Analyzing Bubbles in the Housing Market: Evidence from China

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Keywords: Housing market, Price bubble, China, SADF test

Abstract: In recent years, the Chinese government has been requesting that efforts be stepped up to prevent asset bubbles, mainly to prevent a real estate market bubble. This paper provides the definition of an asset price bubble as well as the relevant theories on asset price bubble measures in order to build a theoretical model of asset price bubbles and a supremum augmented Dickey-Fuller (Sup ADF or SADF) bubble test model. Based on the SADF model, the paper conducts a bubble test of the time series data on newly-built housing prices in 70 large or medium-sized Chinese cities (categorized in Tiers 1, 2, and 3) from January 2011 through October 2018. An estimation of the times of appearance and disappearance of the price bubble is included. The findings show that: a) Tier 1 cities had many instances of price bubbles; b) in general, the majority of Tier 2 and Tier 3 cities had fewer instances of price bubbles than Tier 1 cities; c) most Tier 2 cities' price bubbles appeared under the influence of Tier 1 city bubbles; and, d) most Tier 2 and Tier 3 cities had price bubbles throughout 2018. Based on the empirical research findings, the paper proposes to a) strengthen housing price dynamic monitoring and bubble early warnings; b) implement a differential regulation for different urban housing markets; and c) institute a long-term mechanism for the development of the housing market as early as possible.

1. Introduction

Fluctuations in housing prices not only affect the financial well-being of many corporations and households, but also play an essential role on the macroeconomic level. Changes in housing prices can trigger or reinforce the fluctuations in the economy on the macro scale. Therefore, to maintain a stable relationship between housing prices and the economy is of great importance. The burst of the Japanese land price bubble and the Asian financial crisis in recent years have resulted in a sharp drop in property prices in many countries and regions, and their economies were badly hit. The case of Hong Kong can be used as an ideal illustration of how property prices can affect the economy (Hui & Yue, 2006). Bubbles are often associated with rising asset prices and subsequent collapse. If the price exceeds the basic value of the asset, a bubble may appear. If investors hold assets because they believe that even if the price of the asset exceeds the basic value, they can sell it at a higher price than other investors, then a bubble may happen (Malkiel, 2010). Of course, defining the existence of a speculative asset bubble is not easy. Some people think that it is impossible to identify a bubble before it breaks. Others believe that investors cannot take advantage of the opportunity to make pricing mistakes in such a housing market, so there are bubbles (Barth & Lea, 2012).

In early 2016, clearing extensive inventories of unsold homes was one of the main challenges facing the Chinese economy. The "de-stocking" component of "supply-side structural reform" was mainly created to achieve this goal. The situation is complicated due to significant market changes. The national bureau of statistics surveys residential prices in 70 cities. According to the level of economic development and the real estate market, 70 cities are divided into three tiers. The real estate inventory levels in various cities are uneven, and there is almost no supply in the first-tier cities, but the lower-level cities have a large inventory backlog. At present, the Chinese government is trying to tighten purchases in large cities with rapidly growing housing prices, while attracting people to smaller cities despite few opportunities for employment and modern lifestyles.

"Supply-side structural reform" has led to insufficient supply in the real estate market, but at the same time, people's increasing demand for home purchasing has led to price inflation in the national real estate market. One of the focuses of Chinese real estate market regulations is property price. Housing prices soared in various provinces and cities, by nearly 30% in Tier 1 and Tier 2 cities alone. The housing price bubble became a problem to be reckoned with. At the subsequent Central Economic Work Conference in 2016, it was made clear that the housing market should not be the cash cow of speculators and profiteers and that housing bubbles must be controlled. It is evident that the Chinese government has become aware of the risk of severe bubbles in the housing market. A housing bubble is related not only to inelastic demand and market speculation but also very closely to the economic cycle. Involving many industries and sectors, the housing market may have a significant negative impact on the Chinese economy and the life of Chinese citizens if the bubble escalates or bursts.

