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Paper by invitation

Are there Irrational Bubbles under the High Residential Housing Prices in China's Major Cities?

Summary: House prices in the main cities of China have been rising to historically high levels. Unsustainable growth of housing prices might cause financial crises and damage the whole economy. This research aims to detect whether bubbles dominate China's real estate market. It begins by systematically analysing the features of China's real estate sector, followed by proposing a theoretical framework to identify the fundamentals of house prices and decompose house prices into cyclical and bubble components. It then applies the vector error correction model and other econometric techniques to testify the theoretical framework with data of seven Chinese cities from 2008M01 to 2017M12. The main findings of this research include the following four parts. Firstly, the residential housing market of Shanghai was exposed to the irrational bubble issue, but the rest six cities examined were at safe positions. Secondly, both long-run and short-run relationships between economic fundamentals and house prices have been verified. Thirdly, economic regulations also have significant effects on house prices. Finally, this research suggests that the root cause of the high housing prices in major cities in China is due to the excessive capital injection into the residential property market.

Key words: China, House prices, Housing bubbles, Political adjustment, Real estate market, Macroeconomics.

JEL: G15, G21, R11, R21, R31.

After the 2008 global financial crisis, the real estate industry became the major pillar industry in China (Mali Chivakul et al. 2015). Facing a slowdown in the macro economy and a significant increase of government debt, the Chinese authorities treated the housing market as the major engine to maintain steady economic growth and fiscal revenues (Yuan Cheng, John K. Dagsvik, and Xuehui Han 2014). With strong fiscal stimulation in real estate investment, sufficient credit in the domestic market. Despite the slump in the global economic market in view of the Global Financial Crisis of August 2007 and the subsequent Great Recession, China's residential property market became prosperous. As a result, house prices soared to extremely high levels in the main cities of China. Real house prices in large Chinese cities have kept a double-digit annual compounding growth rates in the past decade (Edward Glaeser et al. 2017).

The excessive growth of residential property prices has aroused concerns that housing bubbles may exist in the real estate markets. If the growth of housing prices is

mainly driven by irrational housing bubble components, and once housing bubbles burst, China and even the world's real economy would be exposed to severe externality. To prevent this situation to happen, it is of vital importance to detect whether China's real estate market contains a bubble. In order to contribute to identify the main drivers of the soaring house prices and detect the existence of housing bubbles, this research begins by systematically analysing the relevant institutional factors of China's residential real estate markets. China's real estate market has its unique features. It is a new-born market with a short history of less than two decades. Besides, instead of an entirely free market, the government regulates the housing demand by periodically changing the real estate market regulations. Moreover, with the enormous wealth of rich people in the country, limited house stocks in super cities, foreign exchange control and lack of investment substitutions, real estate market has become the prior and the only choice for hedging inflation. With all these special situations, this research proposes a theoretical explanation of the fundamental values and dynamics of house prices. Economic fundamentals, government macro-controls and idiosyncratic features of China's real estate markets are considered as key determinants of house prices. Furthermore, this research applies an econometric analysis to testify the proposed theoretical framework. The Vector Error Correction Model (VECM) is used to model long-run and short-run house prices due to its advantages of accounting for endogeneity, non-stationarity and reverse causalities. In addition, house prices are decomposed into the cyclical component, bubble component and fundamental values to identify the bubble episodes.

This research contributes to the previous literature in the following aspects. Firstly, the research systematically analyses the unique institutional factors of China's residential property sector and examines the key determinants of house prices in big cities in China. Monetary and administrative policies, such as the purchase restrictions and loan-to-value ratio, are included as explanations of the fundamental values and dynamics of house prices, which have not been systematically studied in the previous literature. Secondly, this research accounts for forces of bubble component and cyclical component on the evolution of house prices by applying the price decomposition technique (Eloisa T. Glindro and Vic K. Delloro 2010; Philip Arestis, Ana Rosa Gonzalez-Martinez, and Lu-Kui Jia 2017). To the best of our knowledge, this method has not been applied to study residential house prices in mainland China.

The remainder of this contribution is organised as follows. Section 1 reviews previous literature in housing bubble-detection techniques and housing bubbles studies in the Chinese market. Section 2 examines the institutional features of China's residential property market. Section 3 outlines the theoretical framework. Data, econometric techniques, and empirical results are displayed in Section 4. Finally, Section 5 summarises and concludes this paper.

1. Literature Review

Olivier Blanchard and Mark Watson (1982) first present the concept of the housing bubble and define housing bubbles as the portion of the house prices, which exceeds the fundamental values of houses. By assuming that houses as a type of financial asset contains no rational bubble and no arbitrage, the present values of future rental

incomes would be the current prices of houses. Eric J. Levin and Robert Wright (1997) decompose house prices into two parts: the fundamental value, which is determined by economic factors, and the bubble part. House prices fluctuate around long-run equilibrium intrinsic values, and the large deviation of house prices from the intrinsic value represents the existence of a "bubble". Bubbles can be further divided into two types: the rational bubble and the irrational bubble. Robert J. Shiller (1981) and Kenneth D. West (1987) distinguish rational bubbles from irrational bubbles. A rational bubble happens when house prices include a portion of overvaluation caused by rational expectations of future rental incomes and capital gains; whereas irrational bubbles are created by investors and agents' irrational behaviour, which could not be captured by models. Glindro and Delloro (2010) further decompose house prices into three parts: the fundamental, cyclical and bubble components. The overvaluation of house prices is mutually determined by cyclical factors, such as the market frictions, and the bubble component.

Frequently used bubble-detecting methods could be categorised into two groups: the direct testing methods and the indirect testing methods. Direct testing approaches compare current figures of some indexes with their historical ones or proposed benchmarks. Frequently used indexes include price-to-rent ratio, price-to-income ratio, real estate mortgage ratio and vacant house ratio (Stephen Malpezzi 1999; Quan Gan and Robert J. Hill 2009), or a combination of selected indexes (Yongzhou Hou 2010).

The indirect testing method takes two steps to detect housing bubbles. It first determines the fundamental values of house prices and then applies statistical tests to capture the existence and scales of housing bubbles. The fundamental values of house prices are determined by two approaches. The first approach is the discounted cash flow (DCF) method. By assuming houses as cash-generating assets, the DCF approach determines fundamental values of houses by discounting future rental incomes using a gauge discount rate (Andrew E. Baum and David Hartzell 2011). The second method is the econometric regression approach. The intrinsic values of houses of the long-run equilibrium are reflected by macroeconomic fundamentals. Since the equilibrium value could hardly be observed, researchers build up models to explore the most fundamentals, which determine what "fundamental" is. Different types of models are used to capture the equilibrium prices of houses, such as the housing pricing model (Arestis and Elias Karakitsos 2010), the hedonic house price model (Jason Beck, Joshua Fralick, and Michael Toma 2012), and the state space model (Hanxiong Zhang et al. 2015). After determining the fundamental values of houses, econometric tests are applied to detect house price bubbles. If statistics vary from the statistical regularities, bubbles exist in the market. Two most frequently used bubble test methods for the fundamental value regression approaches are the variance bounds test and the co-integration test (Shiller 1981; John Y. Campbell and Shiller 1987; West 1987). Shiller (1981) applies the variance bounds test, and West (1987) improves Shiller's (1981) model and develops the two-step test. Campbell and Shiller (1987) test the existence of a bubble by applying the unit root test to confirm the stationarity of the fundamental value and the asset price as well as examine explosiveness. Behzad T. Diba and Herschel I. Grossman (1988) then use the integration test as the tool to identify the explosive

phenomenon of rational bubbles. As bubbles may collapse and rebuild periodically, which interferes above-mentioned bubble detection process, Peter C. B. Philips, Yangru Wu, and Jun Yu (2011) (using the PWY method as labelled hereafter) solve this problem by applying the recursive right-side unit root test and sub-test mechanism for testing the explosive behaviour of bubbles and growth rates, as well as stamping the beginning and termination time of bubbles. The Phillips, Shu-Ping Shi, and Jin Yu (2015) study (using the PSY method as labelled hereafter) further improves the previous PWY method to test multiple bubbles in a long-time horizon. The PSY updates the PWY methods by using the backward sup-ADF test to improve the accuracy of the bubble period identification and a flexible double recursive date-stamping technique to capture bubble windows with corresponding starting points and endpoints.

