic sign of a bubble, let alone the anecdotal price fluctuations in a single property or casual observations on the housing markets. In contrast, the golden rule of the evaluation boils down to a non-arbitrage condition on the rent-to-price ratio, which is equal to the difference between the user cost of housing capital and the expected appreciation in house prices at equilibrium. Himmelberg et al. (2005) is one leading example in applying this approach to assessing the house prices in the US.
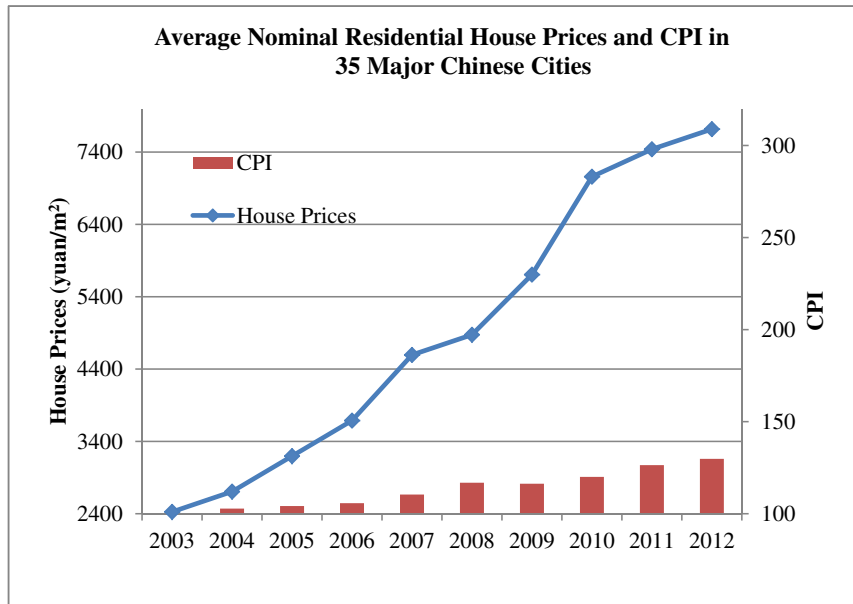
This paper aims to address whether there is a house price bubble in China using this asset-pricing approach. We argue that the expected house price appreciation, instead of high house price growth or price-to-income ratio, is central to the debate on the existence of a house price bubble. There are, however, three significant challenges in implementing the approach to China. First, there are no readily available data on rent-to-price ratio that have properly controlled for house characteristics. Second, little is known on each component in the user cost of housing capital for a nascent market like China. Last and most importantly, although economic theory provides useful suggestions on the fundamental factors that determine the house prices, there is no prior information on, either their own expected growth rates, or their elasticities in house price growth accounting.

This paper contributes to the literature by addressing all these issues in a systematic way. We construct a set of pair-wise matched rent-to-price ratio across 60 large and medium-size Chinese cities using micro-level data. The actual rent-to-price ratio collected in the fourth quarter of 2013 has an average of 3.21%. Using fundamental factors to forecast the expected house price appreciation, our calculated equilibrium rent-to-price ratio as a whole ranges from 2.85% to 3.39%, conditional on the

Average Nominal Residential House Prices and CPI in 35 Major Chinese Cities

Notes: Data on house prices are from the China Real Estate Statistic Book 2004-2013.

Data on CPI are from the China Statistics Yearbook of Regional Economy 2004-2013.

Fig. 1. Average nominal residential house prices and CPI in 35 major Chinese cities. Notes: Data on house prices are from the China Real Estate Statistic Book 2004–2013. Data on CPI are from the China Statistics Yearbook of Regional Economy 2004–2013.

public information available at the end of 2013. Thus, our empirical exercises do not indicate that the residential houses are systematically overpriced at the national level.

Two important insights also arise from our analyses. First, cities with different expected house price inflation could have very different rent-to-price ratio. It is therefore impossible to conclude whether there is a house price bubble in a specific market without taking into account its

prospect in income, population and housing supply. Second, even at the aggregate level, the evaluation on whether there is a house price bubble highly hinges on the expected growth rate of the fundamentals, especially income, in the case of current China.

We then produce two sets of information which are particularly useful in addressing the ongoing hot debate. The first set includes the cutoff values of the expected growth rate of house prices, disposable income
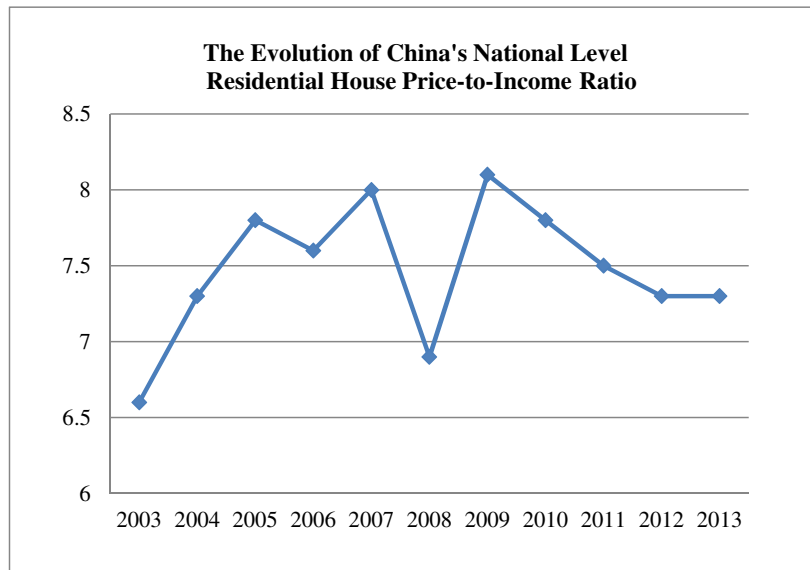
The Evolution of China's National Level Residential House Price-to-Income Ratio

Notes: Data are cited from E-house China (2014). The ratio is calculated as average

house price per m^2 × urban house size per person / urban disposable income per capita.