In order to regulate the housing market, policymakers should detect potential bubbles with precision, which involves the necessity of an analysis of the dynamics of the bubble in various Chinese cities. This paper approaches the problem by analyzing the measure of the price bubbles in representative big and medium-sized cities and gaining deep insights into the historical bubbles in these cities. This paper changes the deficiency of previous research. Also, the literature search, covers studies concerning the bubbles in the housing market in and it has been observed that the housing price fixed base index is not considered in these studies. In conclusion, the paper proposes solutions to controlling housing bubbles.

2. Literature Review

A price bubble is a steep rise in the price of one or more assets which results in serial new rises. The initial price rise induces the buyers to expect more serial rises, therefore drawing more buyers who expect further rises in the asset price. However, contrary to the buyers' wishes, what follows a spell of rises in many cases is a reverse in the price trend expectations which end in a fast price fall and finally a financial crisis. As noted by Stiglitz (1990), if the price of an asset turns out to be higher than investor expectations, the present value will increase, hence a bubble. The housing bubble, as described by Fan Xinying, Zhang Suodi and Feng Jiangru (2013), is an asset bubble or price bubble in the real estate market. Investor expectations, compounded by speculation and other motivators, can drive steep price rises continually until they get out of hand and deviate seriously from market fundamentals. Vogiazas and Alexiou (2017) investigated the relationship between house prices and business cycles in seven OECD countries from 2002 to 2015 through the GMM model (generalized method of moments). The results show that GDP, credit growth, long-term bond yields, and real effective exchange rates are the determining factors affecting housing prices, while credit-based economies have an essential impact on the proliferation of real estate bubbles.

The measurement method of an asset bubble evolved from market fundamentals as a measure to sup ADF (SADF) as a measure. SADF involves the testing of a series of bubble processes. The market fundamentals method originated from the asset pricing model propounded by Lucas (1978). According to West (1987), most empirical studies of bubbles are based on a two-step test. Shiller (1981) proposed an asset bubble test based on a variance bounds test. Diba and Grossman (1988) proposed a bubble test method based on cointegration analysis. In the opinion of Evans (1991), a right-tailed unit root test, which applies to the whole sample, cannot predict regularly-popped bubbles, but it is possible to corroborate the discovery using a simulation method. To solve the unit root test problem found by Evans (1991), Philips (2011a) proposed to adopt an augmented Dickey-Fuller test, i.e., sup ADF test (also called sup ADF right-tailed unit root test), for a unit root test. SADF can be used to test the bubble processes in all samples in that through forwarding recursion regression, it couples with a right-tailed unit root test, and through sequential testing, it assesses the evidence of how unit root behavior impacts the bubble. Further studies by Philips (2011b) discovered SADF's applicability as a measure to multiple bubbles, pointing out the substantial effect of SADF in bubble test for not only stock market prices, but also product prices and housing prices. As noted by Homm and Breitung (2012), SADF proves to be more robust than other test methods when it comes to multiple bubbles.

There is a growing literature that focuses on the determinants of China's rising home prices. In China, price bubble research began from housing price bubbles. Jiang Chunhai (2006) redefined and obtained calculations of fundamental values, speculative bubbles, and bubble severity, concluding that comparatively severe bubbles existed in the Chinese housing market. Ren et al. (2012) suggest that house returns in Chinese cities do not satisfy the necessary condition for the existence of rational expectation bubbles between 1999 and 2009. Wu et al. (2012) indicate that price-to-rent ratios in Beijing and seven other large markets across the country have increased from 30% to 70% between 2007 to 2012, and that much of the increase in prices is occurring in land values. Moreover, their study shows that state-owned enterprises controlled by the central government have played an essential role in this growth. Dreger and Zhang (2013) provide evidence that the bubble is about 25 percent of the equilibrium value implied by fundamentals at the end of 2009. Moreover, the bubble is particularly large in the cities in the southeast coastal areas and special economic zones. Hang and Hung (2018) investigated evidence of housing bubbles in different locations of China by looking at data at the provincial and city levels from the late 1990s to 2016. Their price-to-rent ratio analysis indicated that housing bubbles began to develop in Shenzhen and Xiamen as early as 2007, while the bubbles in Beijing, Hangzhou, Ningbo, Hefei, and Wenzhou started later in 2009. Ouyang Zhigang and Cui Wenxue (2015) performed a SADF test on the bubbles in the Beijing market, detecting multiple times of appearance. As shown in a statistical comparison of cities of various tiers (Chen & Chen, 2017), the national housing market had a bubble anomaly in the 2013-2016 interval.