In recent years, researchers applied the above-mentioned methods to investigate fundamental housing prices and test irrational housing bubbles in China's residential property markets; it is the case, though, that different empirical results have emerged. For instance, Ashvin Ahuja et al. (2010) use a fundamental price model to analyse whether housing prices in China grew too fast by empirically estimating the demand- and supply-side factors of house prices under the rational expectations hypothesis and exploring the equilibrium house prices. They point out that most of the rising house prices could be interpreted by economic fundamentals; still, signs of overvaluation of house prices could be evidenced and the rising trend of house prices might be sustained in the following years. Hou (2010) applies the indicator analysis approach to detect housing bubbles in China by proposing a gauge index through weighting a series of indexes in the production, transaction, financing and consumption chains of the real estate sector and comparing the current figures of the constructed index with the proposed benchmark. Yongheng Deng, Eric Girardin, and Roselyne Joyeux (2018) construct daily hedonic housing prices in Beijing and Shanghai and apply the PSY test to detect housing bubbles. They point out that bubbles are not a significant feature in big Chinese cities during the period from 2005 to 2010. Tianhao Zhi et al. (2018) adopt the Log-Periodic-Power-Law-Singularity (LPPLS) framework to detect unsustainable speculative behaviours in house prices time series in nine representative Chinese cities, and they spot signs of housing bubbles in eight of nine examined cities except Guangzhou.

Previous literature helps us to have an understanding about the residential property prices in big Chinese cities. Nevertheless, numerous gaps in this field still exist. Some approaches may not be sufficiently suitable. Specifically, the indicator analysis approach is the dominating method applied in Chinese real estate market. It has the advantage of requiring much less data. However, setting the benchmark is a complicated task, and there are no consensus criteria for determining a precise and universal reference value. Hence, this method can be used to have some understanding of the housing market, but it is not the best one to test and gauge house price bubbles. The fundamental value regression approach is relatively accurate in testing and gauging bubbles; nonetheless, previous studies focused on modelling house prices and acknowledged long-term determinants in efficient and free markets, such as interest rates, disposable income and GDP growth. The salient features of Chinese property markets, such as the frequent administrative intervention, have not been considered.

This research fills the gaps mentioned above in the following aspects. Firstly, this research systematically analyses influential factors of house prices in seven big cities in China and builds up a theoretical framework of the relationship between house prices and economic determinants. Economic regulations including both monetary and administrative regulations are taken into consideration as explanatory factors of house prices, which have not been studied together by other studies. Secondly, this research applies empirical analysis to testify the proposed theoretical framework. Thirdly, this research uses the price decomposition method to scale the bubble component and detect housing bubble episodes, which have never been applied in real estate markets in mainland China.

2. Institutional Features of China's Residential Property Market

China's real estate market has its unique institutional features. To begin with, the real estate industry is a major pillar industry in China as well as a key resource of government financing and the engine to maintain steady fiscal revenues. Besides, the Chinese government interferes in the real estate market directly by using administrative adjustment tools. Thirdly, the booming shadow banking provides excessive financial support to the real estate sector. Lastly, Chinese residential property sector has extremely high home ownership ratio.

2.1 Real Estate as a Pillar Industry

China's real estate market is a relatively new one, with a short history of fewer than two decades. Despite its short history, the real estate sector is a dominating driver of the nation's GDP growth. The average ratio of real estate investment over GDP in the past 15 years was around 45%; and China's residential property investment plays a dominant role in total real estate investment, with a 72% ratio in the first quarter of 2019 (National Bureau of Statistics of China 2019)[1]. Not only is the real estate sector the main field of fixed investment and the key driver of the nation's GDP growth, but also it is a major resource of government financing as well as the key contributor to fiscal revenues. The real estate sector directly contributes to the governments' revenues from land sales and real estate taxes. Real estate taxes contribute around 25% of local governments' tax revenues (National Bureau of Statistics of China 2019). Meanwhile, local governments also collect money by selling land. As a limited and precious resource owned by local governments, sales of land in urban areas have become a key funding source of local governments. From 2010 to 2017, real estate taxes and land sale income comprised an average of 70% of local governments budget revenues; and in the year 2010, nearly 90% of the budget revenues of regional governments was accomplished by the real estate industry (National Bureau of Statistics of China 2019).

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[1] **National Bureau of Statistics of China.** 2019. Data. http://www.stats.gov.cn/english/Statisticaldata/AnnualData/ (accessed July 30, 2019).

2.2 Frequent Administrative Adjustments on House Prices

The frequent administrative intervention in the residential property market is a salient feature of China. With consecutive and changeable administrative adjustments, the normal functioning of the residential housing market is disturbed. After the hiking of house prices in 2010, the Chinese government published a series of administrative policies for the sake of cooling down the overheated residential housing markets. Since then, house purchase restrictions, interest rates for mortgage loans and the down payment ratio became three major tools for the government to intervene in the residential real estate market.

Theoretically speaking, administrative policies could be an effective and efficient method to adjust the real estate market. However, in practice, the central government in collaboration with local governments introduced a great deal of monetary and administrative policies to contain the soaring housing prices, which disturbed the normal market order and market behaviour. Changeable policies confuse investors. The effects of administrative policies are weakened or even becoming opposite to their intentions. After several years' of observations, speculators and investors interpret the real estate policies as the barometer of the real estate market. Harsher policies may be interpreted as those in the real estate markets where house prices keep increasing. As a result, speculators feel that it would be a good opportunity to invest. Meanwhile, potential buyers, who decide to afford houses for their living, feel obliged to buy immediately, as they are afraid that they would not be able to afford accommodations anymore if they do not purchase promptly. In contrast, governments tend to loosen constraints when house prices fluctuate or drop. At this stage, speculators would give up their ideas of buying houses; whereas investors would wait for house prices to fall to the expected bottom.

2.3 Excessive Financial Supports and Booming Shadow Banking

The easing monetary environment and the booming shadow banking sector give excessive financial support to China's real estate sector. Under the loose monetary environment, house purchasers could easily get funding from traditional banks. Meanwhile, funding for construction companies is gathered from numerous channels, especially from the shadow banking.

To begin with, traditional banks give strong financial support to the real estate industry by lending to house purchasers and constructors. The outstanding real estate loans of Chinese banks increased from 8 trillion CNY in 2010 to 38.7 trillion CNY in 2018, with the average growth rate 22%, which was higher than the 10% M2 growth rate (People's Bank of China 2019)[2].

Shadow banking is another major channel for real estate developers to seek funding. Shadow banking lending in China includes banks off-balance lending and lending from other non-financial companies. As the People's Bank of China published credit policies discouraging commercial banks from lending to real estate developers in 2010, banks were encouraged by high yields of real estate loans to explore a new

[2] Only M1 and M2 relevant data are published on the official website of the People's Bank of China.

way to issue loans but avoid regulatory hurdles; that is through the shadow banking system. In the meantime, property developers can also seek shadow-banking credit. Statistics show that funds raised from the shadow banking accounts for more than 50 percent of total financing of construction companies, which means that the shadow-banking sector has become the main channel for real estate developers to seek funding (Sina Finance 2019). Traditional bank loans only account for 10 percent of total social funding raised by real estate developers.