Fig. 2. The evolution of China's national level residential house price-to-income ratio. Notes: Data are cited from E-house China (2014). The ratio is calculated as average house price per m^2 × urban house size per person/urban disposable income per capita.

and urban population for each city, conditional on its current rent-to-price ratio. If the actual growth rates are lower than the cutoff values in a city, a crash in its residential housing market may not just be a prophecy of Cassandra. The second set summarizes the implied equilibrium rent-to-price ratio for China as a whole, had there been a slowdown in economic growth or urbanization. For example, a 2 percentage-point drop in the expected income growth rate could completely reverse our conclusion on the absence of a house price bubble.

Our research is most closely related to the following papers. Wu et al. (2012) also adopt the asset-pricing approach to assess China's housing market. However, no decisive conclusion is reached due to the difficulty in measuring the expected house price inflation. Our paper contributes to the literature of this particular field by constructing an expected growth rate of house price using fundamental factors, under the assumption that agents are forward-looking. Regarding the importance of fundamentals, such as income and population, in explaining the observed house price appreciation in China, we are in line with Wang and Zhang (2014). The crucial role of the expected income growth rate emphasized in this paper echoes the finding in Shen (2012), who rationalizes the high price-to-income ratio in China by differentiating permanent income from current income when there is a high income growth rate. The rejection of a house price bubble is also made by Ren et al. (2012) using a different approach from a time-series perspective.

The rest of the paper is organized as follows. Section 2 describes the framework of our analysis. Section 3 explains how we address the three challenges in applying the asset-pricing approach to the context of China. Section 4 reports our evaluation and emphasizes the importance of income growth expectation in resolving the riddle.

2. A framework for house price bubble evaluation

2.1. The rent-to-price ratio

Each household consumes housing service, either as a tenant renting from landlords, or as a homeowner effectively renting to himself. In making its tenure choice, a household compares the marginal benefit of owning a house – the imputed rent, or what it would have cost to rent an equivalent house, with the marginal cost of owning the house – the opportunity cost of capital, or the forgone income that the household would have received if it had invested the capital in an alternative asset. Equilibrium in the housing market thus implies a well-known relationship between rent and price, formally derived from Poterba (1984, 1991):

$$\frac{R}{P} = (1-\theta)\left(i+\tau_p\right) + \delta + m + \alpha - \pi^e, \qquad (1)$$

where R denotes the rental price, or the marginal value of the rental services per period on owner-occupied house, P the price of existing house, θ the homeowner's marginal tax rate, i the nominal interest rate, τ_p the property tax rate as a share of house value, δ the depreciation rate on housing capital, m the maintenance cost per unit value, α the risk premium required on assets with the risk characteristics of housing capital relative to safe assets, and π^e the expected rate of nominal house price appreciation. [1]

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[1] The equilibrium asset-pricing approach assumes that renting and owning are perfect substitutes in providing utility. This may not be true in China, where there is a strong preference over home ownership. For example, Wei et al. (2012) model home ownership as a status good which enhances the success in competition for marriage partners. To reflect the additional utility yielding from home ownership, one may think that an ownership premium, similar to risk premium but working in the opposite direction, is allowed in the user cost. Then the actual rent-to-price ratio in China should be even lower than that predicted by the standard theory. This will work in favor of our conclusion of no house price bubble.

The right hand side of Eq. (1) is known as the generalized user cost of housing capital. It is the difference between the user cost of housing capital, had there been no change in house prices $((1-\theta)(i+\tau_p)+\delta+m+\alpha)$, and the expected inflation in house prices (π^e). If the house price multiplied by the generalized user cost exceeds the rent, ownership is too costly and the price must fall to convince potential home buyers to buy instead of renting. This non-arbitrage condition therefore characterizes housing market equilibrium as the natural outcome of a rational choice.

2.2. Definition of a house price bubble

Rational choice, however, does not necessarily imply the absence of a house price bubble. It is apparent that the assessment on the user cost of housing capital plays a key role in the decision-making on renting or buying. While among the components of the generalized user cost, the expected growth rate of house prices (π^e) is the most critical and least understood determinant. Keeping all other factors constant in mind, households with different π^e could make completely different decisions.

This explains why it is crucial to distinguish speculations from fundamental factors in driving house price growth. In a general sense, such as in Stiglitz (1990) and Brunnermeier (2008), when speculation happens, it can be rational to buy an asset at a high price as long as an investor is sure that he can sell out the asset at an even higher price in the future. If it yields a return equal to that on alternative assets, the high price of the asset is merited at least in the short run. However, if the reason that the price is high today is only because investors believe that the selling price will be higher tomorrow, while the price level cannot be easily justified by the outlook of fundamental factors, a bubble exists.