Compared with the existing literature, the main contributions are as follows. Research on the asset price bubble and the housing price bubble have two characteristics. First, with the popularization of, and progress in, price bubble measurement methods, especially the SADF test, people have a more profound knowledge of asset bubbles because the test detects and identifies the times of appearance in a time series. Second, domestic research on housing price bubbles is confined to price changes in megacities and critical areas and lacks combinations of bubble indicators and research methods; also, domestic research is based mostly on year-over-year statistics rather than the fixed base index. Therefore, this paper uses the SADF test for the new housing price index numbers for 70 big and medium-sized Chinese cities and for an estimation of times of appearance and disappearance in recent years. Based on the findings, the paper makes proposals on housing bubble control.

3. Theoretical Models

Following the analyses based on the bubble test done by Chinese and foreign scholars, this paper proposes an SADF test for the housing bubbles in China.

3.1 ADF model-based Testing for Bubbles

Gürkaynak (2008) proposed an asset price bubble test; asset price can be worked out as follows:

$$P_t = \sum_{i=0}^{\infty} \left(\frac{1}{1+r_f}\right)^i E_t(D_{t+i} + U_{t+i}) + B_t \tag{1}$$

In Equation 1, P_t is the asset price at time t, D_t is the income from the asset, r_f is the risk-free interest rate, U_t is the invisible fundamentals and B_t is the bubble. The equation P_t^f = P_t - B_t is commonly termed market fundamentals. B_t can be characterized as follows:

$$E_t(B_{t+1}) = \left(1 + r_f\right)B_t \tag{2}$$

Based on the characteristics of the bubble that appear, Equation 2 indicates that potential buyers expect price rises and continue to even when the price climbs to a specific level. Therefore, the buyers who are buying in anticipation of price rises will push up the price and this may result in bubbles.

3.2 SADF Model-based Testing for Bubbles and Testable Hypotheses

Philips (2011b) proposed the SADF model for the testing of periodic bubbles, which is widely found in the Chinese housing market. Therefore, the SADF model can be applied widely to bubble testing in the Chinese housing market. In an SADF model, the sample size is forward-expanded to get multiple sub-samples to work out the right-tailored unit root, based on which order the statistics of ADF recursive testing are worked out. After that, the maximum values in the SADF order statistics are compared to determine whether a bubble exists.

$$P_t = \alpha + \rho P_{t-1} + \sum_{j=1}^{P} \varphi_j \Delta P_{t-j} + \varepsilon_t, \varepsilon_t \sim iid(0, \delta^2) \tag{3}$$

Equation 3 is an ADF model. The SADF model is used to test whether ρ in Equation 3 is greater than 1. When ρ<1, the generation of price lining involves a stationary process; when ρ=1, the generation involves a unit root process; and when ρ>1, the generation involves a bubble process. The alternative hypothesis of the ADF model is that $H_{1:}\,\rho$<1, and the alternative hypothesis of the SADF model is that H_1 >1 ($\rho=1+c/k_n, c>0, k_n\rightarrow\infty$). Therefore, the SADF model can detect bubbles with a sensitivity higher than ADF if they appear before or after the unit root.