By easily raising funds from the above-mentioned channels, real estate developers gather sufficient cash flows to invest in land and housing. The leverage ratio of the real estate industry is the highest across all industries. Currently, the average ratio of liabilities to assets of all listed real estate companies is higher than 80 percent, which is ranked first across all sectors (Wind 2019)[3]. With excessive liquidity support, real estate developers borrow lavishly to purchase land, construct real estates and house sales.

2.4 The Extremely High Home Ownership Ratio

The extremely high home ownership ratio is another key feature of Chinese residential property sector. The home ownership rate in China is above 90 percent, which is significantly higher than the world average. In comparison, this ratio in the US during its 2007-housing boom was 69 percent, the highest on record (Survey and Research Center for China Household Finance 2019)[4]. In the meantime, the average home-ownership rate of Chinese millennials is 70 percent, which is much greater than the 40 percent global level (HSBC Holdings 2019).

The rationale behind the extremely high home ownership ratio in China is plentiful. Firstly, tenants' rights are not well protected by the current legal system. In most well developed and some developing countries, the "security of tenure" right protects tenants. Specifically, tenants have the right to continue to occupy their dwellings after the terms of tenancy expire. Under the statutory protection, tenants could not be evicted unless property owners are granted the possession orders from the courts. However, there is not any similar right for tenants in China. Besides, China's social housing system is still under-developed. Both the public rental housing and the affordable housing supplies could not match with the demands, especially in big cities where rural migrant workers with middle or lower incomes flow in. The lack of alternatives for investment is also a key reason behind the high ownership ratio. Currently, the nominal deposit rates are lower than the inflation rate, and the performance of the stock market is unsatisfactory, especially with the burst of the stock market bubble in 2015. Thus, Chinese households treat houses as the main and even the only type of financial assets to offset inflation. In 2018, nearly 77.7% of national average household assets were allocated in residential houses (Changsha Jingluo Zhichuang Information Technology Co. 2019). This proportion is almost two times higher than the US equivalent. The high

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[3] **Wind.** 2019. Wind Economic Database. https://www.wind.com.cn/en/edb.html (accessed July 30, 2019). The comparison of liability to asset ratios and fixed-asset to total asset ratios among industries is calculated based on 2390 listed corporations.
[4] **Survey and Research Center for China Household Finance.** 2019. China Household Finance Survey. https://datascience.shanghai.nyu.edu/tags/survey-data (accessed July 30, 2019).

house to total asset ratio indicates huge illiquidity risks in household portfolios. Once house prices drop under a breakeven level, Chinese households would suffer from tremendous losses.

2.5 Signs of Overvaluation of Residential Housing Prices

The overheat of residential housing markets and overvaluation of housing prices can be reflected from the soaring house price-to-rent ratio and the price-to-income ratio. Theoretically speaking, as the cash flows generated by properties, rental incomes should maintain a stable positive relationship with house prices. However, in China, the increases in house prices in some major cities have been much steeper than the increases in rents in the past decade. The average growth rate of rents among seven cities was around 50 percent, which was much less than the nearly 300 percent growth rate of house prices in the past eight years (National Bureau of Statistic of China 2019). The increasing gaps between two indices indicate the misalignment between house prices and rental prices. We also compare the house price-to-rent ratio in the main cities of China with other major cities of other countries in the world. In 2019, six of the top nine cities with the highest price to rent ratio are Chinese ones, with five in mainland China, namely Shenzhen, Shanghai, Guangzhou, Beijing and Chengdu, and the other one in Hong Kong. Shenzhen even outpaced its neighbour Hong Kong and became the city with the second highest price-to-rent ratio all over the world (Numbeo 2019)[5]. Not only did the price-to-rent ratios of major Chinese cities obtain top rankings all over the world, but also the price-to-income ratios of Chinese cities peaked in competition with metropolies in other countries. Though the disposable income of Chinese city dwellers has increased significantly in the past years, the growth of incomes is still lagging far behind the growth of house prices. Two cities in mainland China, Beijing and Shanghai, are on the list of eight cities with the highest house price to income ratios across the world (Bloomberg 2017). In other words, city dwellers in the listed two cities need save for 30 years to afford an apartment.

3. Theoretical Framework

In this study, the detection of housing bubbles comprises two steps. The first step is to explore the determinants of residential properties. Economic fundamentals, monetary policies and real estate policies are considered as possible explanations of house prices. The second step is to decompose the bubble component from house price overvaluations and detect housing bubble episodes.

The second-hand residential house prices in big cities in China are studied in this research. The main rationale behind the choice of the second-hand house prices instead of the first-hand is twofold. Firstly, a majority of newly constructed houses in big cities in China are in the newly expanded urban-rural fringe areas, which could not reflect the real house price levels. Secondly, the second-hand house prices are better indicators of market conditions, compared with the first-hand house prices. The first-hand house prices are mainly determined by developers' margins; while the second-

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[5] **Numbeo.** 2019. https://www.numbeo.com/property-investment/rankings.jsp (accessed July 18, 2019).

hand house prices depend more on market behaviour. Under this situation, the second-hand residential house prices are the most appropriate objectives to study housing bubbles.

3.1 Fundamentals of the Residential Housing Markets in China

According to a relevant economic theory, house prices are determined by the dynamic interaction of demand and supply in the real estate sector. The demand and supply of housing are determined by economic fundamentals. The main economic fundamentals of demand for housing are disposable income, demography, rental income, GDP and inflation, money supply, as well as stock prices. The increase of income represents the increase of affordability to spend on housing. In the past decade, with the steady economic growth of China, disposable incomes of urban residents have increased by 8.7 percent year-on-year from 2006 to 2019 (National Bureau of Statistics of China 2019). The strong increases in disposable incomes fuel the demand for houses. The population inflow driven by the urbanisation process is another key factor of the soaring demand of housing in cities. China's urbanisation process began when the central government launched the reform and opening-up policy at the beginning of 1990s. Since then, both China's economy and its urbanisation process steps into a fast-growing age. Urbanisation provides a feasible way to pull housing demand. The GDP and inflation affect housing demand by increasing social confidence and encouraging consumers spending on purchasing properties as well as borrowing from banks. Money supply, in terms of M2, is included as an explanatory factor of both housing demand and housing supply as well. In China, M2 includes cash in circulation, deposits, which can instantly convert into cash, and short-term investments, which can be cashed very quickly. The cash in M2 can be explained as the central bank's liability to residents and economic entities, and deposits are the commercial banks' liability. Hence, M2 is a good gauge of social debts. With loose credit policy and nearly unregulated shadow banking business, both real estate developers and house purchasers are supported by excessive social debts. Another explanatory factor of housing demand and supply is rental income. Rents are the cash flows generated by houses. When the rental prices increase, tenants are stimulated to afford their own houses due to the increase of renting cost, and investors are encouraged to buy to enjoy higher rental incomes. Hence, rental incomes greatly influence the demand for residential houses in a positive way. There is also the suggestion that rental income has a negative impact on second-hand housing demand. With more cash flow generated by properties, owners tend to hold the real estate instead of selling it.

Beyond the above-mentioned economic fundamentals, governments' regulatory controls also play a key role in China's real estate market. Huayi Yu (2010) suggests that China's GDP growth is much smoother than the exponential growth of house prices, which means that the major determinants of China's soaring house price are not only the macroeconomic fundamentals, but also includes the government's macro-controls. Instead of an entirely free market, in China, the housing demand is influenced by the government through periodically changing the house-supply constraint policy. Hence the demand of housing is manipulated by purchase restrictions. In this study, we also suggest that the guided mortgage interest rate and down payment ratio are two

regulatory factors, which affect housing demand. The People's Bank of China (PBOC) frequently adjusts the down-payment level for home buyers according to the situations of cities. When the real estate market is sluggish, and in order to boost the property sector, PBOC cuts the minimum down-payment level and decreases the interest rate for home purchasers. Whereas when the property market is overheated and house prices increase too fast, POBC usually increases the down-payment level and the guiding mortgage rate.