By analogy, the housing literature, led by Case and Shiller (2004) and Himmelberg et al. (2005), has defined a house price bubble as being driven by home buyers who are willing to pay inflated prices today because they expect unrealistically high house appreciation in the future. Formally, let π^{fe} be the expected rate of nominal house price appreciation which is justified by fundamental factors and is sustainable in the long run. Eq. (2) then states a golden rule in evaluating house price bubbles:

$$\frac{R}{P} < (1-\theta)\left(i+\tau_p\right) + \delta + m + \alpha - \pi^{fe}. \qquad (2)$$

If the price-to-rent ratio is too high, or equivalently if the rent-to-price ratio is too low, relative to the generalized user cost of housing capital that is calculated based on π^{fe}, the house price is unsustainable and the housing market has a bubble.

The definition of a house price bubble has three important implications. First, neither the level nor the growth rate of house prices itself is an indicator of house price bubbles. Second, comparing rent-to-price ratios over time or across markets without considering changes or variations in the user cost could be misleading. Last but not the least, the expected house price appreciation supported by fundamental factors is central to the debate on the existence of a house price bubble.

The house price bubble defined above is closely related to the measures of bubbles proposed by the literature, including the difference between stock prices and the present value of the dividend (Yoon, 2012), and the difference between the fundamental price and the actual market price (e.g., the stock price bubble studied by Narayan et al. (2013), and the house price bubble in Kim and Min (2011)).

3. Addressing three challenges

3.1. Data on rent-to-price ratio

The equilibrium asset-pricing approach has been rather difficult to execute in the context of China, due to the poor documentation of

many important variables, especially the rental price. This probably explains why little literature has so far adopted this method in studying China's housing market. Nevertheless, as argued in Wu et al. (2012) owned and rented housing units are more similar in nature in China than in many other countries. Both of them tend to be in high-rise buildings, have similar size and are located in many of the same neighborhoods. It is therefore more straightforward to compare owner-occupied housing unit prices to apartment rents in China.

Using transaction data provided by a leading national-wide broker in China, Wu et al. (2012) calculate the price and yearly rent for a typical housing unit, by estimating hedonic models on the underlying samples of owner-occupied and rental units. This allows them to create constant quality price and rent series for the same typical unit. They then obtain the rent-to-price ratio based on those series for 8 major Chinese cities from Q1 of 2007 to Q1 of 2010.

Instead of using the hedonic techniques in quality control, we construct the rent-to-price ratio using direct matching. To be specific, we collect the asked selling price and rental price of second-hand apartments for 60 major cities in Q4 of 2013, using detailed information from leading online house brokers in China.[2] For each city, 4 to 8 districts are randomly selected depending on city size. Within each district, 10 neighborhoods are randomly sampled. Within each neighborhood, we then screen a pair of apartment, one for selling and the other one for renting, which are on the same story and have similar floor space, number of rooms, number of bathrooms, and degree of furnishing. This allows us to calculate the rent-to-price ratio for every pair of apartments and obtain an average rent-to-price ratio in each city.

Column (1) of Table 1 reports the matched rent-to-price ratio for 60 large and medium-size cities.[3] It has an average of 3.21% and a standard deviation of 0.67. This ratio is even lower and more dispersed in the 35 major cities, with an average of 3.15% and a standard deviation of 0.76. This implies that first, on average the house price in China is about 31 times as large as the yearly rent, consistent with the general impression of a high price-to-rent ratio in current China. Second, the rent-to-price ratio also varies substantially across different cities within China. For example, cities like Beijing, Wenzhou, Shanghai, Hangzhou and Xiamen have a rent-to-price ratio only half of those in Guiyang, Harbin and Xining, implying a great heterogeneity across local housing markets.

3.2. User cost of housing capital

Given that there is no general property tax and mortgage interest is not tax deductible in China, we assume that $\theta = \tau_p = 0$ here.[4] Thus, the user cost of housing capital in China's context becomes $i + \delta + m + \alpha$. This subsection discusses the possible values of each component.

The nominal risk-free interest rate i is often proxied by the nominal rate of return on government bonds. Column (1) of Table 2 lists the yield to maturity on 5-year government bonds in China in the past decade. It varies from 2.63% in 2003 and 6.27% in 2008, with an average at 4.51%. As a useful benchmark, the nominal average rates of return on US Treasury bills (mature in less than one year) and Treasury bonds (mature in more than ten years) in the past century are 3.9% and 5.4%, respectively.

We thus regard 4.51% as a moderate value and take it as China's mediate-term nominal risk-free interest rate.

There has been very little research on the depreciation rate δ in China. One exception is the recent work of Hao and Chen (2012). Using a micro-level data set in Shanghai in 2010, they estimate an average depreciation rate between 2.70% and 3.30% from a hedonic house price model. Since most housing units in Chinese cities are high-rise apartments, maintenance costs m are mainly paid as property management fee. With a large scale of economy, the annual property management fee is generally far less than 0.10% of the property value.[5] Thus, compared with the magnitude of depreciation rate, maintenance cost is negligible. We therefore assume $(\delta + m) = 3.00\%$ for China's residential houses. This is slightly higher than 2.50%, the value for $(\delta + m)$ that Poterba and Sinai (2008) have estimated in the US context.