$$\sup\left\{\frac{r_w\left[\int_0^{r_w} WdW - \frac{1}{2}r_w\right] - \int_0^{r_w} Wdr.W(r_w)}{r_w^{1/2}\left\{r_w \int_0^{r_w} W^2 dr - \left[\int_0^{r_w} W(r)dr\right]^\wedge 2\right\}^\wedge \frac{1}{2}}\right\} r_w \in [r_0, 1] \tag{4}$$

The null hypothesis H_0 demonstrates that the real process is a random-walk-without-drift process. See Equation 4 for the distribution of SADF statistics. W is a standard Wiener process. According to this theory, the following two testable hypotheses are obtained for the housing market bubble in China:

Hypotheses 1: China's housing market has an overall price bubble.

Hypotheses 2: Housing markets in different regions have multiple price bubbles.

4. Empirical Analysis

In this empirical analysis, cities with relatively complete housing price data and information disclosure are selected as the target. Upon the determination of the target and samples, the historical price bubble processes are put to the SADF model test using EViews. An estimation of the times of appearance and disappearance is also made. According to Philips (2011a,b), the window size in the interval is ordinarily equal to 10% of the observed value in the SADF test. In the paper, each set of data has 94 observed values. We set the time window size as 5% of the observed value in order to estimate the bubble process more precisely. The Monte Carlo simulation was performed 2,000 times to compute critical values.

4.1 Sample Data

China has been gathering housing price statistics of 35 big and medium-sized cities since 1997. In 2005, the quarterly housing price index numbers were changed to a monthly basis and expanded to include around 70 cities chosen by the National Bureau of Statistics (NBS) for specific statistics. All of the 35 new cities are fast-developing economies with the housing industry occupying a large portion of the economy. The original 35 cities were expanded to 70 cities for housing price statistics, with local housing-to-national housing ratio growing from 70% to 80% or higher. In order to adapt to the market of different cities, we divide the 70 cities by three tiers according to NBS classification standards. The Tier 1 cities comprise Beijing, Shanghai, Guangzhou, and Shenzhen. The Tier 2 cities comprise 31 sub-provincial cities, or the capital cities of provinces and autonomous regions. The Tier 3 cities comprise 35 cities other than the Tier 1 and Tier 2 cities.

Table 1 Descriptive statistics of Tier 1 cities' data

	Beijing	Shanghai	Guangzhou	Shenzhen
Mean	134.8625	137.2792	134.925	154.8464
Median	127.5	124.65	127.85	126.25
Maximum	183.196	204.849	191.11	274.5329
Minimum	102.2	100.9	102.7	102
Std. Dev.	27.85106	34.18071	27.78483	53.49719
Skewness	0.462256	0.605323	0.564793	0.784408
Kurtosis	1.775837	1.870184	1.950828	2.268099

Table 1 lists some descriptive statistical properties of Tier 1 cities. Therefore, we select 70 sets (comprising 6,580 records) of monthly data on the new housing price index numbers for 70 big and medium-sized cities from Jan. 2011 to Oct. 2018. All the data are fixed base index numbers compared to the base period of 2010. The fixed base index is effective in addressing the deviation of the nominal housing price from the real price due to price index changes. The influence of quantity structure changes on the monthly chain price index can be eliminated using the fixed base index so that monthly price changes are solely shown. Also, this will lead to a more effective analysis of the influence of short-term price changes, of the changing trends, and macroeconomic monitoring.

Except for Wenzhou, the new housing price index for the 70 big and medium-sized cities climbed on the whole during the sampling period. Hit by the 2008 financial crisis, Wenzhou's private credit market crashed, and the aftermath spread to the housing market, which took a decline from 2011 to 2014. While taking successive highs from 2015 to Oct. 2018, the index has never returned to the 2011 maximum.

4.2 SADF Test Results and Bubble Time Analysis

To conduct an in-depth analysis of the housing bubble in the 70 big and medium-sized cities, we use the SADF test to check the price index during the sampling period for the cities. We compare SADF statistics with critical values in order to estimate the actual times of appearance and disappearance of bubbles in the cities. The below tables outline the results.