This discussion can be summarised into Equations (1) and (2), which are proposed equations for the housing demand and supply respectively.

$$H_d = D\big(H_p,\ Y,\ P_o,\ R_I,\ CPI,\ GDP\ I,\ M2,\ LTV,\ P_r\big), \tag{1}$$
$$\qquad\quad -\ \ \ +\ \ +\ \ +\ \ \ \ \ +\ \ \ \ \ +\ \ \ \ \ -\ \ \ +\ \ \ +\ \ \ -$$

$$H_s = S(H_p,\ R_I,\ P_o,\ M2), \tag{2}$$
$$\qquad\quad +\ \ \ -\ \ \ +\ \ \ +$$

where *Hd* stands for the second-hand residential housing market demand, *Hp* for housing prices, *Hs* for housing supply, *Po* for population, *RI* for rental incomes, *CPI* for the consumer price ratio, *I* for the mortgage interest rate, *M2* for M2 money supply, *LTV* for the loan-to-value ratio, and *Pr* for the purchase restriction.

When the housing market is at equilibrium, *Hd* and *Hs* are equal and solving for the equilibrium housing price *Hp*, would give:

$$H_p = P(R_I,\ Y,\ P_O,\ I,\ M2,\ CPI,\ GDP,\ LTV,\ P_R). \tag{3}$$
$$\qquad\quad +\ \ \ +\ \ \ +\ \ -\ \ +\ \ \ \ +\ \ \ \ \ +\ \ \ \ \ +\ \ \ -$$

Equation (3) shows that second-hand residential house prices, *Hp*, are determined by the rental income, *RI*, the disposable income *per capita*, *Y*, urban population in the city, *PO*, the mortgage interest rate, *I*, the money supply, *M2*, the consumer price index, *CPI*, the gross domestic product, *GDP*, the loan-to-value ratio, *LTV*, and the purchase restriction, *PR*. The signs below the independent variables are the partial derivatives of the dependent variable with respect to the independent variables.

3.2 The Decomposition of House Price Overvaluation

Glindro and Delloro (2010) and Arestis, Gonzalez-Martinez, and Jia (2017) decompose house prices into three parts: the fundamental, cyclical and bubble components. Either cyclical forces or bubble components could drive the housing price overvaluation. The house price decomposition includes three steps.

(a) Firstly, the price overvaluation is the difference between the actual house prices and the long-run fundamental prices:

$$P_{i,t}^{over} = P_{i,t} - P_{i,t}^{long}, \tag{4}$$

where $P_{i,t}^{over}$ is the actual house prices in city *i* at time *t*; and $P_{i,t}^{long}$ is the long-run fundamental prices of houses.

(b) Secondly, the cyclical component of house price overvaluation is calculated by Equation (6), as below:

$$P_{i,t}^{cyclical} = \left(P_{i,t-1} + E\Delta P_{i,t}\right) - P_{i,t}^{long}, \tag{5}$$

where $P_{i,t-1} + E\Delta P_{i,t}$ is the short-run price in city i at time t; $E\Delta P_{i,t}$ is the expected changes of house prices in city i at time t, which is captured by the error correction model.

(c) Finally, the bubble component is calculated as the difference between the price overvaluation and the proportion of overvaluation caused by the cyclical component:

$$P_{i,t}^{bubble} = P_{i,t}^{over} - P_{i,t}^{cyclical}. \tag{6}$$

By substituting Equations (4) and (5) into the right-hand side of Equation (6), the latter equation is rewritten as follows:

$$P_{i,t}^{bubble} = \left(P_{i,t} - P_{i,t-1}\right) - E\Delta P_{i,t} = \Delta P_{i,t} - E\Delta P_{i,t}, \tag{7}$$

and

$$P_{i,t} = P_{i,t-1} + E\Delta P_{i,t} + P_{i,t}^{bubble}. \tag{8}$$

To the best of our knowledge, this method has not been previously applied to study residential house prices in China.

4. Empirical Analysis

4.1 Data

This research utilises monthly data from 2008M01 to 2017M12 in seven major cities in China. These cities are Beijing, Shanghai, Tianjin, Guangzhou, Shenzhen, Hangzhou and Chengdu. The choice of the cities in this study is determined by: (a) GDP more than 100 billion US dollars; (b) a significant increase in the second-hand residential house prices in the past 24 months; (c) the availability of required statistics.

The China Index Academy (CIA 2019)[6] is the main data provider; it publishes monthly data on second-hand residential house price indexes and rental indexes. The National Bureau of Statistics of China (2019) provides the annual data for urban *per capita* disposable income, the annual data for urban population and the monthly data for CPI and GDP. Due to lack of official monthly data for these three variables, time series are built by conversing the annual data of disposable income and annual urban population into monthly frequency. The People's Bank of China (PBOC 2019) reports the weighted average interest rate of individual mortgage loans monthly. The Shanghai Composite index is used to represent the performance of Chinese stock markets, which could be found in the website of Shanghai Stock Exchange (2019)[7]. Finally, information about administrative policies, including the purchase constraints and the regulated loan-to-value ratios, are searched and gathered from public announcements on the official websites of municipal governments.

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[6] **China Index Academy (CIA).** 2019. http://industry.fang.com/ (accessed July 18, 2019). China Index Academy is the biggest real estate research organization in China.
[7] **Shanghai Stock Exchange.** 2019. http://english.sse.com.cn/ (accessed July 30, 2019).

4.2 Econometric Specification

In order to model and test the testable hypothesis, the vector error correction model (see Søren Johansen 1991), is applied to estimate both short-term and long-term effects of house-price fundamentals. The VECM model overcomes the problem of endogeneity of explanatory variables, as all variables are treated as endogenous variables. Moreover, the VECM model can be estimated for non-stationary as well as stationary time series so that the pre-testing of the order of integration of variables is not necessary.

The VECM model is the vector autoregressive (VAR) framework embedded with the cointegration concept. If individual variables have both I(0) and I(1)[8] processes, and all variables are cointegrated and have long-run relationships, the system is a VAR(j) process. Then the short-run dynamics of house prices would be estimated by including the deviation of the short-run estimates from the long-run equilibrium, which is the error correction term. This approach is specified in Equation (9):

$$\Delta P_t = \alpha \ \Delta P_{t-j} + \beta \ \Delta X_{t-j} + \gamma \ E_{i,t-1} + c + \varepsilon_t, \tag{9}$$

where Δ is the difference operator, P_t accounts for the real house price index, X_t is a vector of explanatory variables of house prices, X stands for the real disposable income *per capita*, Y, the real money supply *M2*, the real stock price, *SP*, the real rental index, *RI*, the real mortgage interest rate, *I*, population, *PO*, the purchase restriction, *PR*, and the loan-to-value ratio, *LTV*. E_t is the error correction term, ε_t is the random error term, c, α, β, γ are the estimated coefficients. α is the degree of serial correlation, which determines the deviation trend of housing price. β is the contemporaneous adjustments of prices to current shocks. γ is the degree of mean reversion, which represents how housing prices converge to the equilibrium level.

Equation (9) shows that short-run house price fluctuations are determined by the historical changes of house prices, current shocks and the mean-reverting effect to its fundamental value. In a perfectly efficient market, the real housing price should be completely adjusted in accordance with the intrinsic value, with $\beta = 1$, $\alpha = \gamma = 0$. In real life, due to the market frictions, the short-run fluctuation of housing prices is influenced by coefficients α and γ.