Given the Chinese housing market only started in late 1990s, it is not surprising that little is known on α, the risk premium of housing capital relative to safe assets in China. Using PSID data during 1968 to 1992, Flavin and Yamashita (2002) find that the real annual rate of return on house is 6.59% while it is 0.60% on Treasury bonds. This implies a 5.99% risk premium of housing capital in the case of US. To get an intuition on this magnitude, consider the risk premium of common stock in the US, which is 7.30% averaged across the past century. If the same value of α applies to China, together with a 4.51% risk-free interest rate, an investor would have required a 10.50% nominal rate of return on the Chinese housing market in the past decade. This is still lower than 13.54%, the actual annual house price inflation in the 35 major cities. Thus 5.99% may be taken as a conservative estimate of α in China.

To sum, our discussion indicates that a reasonable estimate of the nominal user cost of housing capital in China is $4.51\% + 3.00\% + 5.99\% = 13.50\%$.

3.3. Expected growth driven by fundamental factors

3.3.1. Institutional background

What are the fundamental factors that support a sustainable house price growth? Incontrovertibly, like the price of any goods, equilibrium house price is determined by the demand and supply for housing. A detailed institutional background on China's housing demand and housing supply can be found in Wu et al. (2012), and Wu et al. (in press), among many others. Other studies on China's housing prices, e.g., from the perspectives of macroeconomic variables and land use controls can be seen in Zhang et al. (2012), and Zhang et al. (2013). On the demand side, rural Chinese residents have been living in self-built houses which are generally not marketable. Before 1998, most urban Chinese residents lived in housing units provided by their work units with a highly subsidized rent. In 1998 the State Council formally abolished this welfare-based public housing system by decree. From then on, urban residents get housing benefits in cash from their employers and have to buy or rent residential housing in the private market. A large scale rural–urban migration together with a fast income growth since the economic reform resulted in a substantial increase in housing demand.

On the supply side, the local governments function as the monopoly supplier of urban land. Before the development of housing market, the land use right was usually not publicly transacted. By law, the state has the ultimate ownership of all land. Any individual or organization has to apply for permission from the government in construction on any land. In April 2001 the State Council announced the reform for land market by emphasizing the importance of market force in land allocation. In a typical case of development, a local government converts a parcel of agriculture land into urban land and sells the land use right to real estate developers in exchange for a land transferring fee. In May 2002 the Ministry of Land and Resources required all residential and commercial land parcel leaseholds after July 2002 to be sold via public auctions.

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[2] The most ideal price should be the transacted price rather than the asking price for our exercises. However, the transacted rents and house prices are not publicly available in China. Nevertheless, evidences summarized in Hao and Chen (2012) indicate that the asking prices collected from online brokers are highly informative on the changes in underlying demand and supply and track the actual transacted prices very closely.

[3] The National Bureau of Statistics of China started to publish the sales price indices of residential houses in 70 large and medium-sized cities in January 2011. Since then these 70 cities are often taken as the standard sample in researches on China's housing market. However, we cannot find enough observations for pair-wise matched rent-to-price ratio for 10 relatively smaller cities out of the 70. Thus Table 1 only reports our analyses for 60 large and medium-sized cities.

[4] Property tax was introduced in Shanghai and Chongqing in January 2011. Bai et al. (2014) show that property tax lowered the average house price in Shanghai, but raised that in Chongqing. Since there is no property tax in other 58 out of 60 cities in the sample, we assume that $\tau_p = 0$ in the calculation of user cost at the national level.

[5] Information on property management fee of apartments can be found on www.anjuke.com, one of China's major online real estate agents.

Table 1
Rent-to-price ratio and the cutoff growth rates (%).

City	Col (1) R/P	Col (2) Cutoff π^{fe}	Col (3) Cutoff $\Delta\ln Y^e$	Col (4) Cutoff $\Delta\ln N^e$	City	Col (1) R/P	Col (2) Cutoff π^{fe}	Col (3) Cutoff $\Delta\ln Y^e$	Col (4) Cutoff $\Delta\ln N^e$
Beijing	1.89	11.62	11.71	3.28	Xi'an	2.91	10.60	10.44	2.44
Tianjin	2.43	11.08	11.04	2.84	Lanzhou	3.33	10.18	9.92	2.10
Shijiazhuang	2.62	10.89	10.80	2.68	Xining	4.12	9.39	8.93	1.45
Taiyuan	3.44	10.07	9.78	2.01	Yinchuan	3.36	10.15	9.89	2.08
Hohhot	2.75	10.76	10.64	2.58	Urumqi	3.86	9.65	9.26	1.66
Shenyang	3.77	9.74	9.38	1.74	Tangshan	3.17	10.34	10.12	2.23
Dalian	3.37	10.14	9.87	2.07	Qinhuangdao	2.66	10.85	10.75	2.65
Changchun	3.80	9.71	9.34	1.72	Baotou	3.58	9.93	9.61	1.89
Harbin	4.83	8.68	8.05	0.87	Jinzhou	3.29	10.22	9.98	2.14
Shanghai	1.95	11.56	11.63	3.23	Jilin	3.91	9.60	9.20	1.63
Nanjing	2.26	11.25	11.25	2.97	Mudanjiang	3.68	9.83	9.49	1.82
Hangzhou	2.01	11.50	11.55	3.18	Wuxi	3.40	10.11	9.83	2.04
Ningbo	2.59	10.92	10.83	2.70	Yangzhou	3.07	10.44	10.25	2.31
Hefei	3.29	10.22	9.96	2.13	Xuzhou	2.92	10.59	10.43	2.44
Fuzhou	2.82	10.69	10.56	2.52	Wenzhou	1.90	11.61	11.70	3.27
Xiamen	2.04	11.47	11.52	3.16	Jinhua	2.29	11.22	11.22	2.96
Nanchang	3.79	9.72	9.35	1.72	Bengbu	3.23	10.28	10.04	2.18
Jinan	3.03	10.48	10.29	2.34	Anqing	3.98	9.53	9.11	1.56
Qingdao	2.48	11.03	10.97	2.79	Quanzhou	3.68	9.83	9.49	1.81
Zhengzhou	3.22	10.29	10.05	2.19	Jiujiang	3.60	9.91	9.58	1.88
Wuhan	3.46	10.05	9.76	1.99	Ganzhou	3.54	9.97	9.66	1.93
Changsha	3.72	9.79	9.44	1.78	Yantai	3.27	10.24	9.99	2.15
Guangzhou	2.52	10.99	10.92	2.76	Jining	2.66	10.85	10.75	2.64
Shenzhen	2.49	11.02	10.96	2.78	Luoyang	3.58	9.93	9.61	1.89
Nanning	3.95	9.56	9.15	1.59	Yichang	3.27	10.24	10.00	2.15
Haikou	4.09	9.42	8.98	1.48	Huizhou	3.84	9.67	9.28	1.68
Chongqing	3.22	10.29	10.06	2.19	Zhanjiang	3.82	9.69	9.32	1.70
Chengdu	2.96	10.55	10.38	2.41	Guilin	3.23	10.28	10.04	2.18
Guiyang	4.83	8.68	8.05	0.87	Sanya	3.77	9.74	9.37	1.74
Kunming	3.07	10.44	10.24	2.31	Luzhou	3.15	10.36	10.15	2.25