Table 2 SADF test result for 70 cities' real estate market

City	>95% Test critical values			>99% Test critical values	
Tier 1 cities	Guangzhou Shenzhen			Beijing Shanghai	
Tier 2 cities	Chongqing Hangzhou Chengdu Jinan Shenyang Changchun Harbin	Nanning Yinchuan Nanchang Zhengzhou Changsha Kunming Lanzhou	Hohhot Urumqi Dalian Ningbo Qingdao Fuzhou Shijiazhuang	Tianjin Nanjing Wuhan Xi'an Xining	Taiyuan Hefei Haikou Guiyang Xiamen
Tier 3 cities	Tangshan Qinhuangdao Baotou Dandong Jinzhou Jilin Mudanjiang Yangzhou	Yantai Jining Luoyang Pingdingshan Yichang Xiangfan Yueyang Changde	Zhanjiang Guilin Beihai Luzhou Zunyi Jiujiang Ganzhou Anqing Quanzhou	Wuxi Xuzhou Sanya Nanchong Dali	

	Wenzhou Huizhou Bengbu Jinhua Shaoguan	

Table 3 SADF test and bubble period of 70 cities in China, Nov. 2011 through Oct. 2018

	Bubble1			Bubble2			Bubble3			Bubble4			Bubble5		
City	Start	End	Duration	Start	End	Duration	Start	End	Duration	Start	End	Duration	Start	End	Duration
Tier 1 cities															
Beijing	Mar-2012	Jun-2012	**3**	Dec-2012	Sep-2014	**21**	Jun-2015	Jan-2016	**7**	Mar-2016	Jan-2018	**22**	Jan-2018	continue	**9**
Shanghai	Feb-2013	Aug-2014	**18**	Jun-2015	Jan-2018	**31**									
Guangzhou	Dec-2012	Aug-2014	**20**	Mar-2016	Jan-2018	**22**	May-2018	continue	**5**						
Shenzhen	Jan-2013	Sep-2014	**20**	Mar-2015	Jan-2016	**10**	Mar-2016	Jan-2017	**10**	Oct-2017	Dec-2017	**2**			
Beijing	Mar-2012	Jun-2012	**3**	Dec-2012	Sep-2014	**21**	Jun-2015	Jan-2016	**7**	Mar-2016	Jan-2018	**22**	Jan-2018	continue	**9**
Tier 2 cities															
Chongqing	Jan-2013	Aug-2014	**19**	Dec-2016	continue	**22**									
Tianjin	Feb-2013	Aug-2014	**18**	Mar-2016	continue	**31**									
Hangzhou	Jan-2012	Oct-2012	**9**	May-2016	Jan-2018	**20**	May-2018	continue	**5**						
Nanjing	Dec-2011	Jun-2012	**6**	Feb-2013	Sep-2014	**19**	Aug-2015	continue	**38**						
Wuhan	Jan-2013	Jul-2014	**18**	Mar-2016	continue	**31**									
Chengdu	Apr-2012	Jun-2012	**2**	Jan-2013	Aug-2014	**19**	Aug-2016	Jan-2017	**5**	May-2018	continue	**5**			
Xi'an	Feb-2013	Aug-2014	**18**	Nov-2016	continue	**23**									
Jinan	Mar-2013	Jul-2014	**16**	Jun-2016	continue	**28**									
Shenyang	Feb-2013	Jul-2014	**17**	Jun-2017	continue	**16**									
Changchun	Mar-2013	Aug-2014	**17**	Jun-2017	continue	**16**									
Harbin	Feb-2013	Sep-2014	**19**	Jun-2017	continue	**16**									
Shijiazhuang	Feb-2013	Aug-2014	**18**	Jun-2016	continue	**28**									
Fuzhou	Feb-2013	Aug-2014	**18**	Apr-2016	Mar-2018	**23**	Jun-2018	continue	**4**						
Kunming	Dec-2012	Jul-2014	**19**	Oct-2017	continue	**12**									
Lanzhou	Feb-2013	Aug-2014	**18**	Aug-2017	continue	**14**									
Yinchuan	Jan-2013	Aug-2014	**19**	Aug-2018	continue	**2**									
Taiyuan	Jan-2013	Aug-2014	**19**	May-2017	continue	**17**									
Hefei	Jan-2013	Sep-2014	**20**	Jan-2016	continue	**33**									
Nanchang	Feb-2013	Aug-2014	**18**	May-2016	continue	**29**									
Zhengzhou	Feb-2013	Sep-2014	**19**	Apr-2016	continue	**30**									
Changsha	Feb-2013	Jul-2014	**17**	Sep-2016	continue	**25**									
Haikou	Sep-2011	Aug-2012	**11**	Nov-2013	May-2014	**6**	Oct-2014	Jan-2016	**15**	Jan-2017	Dec-2017	**11**	Feb-2018	continue	**8**
Guiyang	Mar-2013	Jul-2014	**16**	Mar-2017	continue	**19**									
Xining	Jan-201	Sep-201	**20**	Aug-20	continue	**2**									