To guarantee stronger linear long-run relationships between the dependent variable and explanatory variables and to model the short-run price elasticity better, the logarithms of the real second-hand house price indexes (*HP*), real rental indexes (*RI*), real disposable income *per capita* (*Y*), stock prices (*SP*), population (*PO*) and real money supply (*M2*) are adopted. The logarithmic transformation of the model allows the relationship to be represented in "percentage" terms.

The Johansen's cointegration test methodology (Gangadharrao Soundalyarao Maddala and Shaowen Wu 1999) is the econometric technique applied in this research to determine the long-run cointegration relationship. The validities of estimated VECM models are checked by diagnostics and statistics including the R-squared, the adjusted R-squared, and the Durbin-Watson statistic. Also, the Breusch-Godfrey Serial

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[8] The I(0) process means the time series is stationary; while the I(1) process means that the time series has a unit root, and it is stationary in first difference.

Correlation LM test (Leslie G. Godfrey 1978; Trevor S. Breusch 1979) is applied to test the serial correlation of the residuals.

EViews 9.5 is the econometric package used to estimate the econometric relationships and conduct relevant tests.

4.3 Empirical Results

4.3.1 Preliminary Analysis and Long-Run Relationships

This approach begins with the selection of lengths of lags for the VECM model by a series of criteria. We input the maximum lags of fourteen to balance the degrees of freedom and year-to-year dynamics. Specifically, fourteen lags allow us to capture the possible effects on the dynamics of housing prices caused by the historical changes one year earlier, with an extra two months included to increase the accuracy of our estimation. The second step is to test the possible cointegrating relationship between the dependent variable and independent variables. To make sure that the long-run equilibrium relationship between the dependent variable and testable explanatory variables exists, the Johansen (1991, 1995) cointegration test is applied. Table 1 reports the results of the Johansen cointegration tests. By choosing the suggested lags and making linear deterministic trend assumptions, the null hypotheses that there is no cointegrating relationship is strongly rejected in all cities. It is confirmed that each city has at least one cointegrating equation.

Table 1 Johansen Test for Cointegration

City	Maximum rank	Log likelihood	Eigenvalue	Trace statistic	5% critical value	*p*-values
Beijing	1	1011.476	0.24551	48.85878	29.79707	0.0001
Shanghai	1	753.5965	0.30743	82.54888	54.07904	0.0000
Tianjin	1	623.6951	0.28839	76.00689	47.85613	0.0000
Shenzhen	1	725.8913	0.27571	46.61063	24.27596	0.0000
Guangzhou	1	660.7300	0.36946	73.11852	47.85613	0.0000
Hangzhou	1	680.1519	0.22205	57.73514	35.19275	0.0000
Chengdu	1	532.2571	0.34074	94.57239	76.97277	0.0013

Source: Own construction.

After determining suitable lags and confirming the existence of one cointegration, the next step is to estimate the VECM model in order to explore the long-run equilibrium relationship between the relevant variables. The results of the cointegrating coefficients are shown in Table 2. Long-run relationships are supported by the relevant tests in each city; and all estimated coefficients are significant at the 5% level.

Table 2   Cointegrating Coefficients of Long-Run Relationships

	L_HP	Constant	L_RI	L_M2	Interest	CPI	GDP	PO	Y
Beijing	1	-28.3822	3.4870*** [5.5791]	0.7859*** [4.5487]	-	-	-	-	-
Shanghai	1	- 6.3171	-	0.9220*** [17.1946]	-0.0386*** [-5.0646]	0.0209*** [6.3537]	-	-	-
Tianjin	1	-59.6196	9.0563*** [7.4241]	-	-0.3239*** [-4.6017]	0.0745** [2.1367]	-	-	-
Shenzhen	1	-	1.3558*** [20.4854]	-	-0.2751*** [-12.5580]	-	-	-	-
Guangzhou	1	-6.7968	1.3262*** [5.4996]	-	-0.1829*** [-6.2517]	-	0.0560*** [5.3477]	-	-
Hangzhou	1	-7.7011	2.3770*** [7.66992]	-	-0.0864*** [-2.9700]	-	-	-	-
Chengdu	1	-5.3421	1.0923*** [8.9745]	-	-0.0726*** [-5.2674]	0.0331*** [5.7968]	-	-	-

Notes: For each variable of each regressor, figures in the first row are the estimators of corresponding coefficient; the second row in brackets is the t-statistics. The first row of the normality test is the Jarque-Bera statistics; and the second row is the corresponding p-value. The asterisks indicate the significances of the coefficients, with ***, **, and * symbolising the significance levels or 1%, 5% and 10% respectively.

Source: Own construction.

Clearly, house prices in the seven cities are determined mainly by either the intrinsic value or the monetary environment, or by both. To illustrate, two major explanations of real house prices in the long-run, and in the seven cities, are the rental income and the M2 money supply. The rental income, which represents the value-in-use of houses, is the dominant explanation of the house prices in the long-run. The rental income index shows significant and positive long-run relationships with house price indexes in five cities, namely Beijing, Shenzhen, Guangzhou, Hangzhou and Chengdu; and the coefficients of five cities are 3.49, 1.36, 1.33, 2.38 and 1.09 respectively, which are significantly higher than the coefficients of any other explanatory variables. The second important determination of house prices is the M2 money supply. M2 shows a positive and significant long-run relationship with house price indexes in top three cities, namely Beijing, Shanghai and Tianjin, with the relevant coefficients being 0.79, 0.92 and 1.75 respectively. The mortgage interest rate also shows a significant but negative effect on house prices in all listed cities except Beijing.

Other than the three above-mentioned explanatory variables, CPI and GDP also determine house prices at certain level in some cities. The CPI shows a significant and positive relationship with house price index in Shanghai, Tianjin and Chengdu; and the GDP influences long-run house prices in Guangzhou.

What is noteworthy is that population and real disposable income *per capita* could not explain the real house price index in the long-run in all seven cities. The reason that population has no explanatory power on housing prices might be because population affects both second-hand housing supply and housing demand, and the effects offset each other. The rationale behind the no effectiveness of real income on housing prices might be because the purchasing power of Chinese economic agents in terms of buying properties is not determined by their incomes, but by their savings and bank loans.

4.3.2 Short-Run Dynamics

In the short-run, house prices fluctuate around the long-run equilibrium values. House-price dynamics are modelled by the changes of fundamental variables to see how much of the evolution of house prices can be explained. The results of estimated short-run relationships between the dynamics of real second-hand residential house price indexes and fundamentals are shown in Table 3.

Table 3   Results of Short-Run Relationships

Dependant variable: ΔL_HP

	E(L_HP)	Constant	ΔL_HP	ΔGDP	ΔL_RI	ΔL_M2	ΔL_Y	ΔInterest	ΔCPI	ΔL_PO	ΔL_SP	LTV	PR
Beijing	-0.0244***		0.4819[1]***		-0.3473[2]***							0.0315***	-0.0227***
Shanghai	-0.2553***					-0.1517[1]**		0.0238[2]***		2.5522*	0.0303**	0.1118***	-0.0133***
Tianjin	-0.0183***	0.0850**	0.3644[1]***			0.1703**		0.0114[1]*				-0.1045**	
Shenzhen	-0.0618***		0.2605[1]** 0.2657[2]** -0.2113[4]**		0.2294[4]** 0.1986[7]**	0.2891**		-0.0438[7]*** 0.0272[8]**				-0.0620***	0.0335***
Guangzhou	-0.0662***	0.0724**						0.0259[1]***			0.0289***	-0.0953***	0.0152***
Hangzhou	-0.0462***		0.5277[1]***			0.2634***		0.0136[2]**			0.0408***	-0.0518***	
Chengdu	-0.1320***		0.1545[1]*	-0.0023[2]*				0.0211[1]***	-0.0052[1]**			-0.1003***	-0.0098***

Notes: In each column of variables, the numbers in brackets show the lag(s). The asterisks indicate the significances of the coefficients, with ***, **, and * symbolising the significance levels or 1%, 5% and 10% respectively.