Notes: R/P is the actual pair-wise matched rent-to-price ratio that the authors collected from micro-level data in Q4 of 2013.
Cutoff π^{fe} is the minimum expected housing price inflation to rule out a bubble conditional on the R/P ratio and a 13.50% user cost of capital.
Cutoff $\Delta\ln Y^e$ and $\Delta\ln N^e$ are the minimum expected disposable income and urban population growth rate inferred from π^{fe}.

3.3.2. A model on expected house price growth

Garriga et al. (2013) propose a general equilibrium model that is consistent with these interesting characteristics. The model predicts that P_t, the long run equilibrium nominal house price in year t, is determined by the nominal disposable income Y_t, urban population N_t and the supply of residential housing S_t. That is

$$\ln P_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln N_t + \beta_3 \ln S_t$$

Table 2
Risk-free interest rate and growth rate of key variables (%).

	Col (1) Interest rate	Col (2) CPI	Col (3) Disposable income	Col (4) Wage income	Col (5) Urban population	Col (6) Total population
2003	2.63	1.20	9.99	13.00	4.31	0.601
2004	2.92	3.90	11.21	14.10	3.64	0.587
2005	3.73	1.80	11.37	14.60	3.55	0.589
2006	3.62	1.50	12.07	14.40	3.69	0.528
2007	4.81	4.80	17.23	18.70	4.02	0.517
2008	6.27	5.90	14.47	17.20	2.92	0.508
2009	4.00	−0.70	8.83	12.00	3.38	0.487
2010	4.60	3.30	11.26	13.50	3.82	0.479
2011	6.01	5.40	14.13	14.30	3.14	0.479
2012	5.60	2.60	12.63	12.10	3.04	0.495
2013	5.41	2.60	9.73	10.10	2.71	0.492
2003–2013 average	4.51	2.94	12.08	14.00	3.48	0.524
2013–2020 expectation	4.51	2.94	10.33	12.25	2.37	0.492

Notes: Data on interest rate are from the webpage of the Ministry of Finance. The rest are from the China Statistics Yearbook 2004–2014.
Interest rate is the yearly-average yield to maturity on the 5-year government bonds.

where β_0 is a constant, which depends on the preference of households, the technology of housing supply and the exogenous amenity.

First-differencing the price equation gives an expression for π_t^{fe}, the expected rate of nominal house price appreciation in year t, supported by fundamental factors,

$$\pi_t^{fe} \equiv \Delta \ln P_t^e = \beta_1 \Delta \ln Y_t^e + \beta_2 \Delta \ln N_t^e + \beta_3 \Delta \ln S_t^e. \qquad (3)$$

Eq. (3) implies that two sets of information have to be in place in order to pin down the value for π_t^{fe}. One is the elasticities of house price with respect to each fundamental factor and the other is the expected growth rates of each factor itself.

3.3.3. The estimated elasticities

To obtain the elasticities, we run the following regression using data for the 35 major cities from year 2003 to 2011,

$$\ln P_{i,t} = \beta_0 + \beta_1 \ln Y_{i,t} + \beta_2 \ln N_{i,t} + \beta_3 \ln S_{i,t} + \eta_i + e_{i,t},$$

where η_i is a city specific effect and $e_{i,t}$ is an error term with mean zero. The sample period starts from 2003 when the market started to play the key role in allocating urban residential land and housing resources, and ends in 2011 when the most recent data are available. It only covers the 35 major cities, for which complete data on the variables discussed below are available.

In our benchmark model, $P_{i,t}$ is the nominal residential house price of city i in year t. $Y_{i,t}$ is measured as the nominal average disposable income per capita of urban residents. $N_{i,t}$ is urban population (*chengzhen changzhu renkou*), which is made of residents who effectively live in the urban area of city i for more than six months in year t, regardless whether they have a *hukou* of city i or not. $S_{i,t}$ is proxied by the residential floor space completed by real estate developers in city i and year t.