	3	4		18											
Hohhot	May-2013	Aug-2014	**15**	Mar-2018	continue	**7**									
Urumqi	Jan-2013	Jul-2014	**18**	Jun-2018	continue	**4**									
Dalian	Feb-2013	Jul-2014	**17**	Dec-2017	continue	**10**									
Ningbo	Dec-2011	Jan-2013	**13**	Jul-2016	continue	**27**									
Xiamen	Feb-2013	Jan-2015	**23**	Sep-2015	continue	**37**									
Qingdao	Mar-2012	Dec-2012	**9**	Jun-2013	Jul-2014	**13**	Sep-2016	continue	**25**						
							Tier 3 cities								
Tangshan	Nov-2013	May-2014	**6**	Jan-2015	Sep-2016	**20**	Dec-2017	continue	**10**						
Qinhuangdao	Feb-2013	Jul-2014	**17**	May-2017	Sep-2017	**4**	Nov-2017	continue	**11**						
Baotou	Jan-2013	Jul-2014	**18**	Jun-2018	continue	**4**									
Dandong	Mar-2013	Aug-2014	**17**	May-2016	Jan-2017	**8**	Jun-2018	continue	**4**						
Jinzhou	Apr-2013	Aug-2014	**16**	Aug-2016	Jan-2017	**5**									
Jilin	Feb-2013	Aug-2014	**18**	Sep-2017	continue	**13**									
Mudanjiang	Mar-2013	Aug-2014	**17**	Jan-2018	continue	**9**									
Wuxi	Mar-2013	May-2014	**14**	May-2016	continue	**29**									
Yangzhou	Apr-2013	Jul-2014	**15**	Oct-2016	continue	**24**									
Xuzhou	Mar-2013	Jul-2014	**16**	Sep-2016	continue	**25**									
Jinhua	Mar-2012	Nov-2012	**8**	Nov-2016	Jan-2017	**2**	Apr-2017	continue	**18**						
Bengbu	May-2013	Jun-2014	**13**	Mar-2015	Jan-2016	**10**	Apr-2017	Apr-2018	**12**	Jun-2018	continue	**4**			
Anqing	Jan-2012	Jun-2012	**5**	Apr-2013	Jul-2014	**15**	Dec-2016	continue	**22**						
Quanzhou	Apr-2013	Jul-2014	**15**	Dec-2016	Jul-2017	**7**									
Jiujiang	Apr-2013	Jun-2014	**14**	Oct-2016	continue	**24**									
Ganzhou	Mar-2013	Aug-2014	**17**	Aug-2016	continue	**26**									
Yantai	Apr-2013	Aug-2014	**16**	Apr-2017	continue	**18**									
Jining	Feb-2013	Aug-2014	**18**	Dec-2017	continue	**10**									
Luoyang	Apr-2013	Jul-2014	**15**	May-2017	continue	**17**									
Pingdingshan	Mar-2013	Aug-2014	**17**	May-2017	continue	**17**									
Yichang	Mar-2013	Jul-2014	**16**	Mar-2017	continue	**19**									
Xiangfan	Mar-2013	Jun-2014	**15**	Jul-2018	continue	**3**									
Yueyang	May-2013	Sep-2014	**16**	Apr-2017	continue	**18**									
Changde	Mar-2013	Jul-2014	**16**	Jul-2017	continue	**15**									
Huizhou	Apr-2013	Jul-2014	**15**	May-2016	continue	**29**									
Shaoguan	Mar-2013	Mar-2014	**12**	Aug-2015	Nov-2015	**3**	Mar-2017	continue	**19**						
Zhanjiang	Jan-201	Aug-20	**19**	Dec-201	continue	**10**									