Source: Own construction.

In all cases, the error-correction term is negative and significant, which indicates how much house prices converge to the equilibrium levels. The speeds of adjustments in the seven cities vary from 2% to 25%, which means 2% to 25% of the disequilibria between short-run real house price index dynamics and long-run fundamental value are eliminated. The coefficients of the error-correction term in estimated models suggest that the speeds of disequilibria corrections in five of seven cities, except Shanghai and Chengdu, are quite slow; nearly two years are required for the misalignments of house prices from intrinsic values to be corrected. One explanation of the slow disequilibrium correction speeds is the illiquidity characteristic of real estate markets (Karl E. Case and Shiller 1989). High transaction costs and high taxation fees make the house-price correction process slower than other financial assets.

Estimations also confirm that real house prices in previous periods significantly affect the dynamics of real house prices in the current period in most cities except Shanghai and Guangzhou. It indicates that the evolution of real house prices has a very large momentum in the short-run. The changes of monetary policy, including the changes of mortgage interest and M2 money supply, can explain a portion of dynamics of real house prices in some cities. The changes of population and rental incomes also affect the changes of house prices. The changes of stock price indexes show positive relationships with the short-run dynamics of house prices in Tianjin, Guangzhou and Hangzhou.

Finally, in the short-run, the government intervention in the residential housing markets are effective in most cities, though the effects might be controversial in terms of the initial aim of the government in some cities. The loan-to-value ratios have positive and significant effects on the dynamics of real house price indexes in Beijing and Shanghai, but negative impacts on other listed cities. In other words, in Beijing and

Shanghai, the larger the proportion people can borrow from banks, the higher house prices would be; and *vice versa*. This is exactly the consequence that local governments hope to see. However, in the rest of the cities, the loan-to-value ratios have a negative relationship with the dynamics of real house prices. The reason might be that the LTV ratio has been regarded as a signal of the housing market confidence. When government increases the LTV ratio in these cities during the time that the real house prices are sluggish, it becomes a signal that the government has lost its confidence in housing market and hopes to stimulate house prices and encourage housing demands by allowing people to borrow more money to purchase houses. Potential house purchasers become more cautious in making decisions to buy-in; and real house prices are driven down further. When it comes to the purchase restriction, the purchase restriction factor has negative correlations with real house price indexes in Beijing, Shanghai and Chengdu, but positive correlations in Shenzhen and Guangzhou. In Tianjin and Hangzhou, the purchase restriction policies have no effect on house price dynamics. The reasons for the controversial effects of purchase restrictions on housing prices might be similar with the LTV ratio. Purchase restrictions could either curb the increase of house prices or give the market the confidence that house prices will keep increasing thus stimulating potential buyers to enter the real estate market.

Table 4 reports the diagnostics and statistics of the validity of estimated models. Models in these cities can explain 40% to 61% in terms of the adjusted R-squared for the dynamics of real second-hand price indexes. The third and fourth rows show the results of Breusch-Godfrey (Godfrey 1978; Breusch 1979), in terms of serial correlation LM tests. In all cases, the null hypothesis that there is no autocorrelation cannot be rejected with one lag and two lags. AIC, HQIC and SBIC are three alternative criteria, which demonstrate the best-fit model with appropriately estimated parameters. We examine all three criteria of the seven models and find that the values of the three criteria are similar with negative values, which clearly implies that our estimated models fit the relevant data well. The Durbin-Watson statistics are around 2, which clearly implies that there is no autocorrelation in the estimated models.

Table 4   Diagnostics and Statistics of Short-Run Equations

Diagnostics / Statistics	Beijing	Shanghai	Tianjin	Shenzhen	Guangzhou	Hangzhou	Chengdu
R-squared	0.4501	0.5720	0.6291	0.7239	0.6222	0.5225	0.6059
Adjusted R^2	0.4038	0.4621	0.5855	0.6190	0.5786	0.4824	0.5595
LM(1)	0.2732	0.1728	0.6427	0.5090	0.2732	0.1709	0.9680
LM(2)	0.4234	0.3464	0.4812	0.1574	0.2012	0.3621	0.9026
AIC	-5.2138	-5.7818	-5.9327	-5.4768	-6.1954	-5.6319	-6.2869
HQIC	-5.1179	-5.5578	-5.8068	-5.1681	-6.0708	-5.5361	-6.1610
SBIC	-4.9777	-5.2298	-5.6224	-4.7157	-5.8885	-5.3959	-5.9766
Durbin-Watson stat.	2.0738	2.0775	2.0176	1.7674	1.9279	1.9469	2.0039

Source: Own construction.

4.4 Identification of the Price Overvaluation

After identifying the fundamentals of the residential housing markets, residential house prices in seven cities are decomposed into their fundamental, cyclical and bubble components. As explained in the theoretical framework, house price overvaluation does

not equal to "bubbles"; it is determined by the cyclical component and the bubble component. The cyclical component captures the market fraction; while the bubble component collects the house price overvaluation, which could not be explained by historical prices and the changes of fundamentals.

Based on the results of the VECM models, the bubble components in the eight cities are calculated by using the price decomposition technique. If the force of bubble component surpasses the cyclical one, then the house price is regarded as in a "bubble episode". Glindro and Delloro (2010) uses the annual average of monthly growth rates of asset prices to detect asset bubbles. Arestis, Gonzalez-Martinez, and Jia (2017) detect bubble episodes by comparing two alternative forces based on quarterly data. This research defines a bubble episode when the bubble component is positive and dominant for three consecutive months. This can avoid an over prediction of bubble episodes due to the imperfections of the estimated models. Figures 1 to 7 (portrayed in the Appendix) illustrate the rate of growth of the residential house prices in each city, and the proportion of house prices of their corresponding bubble and cyclical components. From these figures, we can spot significant housing bubble periods in all cities; however, a majority of residential housing markets of listed cities did not suffer from severe housing bubble issues, except Shanghai.

In Beijing, there were two periods of significant increases in real house prices, with the monthly real house price index increased 11% and 9% in 2010M04 and 2016M04 respectively. However, only the second jump of house prices was not driven by the dynamics of fundamentals. Besides, two short bubble episodes have been spotted; they were 2012M04-2012M08 and 2015M10-2016M04. The total bubble period was 12 months, which was 10% of the total sample period.

In Shanghai, there were also two periods of significant surge of house prices. The real house price index increased 8% in 2009M12 and 6% in 2019M02. Both increases of real house prices were driven by the changes of cyclical components, not the bubble components. However, in other periods, the increase in real house prices in Shanghai were largely determined by bubble components. Specifically, there were eight bubble episodes, which covered 62 months in 120 sampled months. Moreover, in all eight bubble episodes, except the first one, ranged from 2009M06 to 2009M11, with the average values of fundamental dynamics being negative.

In Tianjin, we can spot one huge jump of house prices at the beginning of 2010 with the monthly increase 7%. This jump mainly resulted from the dynamics of economic fundamentals. Three short bubble periods were found; they were 2008M11-2009M01, 2011M11-2012M02 and 2013M10-2014M02.

In Shenzhen, the only huge increase of house prices happened in 2009. There was a significant hike of real house prices in 2009M07; the real house price index increased 10% in one month, followed by a huge drop of 6% in the next month. This big volatility of house prices was triggered by evolution of the fundamentals. Meanwhile, three negligible bubbles episodes were spotted, with the average monthly increase of bubble components being less than 1%.

In Guangzhou and Hangzhou, similar patterns of evolution of house prices and bubble episodes emerged. In Guangzhou, four bubble episodes were found, with the

total bubble period 17 months, which occupied 14% of total sampled months. In Hangzhou, three bubble periods, which spanned 10 months, were there.