A set of alternative measures for the independent variables is also employed for robustness checks. For example, the nominal average wage of urban employees may be an alternative to disposable income. Total population (*changzhu renkou*) could be another candidate for population measure. In contrast to residential housing supply, the residential urban land supply highlights the fact that as the monopoly supplier of urban land, the local governments control the ultimate supply of residential housing. To get a useful measure for residential urban land supply, we normalize the built-up area of a city by the number of employees in its secondary and tertiary industries. This is because by definition the built-up area is made of an area that is either already an urban area or is ready for urban development — industrial, commercial and residential activities. After catering the demand from the expansion of secondary and tertiary industries, the additional increase in the built-up area may be taken as a proxy for residential land supply. Table 3 reports the sources of the data and lists the summary statistics for the growth rate of the variables that are utilized in the regression analyses.

Fixed effects estimation results are presented in the upper panel of Table 4. Although fixed effect estimates eliminate the city specific effects, the estimates for the βs could still be potentially biased. For example, a positive productivity shock may lead to an increase in both house price and disposable income, which implies an upward bias of $\hat{\beta}_1^{FE}$. In addition, a high house price may discourage migrant influx, which implies a downward bias of $\hat{\beta}_2^{FE}$. Finally, a positive wage shock could simultaneously increase housing demand and the cost of housing supply. This may lead to a negative correlation between house price and housing supply, and consequently a downward bias of $\hat{\beta}_3^{FE}$. To mitigate the possible simultaneous bias and the reverse causality, lagged independent variables are used in the regressions. The corresponding results are listed in the lower panel of Table 4.

Across the eight columns of Table 4 with different combinations of income, population and housing supply, the coefficients on income all move down while the coefficients on population and housing supply all move up in the lower panel. This is consistent with our prior on the possible direction of biases. Thus we will take the estimates in the lower panel as our benchmark results. According to these estimates, the income elasticity is from 0.75 to 0.97 and the population elasticity ranges from 0.79 to 1.22. The elasticity of supply is much smaller, which is no larger than 0.10 in absolute value. The finding that it is income and population that play a key role in China's house price inflation is consistent with the recent literature, such as Chow and Niu (2010), Wang and Zhang (2014) and Wu et al. (in press).

3.3.4. Expected growth rate of the fundamentals

To predict the expected house price growth, one also needs the expected growth rate of the fundamentals, which is usually a big challenge.

Table 3
Summary statistics for the growth rate of key variables.

Variable	Obs	Mean	Std. dev.	Min	Max
Nominal house prices	280	0.1354	0.1008	−0.1948	0.4545
Nominal disposable income	280	0.1155	0.0419	−0.2499	0.2567
Nominal wage income	280	0.1280	0.0484	−0.1220	0.3688
Urban population	280	0.0400	0.0167	0.0105	0.0793
Total population	280	0.0252	0.0200	−0.0035	0.1061
Residential floor space completed	280	0.0688	0.2870	−0.8487	0.8798
Residential urban land supply	280	0.0215	0.1520	−0.5749	0.8494

Notes: Data on nominal house prices are from the China Real Estate Statistic Book 2004–2012.
Data on residential floor space completed are from the webpage of the National Bureau of Statistics.
Data on nominal disposable income, wage income and residential urban land supply are from the China Statistic Yearbook for Regional Economy 2004–2012.
Data on urban population and total population are from China Statistic Yearbook for Regional Economy for those cities reporting such information. For cities without this information, data are inferred from their 2000 and 2010 census data assuming a constant geometric growth rate from 2000 to 2011.

However, the interesting feature of China's government-led market economy provides us a unique possibility. The 18th National Congress of the Communist Party of China (CPC) took place in November 2012 in Beijing.[6] Two important goals were made at this Congress that could be the foundations for households, real estate developers, local governments and investors at large in forming their expectations. One is to double China's 2010 GDP and per capita income for both urban and rural residents in 2020; another is to further promote urbanization so that 60% of China's total population will live in an urban area by 2020. In November 2013, the Third Plenary of the 18th Central Committee of the CPC passed a resolution allowing couples to have two children if either parent is an only child.

The first goal implies a 7.18% real annual growth rate of disposable income till 2020. If the expected CPI growth rate is 2.94% per year, the average yearly growth rate in the past decade as listed in column (2) of Table 2, one may expect a 10.33% growth rate of nominal disposable income. This value is obviously lower than 12.80%, the average national income growth rate during 2003 to 2013, as reported in column (3) of Table 2. However, a lower expected income growth is consistent with an expected slowdown of the Chinese economy. The growth rates in columns (4) and (3) of Table 2 indicate a 1.92 percentage point gap between wage income and disposable income. If this relationship also applies to the future, the expected growth rate of nominal wage would be 12.25%. Until July 2014, the Bureau of Human Resources and Social Securities in 15 provinces and municipalities have announced the suggested nominal wage increase as a guideline for firms to set wage for year 2014. The mean value of the announced wage growth rate is 12.53%, which is very close to 12.25%.