	3	14		7											
Guilin	May-2013	Jul-2014	**14**	Dec-2017	continue	**10**									
Beihai	Apr-2013	Aug-2014	**16**	Apr-2017	continue	**18**									
Sanya	Mar-2013	Jul-2014	**16**	Jan-2017	Jun-2017	**5**	Oct-2017	continue	**12**						
Luzhou	Jun-2011	Aug-2011	**2**	Jan-2013	Jul-2014	**18**	Jan-2018	Mar-2018	2	May-2018	continue	5			
Nanchong	Dec-2012	Aug-2014	**20**	Jan-2018	continue	**9**									
Zunyi	Feb-2013	Jul-2014	**17**	Jan-2018	continue	**9**									
Dali	Apr-2013	Aug-2014	**16**	Dec-2017	continue	**10**									

Table 4 SADF test results and bubble time estimates for the new housing price index in Tier 1 cities

	SADF	Bubble1		Bubble2		Bubble3		Bubble4		Bubble5	
City	t-Statistic	Start	End	Start	End	Start	End	Start	End	Start	End
Beijing	7.532607***	Mar-2012	Jun-2012	Dec-2012	Sep-2014	Jun-2015	Jan-2016	Mar-2016	Jan-2018	Jan-2018	continue
Shanghai	7.433099***	Feb-2013	Aug-2014	Jun-2015	Jan-2018						
Guangzhou	6.25438**	Dec-2012	Aug-2014	Mar-2016	Jan-2018	May-2018	continue				
Shenzhen	5.713982**	Jan-2013	Sep-2014	Mar-2015	Jan-2016	Mar-2016	Jan-2017	Oct-2017	Dec-2017		

Note: Triple asterisks (***) denote significance at 1% critical level, double asterisks (**) at 5% level, and single asterisks (*) at 10% level, respectively.

(1) Multiple price bubble processes existed in the 70 big and medium-sized cities

Based on the empirical results, Hypothesis 1 and Hypothesis 2 are supported. The two Tier 1 cities (e.g., Beijing and Shanghai), the ten Tier 2 cities (e.g., Tianjin and Hefei) and the five Tier 3 cities (e.g., Wuxi and Xuzhou) have SADF statistics greater than the 99% critical value. The remaining 53 cities (e.g., Guangzhou and Chongqing) have SADF statistics greater than the 95% critical value. Overall, the new housing markets in the 70 cities had price bubbles to a varying extent in the sampling interval.

(2) Price bubbles existed for significantly different lengths

The top 10 cities with the longest accumulated time of the bubble process are Tier 1 and Tier 2 cities. Nanjing experienced the most protracted bubble processes, adding up to 63 months in the aggregate. Beijing came second, with 62 months in the aggregate. Twenty-six cities experienced bubbles longer than 40 months, accounting for 37.1% of all the cities. The vast majority of the cities in the study are still in an ongoing round of bubbles. That is, as of Oct. 2018, 65 cities, or 92.9%, are still in the ongoing round of price bubbles.