In Chengdu, the growth of house prices was much more moderate than in other cities. There was a significant drop of house prices in 2008 with a 6% decrease of real house price index in one month, whereas the highest increase of monthly real house price index was less than 4% in 2017M07. In the rest of the sample period, the dynamics of the house price index fluctuated around the horizontal axis. Four bubble episodes were found; they were 2011M02-2011M07, 2012M02-2012M04, 2015M03-2015M06 and 2015M09-015M11.

In conclusion, residential housing markets of the analysed seven Chinese cities were all at safe positions, except Shanghai. In all cities excluding Shanghai, though bubble episodes were spotted in every analysed city for several times, the dominant position of bubble components could not last for longer than five months. Shanghai is an exception. The evolution of the average real house price index was dominated by the dynamics of bubble components. Combining the cointegrating long-run relationship of house prices in Shanghai, with the fact that the real house prices were mainly driven by the M2 money supply, the mortgage interest rate and the CPI index, an interesting conclusion emerges. This is that the residential real estate market in Shanghai was more investing focused, rather than dwelling focused, and investors are more irrational, compared with other cities.

Our empirical results support our theoretical framework that both economic fundamentals and government regulations are determinants of residential housing prices in big cities in China. Moreover, government's macro-controls show some effects on housing prices in the short-term, but the direction of the effects is obscure. In other words, government controls can have both positive and negative effects, or have no power on housing prices; these governmental adjustments can be effective in some cities but have very ineffective results in other cities. In the long-run, the most significant economic fundamental explanatory factors are rental incomes and mortgage interest rate. They explain the fact that the inherent dwelling value of residential properties is the key determinant of housing prices in big cities in China. Interest rates, which represent the cost of borrowing and the discount factor of future cash flows, have a strong explanatory power in the long-run. This result supports the discounted cash flow theory of housing prices. Money supply has significant positive relationship with housing prices in Beijing and Shanghai, but has no obvious effects in the other selected big cities. It is proved that the money injection enters the real estate market and drives up asset prices significantly in these two most important cities in China. We also show that population and income have no explanatory power to housing prices. Thus we can further reach the conclusion that the purchase power of Chinese economic agents in terms of buying properties is not determined by their incomes, but by their savings and bank loans. This might result from the extremely high income to housing price ratio in Chinese big cities, which is what we discussed in Section 2.5.

From the empirical results, we also find that housing price dynamics are dominated by economic fundamentals and regulatory controls instead of bubble components in seven big Chinese cities except Shanghai; and monetary policy is a general and the most efficient policy to guide housing prices. No generalised effects for other

government controls prevail, when the government intends to apply political adjustments on local housing markets. Historical performance and consistency of the same type of adjustments as well as of other influential factors, such as the average wealth and concept of investment of local dwellers, as discussed in Section 2.4, should be carefully considered.

5. Summary and Conclusions

With the rapid development of the real estate market, house prices soared to extremely high levels in big cities in China. The house price-to-rent ratios and house price-to-income ratios in big cities are reaching the peak levels world-wide.

To detect irrational bubbles in residential real estate markets in major Chinese cities, this contribution begins by providing an analysis of the institutional features of China's residential property market. The real estate industry is a major pillar industry in China and the key resource of government financing and fiscal revenue. Frequent administrative adjustments of the residential housing markets and high home ownership ratio are unique features of China's residential property markets.

This contribution then proposes a theoretical framework to identify the fundamentals of house prices and decompose house prices into cyclical and bubble components and using econometric techniques to support the theoretical framework. By applying the VECM model, the empirical results of this research confirm the relationship between house prices and economic fundamentals as well as regulatory controls, which are proposed in the theoretical framework. After correcting in terms of inflation, a majority of the dynamics of real house prices in the long-run could be explained by the M2 money supply, mortgage interest rates and rental incomes. By contrast, the disposal income per capita, which determines the affordability of purchasers, has no explanatory power in all cities. In the short-term, the evolution of house prices is mainly influenced by the house prices in previous months, housing market intervention policies, including purchase restrictions and loan-to-value ratios, as in the cointegrating relationship with economic fundamentals and economic regulations. The evolutions of stock market prices and population can also explain a small portion of dynamics of real house prices in some cities.

Also, by applying the price decomposition technique, this research finds that the housing bubble issue was not a severe problem in six of the seven examined cities in China during the period from 2008M01 to 2017M12. The only city that suffered from the housing bubble issue was Shanghai, with bubble components dominated the evolution of house prices over 62 months out of 120 sampled months.

To conclude, housing prices in most big Chinese cities are mainly determined by economic and government fundamentals, instead of the irrational bubble component. Nevertheless, extremely high house prices compared with disposable incomes become a heavy burden on city dwellers. Although the fiscal and monetary adjustments on surging house prices have some effect, they cannot address the high house prices issue thoroughly. The fundamental way to address the high property price issue is to support the development of real economy instead of the real estate economy. The policy recommendation for the Chinese authorities is to supervise the social credit allocation to make sure that a majority of capital in the market is injected in the real economy instead of in the overheated real estate markets.

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Appendix

Residential Real House Price Decomposition
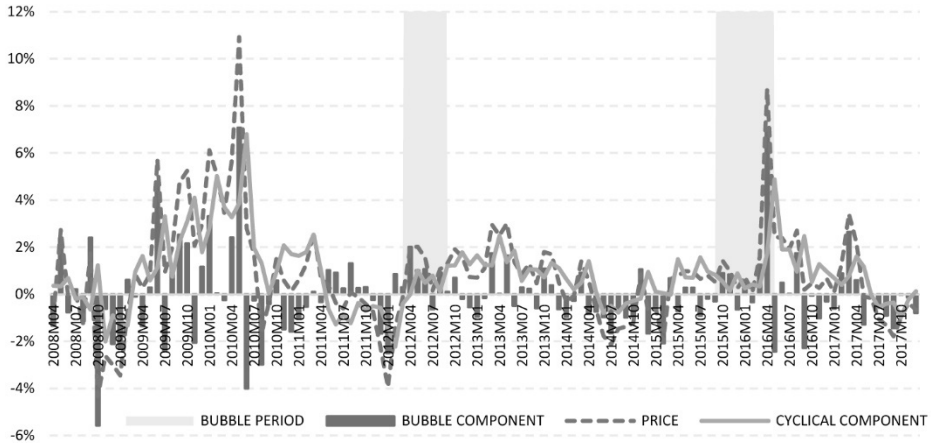
Source: Authors' own construction.