The second goal helps to pin down the expected urban population growth rate, which depends on the change in both the total population and the urbanization rate. According to column (6) of Table 2, the past decade has witnessed a gradual decline in the growth rate of total population. There was a general concern that it may further decline in the future had no action been taken. However, the ease of the one-child policy could stabilize or even reverse the trend. A neutral prediction is to assume that the total population in the next decade may continue to grow at 0.492%, the same rate as year 2013. In 2013, 53.7% of the total population lives in an urban area. If this ratio increases to 60% in 2020 as targeted by the Congress, together with a 0.492% total population growth rate, the urban population is expected to increase by 2.37% per year from 2013 to 2020. This growth rate is lower than 3.48%, the average urban population growth rate in the past ten years. However, it is consistent with the declining trend in the growth rate series, as we observe from column (5) of Table 2.

There is very little specific information one can rely on in expecting future housing supply or land supply. However, since the housing market has experienced an unprecedented boom in the past decade, the quantity of housing supply in the near future would hardly grow as fast as in the past. The residential land supply would generally get tighter, due to the concern on food security and land misallocation.[7] Thus the historical growth rates could be taken as an upper bound for the expected growth rate, which are 6.88% and 2.15% respectively for residential housing and land supply in the 35 major cities. Given that the elasticities on supply are very small, the expected house price growth will not be very sensitive to the value imposed here anyway.

3.3.5. The predicted expected house price growth

Panel A of Table 5 presents our predicted expected house price growth according to Eq. (3), for different combinations of income, population and housing supply. The results are very robust to the alternative measures

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[6] The National Congress of the CPC is a party congress that is held about once every five years. It is the top legislature of China and has been making pivotal decisions on political power change, economic growth and social development. Goals announced at the Congress are taken as the top policy guidelines that will be executed nationwide.

[7] For example, on 20 February 2014 the Ministry of Land and Resources of China published the No. 18 notice on "Strengthening the implementation of the most stringent control of arable land protection system".

Table 4
Regression results for fixed effects models.

Dependent variable: log nominal house prices								
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Panel A: *Current period independent variables*								
Nominal disposable income	0.8755	0.8208	1.0130	0.9686				
	(15.51)	(14.29)	(22.88)	(24.66)				
Nominal wage income					0.7896	0.7898	0.9327	0.9310
					(14.51)	(13.93)	(21.48)	(23.79)
Urban population	1.0205	1.0345			0.9889	0.9220		
	(7.00)	(6.84)			(6.33)	(5.69)		
Total population			0.8669	0.9515			0.7253	0.7391
			(6.07)	(6.86)			(4.65)	(4.93)
Residential floor space completed	−0.1143		−0.0808		−0.0904		−0.0602	
	(−4.28)		(−2.85)		(−3.34)		(−2.06)	
Residential urban land supply		−0.0762		−0.0889		−0.1219		−0.1439
		(−1.66)		(−1.95)		(−2.55)		(−3.01)
Panel B: *Lagged independent variables*								
Nominal disposable income	0.8049	0.7650	0.9742	0.9473				
	(13.05)	(11.94)	(20.32)	(21.03)				
Nominal wage income					0.7471	0.7556	0.9098	0.9218
					(12.49)	(11.84)	(19.5)	(20.57)
Urban population	1.2207	1.2141			1.1068	1.0366		
	(7.53)	(7.25)			(6.28)	(5.70)		
Total population			1.0225	1.0711			0.7965	0.7857
			(6.48)	(6.88)			(4.63)	(4.65)
Residential floor space completed	−0.1014		−0.0668		−0.0752		−0.0437	
	(−3.46)		(−2.17)		(−2.56)		(−1.40)	
Residential urban land supply		−0.0567		−0.0723		−0.0910		−0.1135
		(−1.17)		(−1.48)		(−1.82)		(−2.25)

Notes: t-values are reported in the parenthesis.
Please refer to Table 3 for definition and data sources of the variables.

for population and housing supply and are slightly more sensitive to how we measure income. Models based on disposable income predict that the expected house prices will grow at 10.11% to 10.65% per year, while models based on wage income deliver a range between 11.24% and 11.51%. Thus we take the growth rate using disposable income as a conservative prediction and the one using wage income as a more optimistic estimate.

4. Does China have a house price bubble?

Equipped with the equilibrium asset-pricing approach and the estimated value for each component, we are now at the stage to address the hot debate on whether China has a house price bubble. For a given user cost of housing capital of 13.50%, if the expected house prices grow at around 10.11% to 10.65% per year, the equilibrium rent-to-price ratio would be 2.85% to 3.39%, as listed in the last row of Panel A of Table 5. This happens to cover 3.21%, the actual average rent-to-price ratio of the 60 large and medium-size cities at the end of year 2013. Models based on wage income predict even higher expected house price growth rates, and even lower equilibrium rent-to-price ratio, which will favor even more to the conclusion of no house price bubble. For owners, a relatively low rent, or a low rent-to-price ratio can be compensated by a high expected house price growth in the future. This is very different from the US context with a low long-run house price appreciation rate of 3.8% (Himmelberg et al., 2005). Such a high expectation is grounded by China's persistently high economic growth and large scale rural–urban migration. Thus, although China has a very rapid house price inflation and a very high price-to-rent ratio, it does not necessarily imply a house price bubble from the perspective of the equilibrium asset-pricing approach.[8] Instead, the Chinese housing market is highly efficient as predicted by the equilibrium condition in the

housing market. The rapid house price inflation is driven by fast income growth and urbanization. The high price-to-rent ratio is a consequence of high expected house price growth, fueled by good perspectives on income growth and further urbanization, at least till 2020.