(3) Tier 1 cities had frequent bubbles

Multiple bubble processes existed in all four Tier 1 cities. As shown by the SADF test, Beijing totaled five bubbles from Mar. 2012 to Oct. 2018, ranking among the highest out of the 70 cities. Test results of the bubbling times of Beijing, Shenzhen, Shanghai, and Guangzhou make it clear that the bubbles are ongoing in Beijing and Guangzhou during the sampling period. In the meantime, Shenzhen and Shanghai saw their last bubbles come to an end on Dec. 2017 and Jan. 2018, respectively.

(4) Regional and structural differences among the bubble processes

Among the samples, the cities experienced as many as five bubble processes. According to the SADF model, Hangzhou, Nanjing, Hefei, Jinan, and Fuzhou began their fourth bubbles from the 2nd half of 2015 to the end of 2016, corresponding with the then “hot list of cities with soaring housing prices.” Also, the last housing bubbles of the provincial capital cities lasted longer than before. Moreover, housing bubbles have an inter-provincial spillover effect. Tier 1 cities’ housing bubbles can infect Tier 2 and Tier 3 cities. At the same time, Tier 2 cities’ housing bubble can be contagious for Tier 3 cities.

In the first bubble process, those cities that experienced previous bubbles returned to normal more quickly with a shorter bubble duration. As shown below, Nanjing and Wenzhou, where bubbles appeared as early as 2011, are among the earlier cities to experience bubbles, yet neither lasted for more than half a year. In contrast, Xiamen, which saw its first bubble in Dec. 2013, was one of the latest cities, yet the bubble lasted as long as 23 months, the longest among the first bubble processes.

5. Bubble Control Proposals

From Oct. 2016 on, the local governments issued various regulations to control steep rises in the housing market. Seen from the empirical analysis, most Tier 2 and Tier 3 cities are experiencing ongoing bubbles, the bubbles are periodic, and the cities are expected to experience more bubbles. Frequent bubbles lasting for an increasing time will adversely impact consumption and the real economy. Regulators at all levels should make regulatory policies by referring to the historical dynamics of buyer demand and housing price and by mastering the beginning and end of bubbles. As shown by the above analysis, bubble control policies should be founded on a long-term mechanism which supports the housing market; also, a differential policy applicable to different cities should be implemented to stress dynamic monitoring and early warning of bubbles.

5.1 A long-term mechanism suitable for the development of the housing market

Long-term development, supported by systematic policies and mechanisms, can minimize the negative impacts of a price bubble because it is built on bubble monitoring and eradication. For one thing, there should be a differential financial policies, especially a long-term mechanism for a growing housing market, for the good of the various areas; for another, credit should be extended to rational self-use customers. The credit structure should be optimized so that speculative buying and home flipping are put under strict control. Homes are for self-use, not for speculation. We should prevent the bubble risk from extending into the financial sector and other sectors.

5.2 Improvements in dynamic monitoring and bubble early warning

As shown by the SADF model test of the housing bubbles, rational and scientific measures enable us to get the bubbles under control and preclude a market crash. For the government, it is essential to collect, disclose and monitor price information, especially information related closely to the interest of the public. Housing price dynamics are closely linked with land supply, land price, and construction material price. Therefore, housing price information should be subject to monitoring under a housing bubble early warning system which analyzes historical bubble periodic analyses and forthcoming bubbles. This will do good for the Chinese housing market.

5.3 A differential regulatory policy for different cities

As shown by the empirical analysis, the 70 big and medium-sized Chinese cities vary significantly in housing bubble severity. Considering that the one-time universal buying limit fails to impact significantly on the housing market in strategic cities, buyers' rational self-use needs are suppressed. Therefore, we conclude that the one-time universal regulatory policy applies no longer to a remarkably differential market and should be diversified to suit the various local markets by taking into account the monitoring dynamics in the various cities.

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