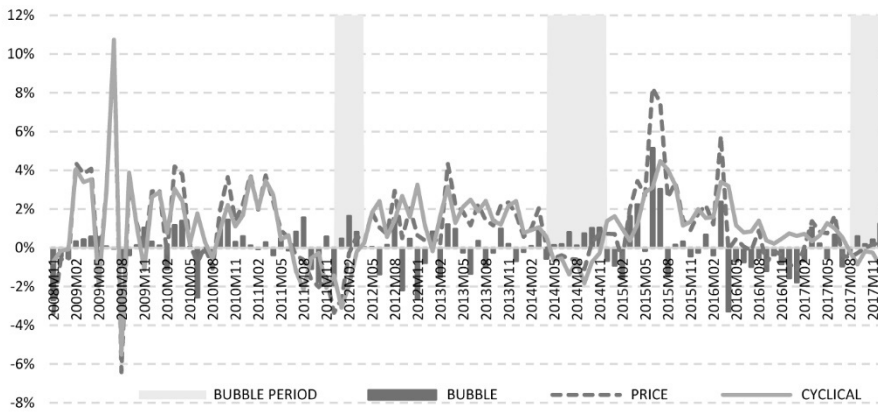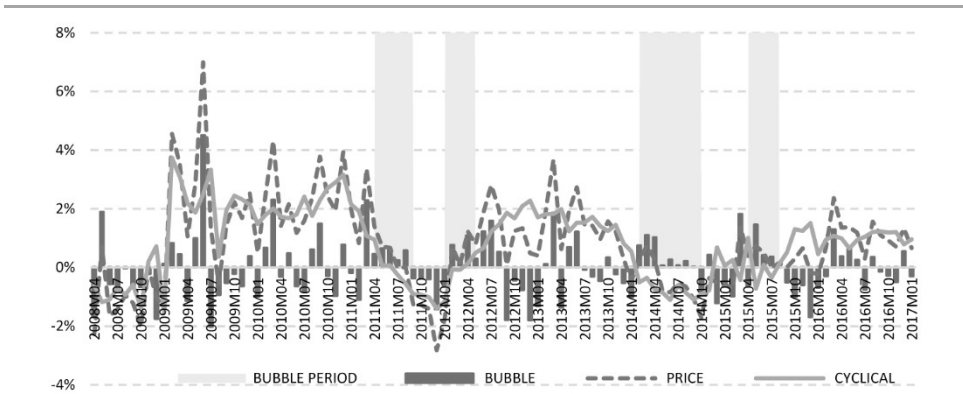**Figure 1** Residential Real House Price Decomposition - Beijing
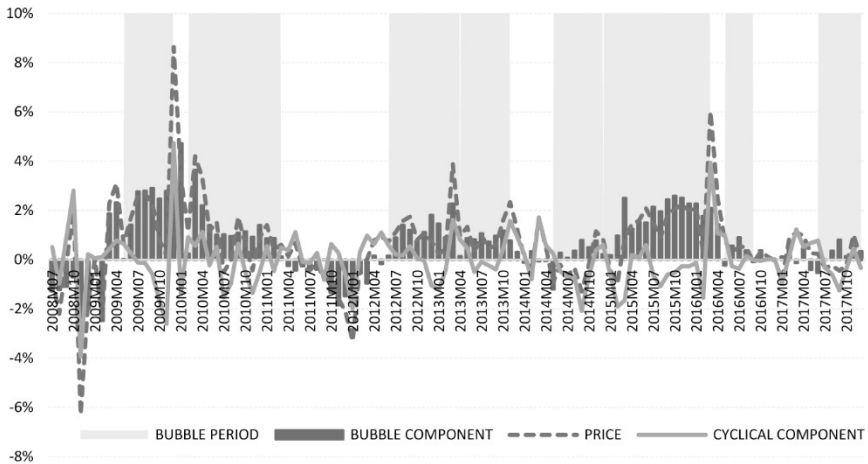
Source: Authors' own construction.

Figure 2 Residential Real House Price Decomposition - Shanghai
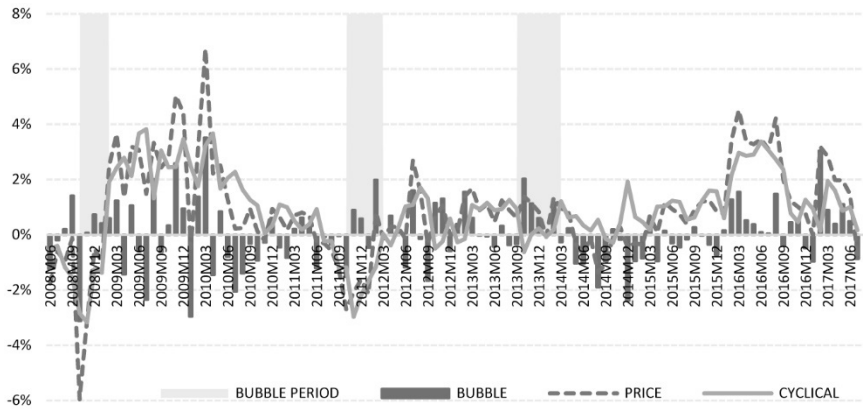
Source: Authors' own construction.

Figure 3 Residential Real House Price Decomposition - Tianjin
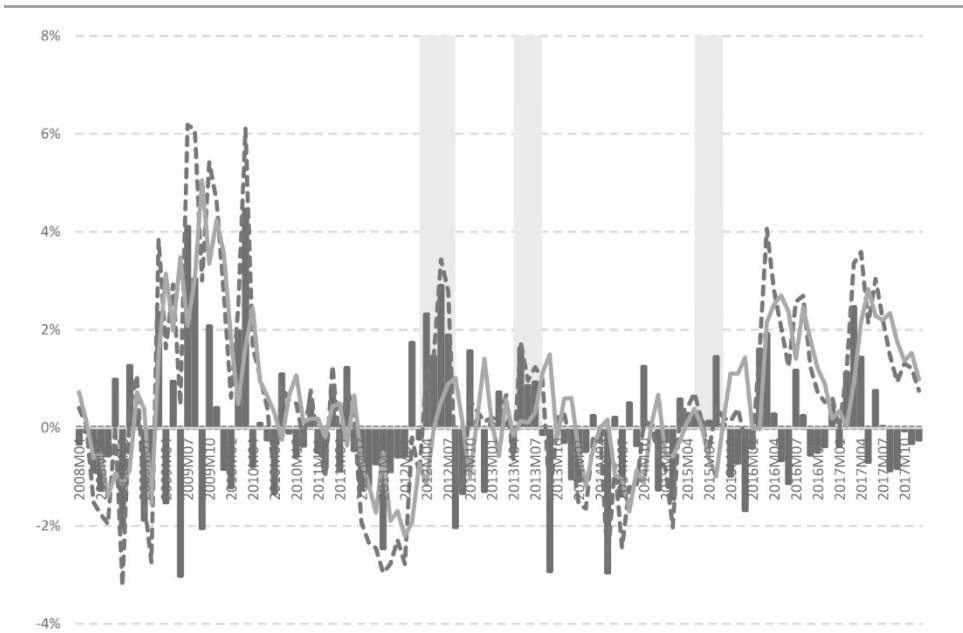

Source: Authors' own construction.

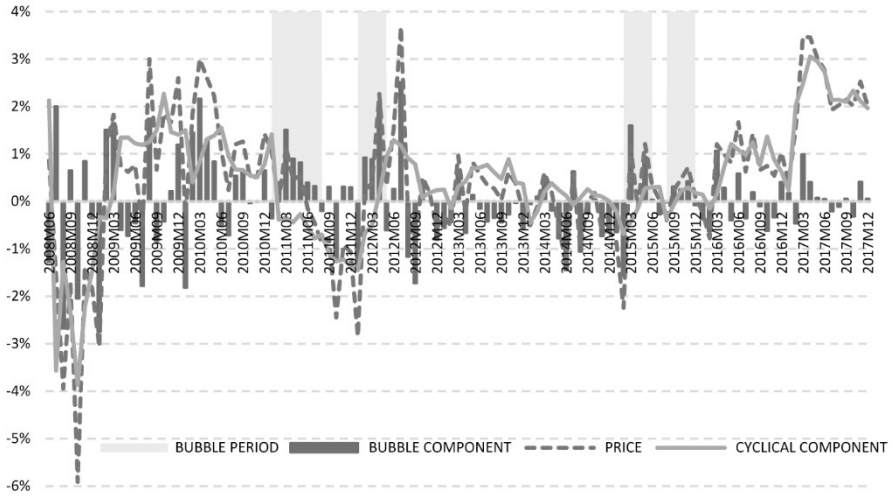**Figure 4** Residential Real House Price Decomposition - Shenzhen

Figure 5 Residential Real House Price Decomposition - Guangzhou

Figure 6 Residential Real House Price Decomposition - Hangzhou

Source: Authors' own construction.

Figure 7 Residential Real House Price Decomposition - Chengdu