Although we reject the existence of a house price bubble at the national level, conditional on public information available at the end of 2013, there are two important points worthwhile to make. First, an equilibrium in the national housing market does not rule out a house price bubble in specific local markets. Our constructed rent-to-price ratio varies from 1.89% to 4.83% across different cities. If the user cost of housing capital is similar across different cities in China, those cities with extremely low rent-to-price ratio would need very high expected house price growth to justify their unusually high house prices. To make a specific evaluation on whether there is a house price bubble for each city requires detailed city-level information, which is much more difficult to obtain.

Nevertheless, we list the cutoff expected growth rate of house prices for each city in column (2) of Table 1, with a 13.50% common user cost of housing capital in mind. According to our framework, if the actual house price growth rate of a city is below its cutoff value, the city is subject to the suspicion of a house price bubble and one may expect a decrease in its house price. To further breakdown the role of income growth and urbanization, we calculate the cutoff disposable income growth rate for each city in column (3), under the assumption that its urban population and housing supply will grow at the national average rate; and the cutoff urban population growth rate for each city in column (4), under the assumption that its disposable income and housing supply will grow at the national average rate. According to our calculation, for example, in order to justify its current rent-to-price ratio, the disposable income of Wenzhou has to grow for at least 11.70% per year, had its urban population and housing supply grown at the national level; or the urban population of Wenzhou has to grow for at least 3.27% annually, had its disposable income and housing supply grown as fast as the rest of the country. In contrast, the cutoff growth rates of income and population are only

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[8] Using a demand and supply framework and a different data source, Chow and Niu (2015) also find no evidence of a house price bubble during their sample period up to 2012 in China as a whole.

Table 5
Predicted expected growth rate of nominal house prices.

Expected growth rate (%)	Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Panel A: Benchmark prediction									
10.33%	Nominal disposable income	0.8049	0.7650	0.9742	0.9473				
12.25%	Nominal wage income					0.7471	0.7556	0.9098	0.9218
2.37%	Urban population	1.2207	1.2141			1.1068	1.0366		
0.49%	Total population			1.0225	1.0711			0.7965	0.7857
6.88%	Residential floor space completed	−0.1014		−0.0668		−0.0752		−0.0437	
2.15%	Residential urban land supply		−0.0567		−0.0723		−0.0910		−0.1135
	Expected growth rate of nominal housing price (%)	10.51%	10.65%	10.11%	10.16%	11.25%	11.51%	11.24%	11.43%
	Implied equilibrium rent-to-price ratio (%)	2.99%	2.85%	3.39%	3.34%	2.25%	1.99%	2.26%	2.07%
Panel B: Counterfactuals with a lower income growth rate									
8.33%	Nominal disposable income	0.8049	0.7650	0.9742	0.9473				
10.25%	Nominal wage income					0.7471	0.7556	0.9098	0.9218
2.37%	Urban population	1.2207	1.2141			1.1068	1.0366		
0.49%	Total population			1.0225	1.0711			0.7965	0.7857
6.88%	Residential floor space completed	−0.1014		−0.0668		−0.0752		−0.0437	
2.15%	Residential urban land supply		−0.0567		−0.0723		−0.0910		−0.1135
	Expected growth rate of nominal housing price (%)	8.90%	9.12%	8.16%	8.26%	9.76%	10.00%	9.42%	9.59%
	Implied equilibrium rent-to-price ratio (%)	4.60%	4.38%	5.34%	5.24%	3.74%	3.50%	4.08%	3.91%
Panel C: Counterfactuals with a lower population growth rate									
10.33%	Nominal disposable income	0.8049	0.7650	0.9742	0.9473				
12.25%	Nominal wage income					0.7471	0.7556	0.9098	0.9218
1.19%	Urban population	1.2207	1.2141			1.1068	1.0366		
0.25%	Total population			1.0225	1.0711			0.7965	0.7857
6.88%	Residential floor space completed	−0.1014		−0.0668		−0.0752		−0.0437	
2.15%	Residential urban land supply		−0.0567		−0.0723		−0.0910		−0.1135
	Expected growth rate of nominal housing price (%)	9.07%	9.23%	9.86%	9.90%	9.95%	10.29%	11.04%	11.24%
	Implied equilibrium rent-to-price ratio (%)	4.43%	4.27%	3.64%	3.60%	3.55%	3.21%	2.46%	2.26%

8.05% and 0.87% for cities like Guiyang. We thus leave the readers to judge how likely the actual growth rate of disposable income and urban population will meet the cutoff values in each city, in evaluating whether there is a house price bubble in that city.

Second, even at the national level, we would like to stress the sensitivity of our conclusion to the expected house price growth rate. In particular, given that income has a big elasticity and the expected growth rate of income itself is very high, a small drop in the expected income growth could change the picture to a large extent. For example, in the Panel B of Table 5 we conduct a counterfactual exercise, in which the expected growth rate of income is 2 percentage-point lower than our benchmark case. Although this still implies a remarkable growth rate — 8.33% in disposable income and 10.25% in wage income, the predicted expected house price growth rates all drop below 10%. Thus the implied equilibrium rent-to-price ratios increase to a range from 3.50% to 5.34%. This would completely reverse our conclusion and imply a downward adjustment in house prices at the national scale. Similar exercise is conducted in Panel C of Table 5, where the expected urban population and total population growth rates are hypothetically halved. This undoubtedly leads to a lower expected house price growth or a higher equilibrium rent-to-price ratio. However, the evaluation on bubble is much less conclusive, depending on the exact model employed in the inference.

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