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LONG MEMORY IN THE HOUSING PRICE INDICES IN CHINA

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ABSTRACT

This study examines the time series behaviour of housing prices series for 69 cities in China. The general housing price index, the index of newly constructed buildings and the price index of second hand buildings from 2005:7 to 2010:12 are examined. The univariate fractionally integrated models are employed in order to determine whether shocks to the variables have transitory or permanent effects. Persistence is accepted for the general housing price index and for the newly constructed buildings. In particular Shanghai, Haikou and Sanya have persistent effects signifying that shocks will be permanent and the series will be very persistent. Mean reversion is accepted in most of the second hand building price indices. Based on the suspicion that there are bubbles in some of the series corresponding to the housing market of China, this paper enables us to understand what the possible consequences are for housing market management in the case of an eventual bubble in the China housing market.

Keywords: China, Housing prices, Fractional integration

INTRODUCTION

This paper aims to analyze the degree of persistence of house prices in China. The analysis of the degree of persistence is essential since it reflects the stability of the macroeconomic variables of the country in question (Holmes and Grimes, 2008). Furthermore, this kind of information is important for policymakers in the event of an exogenous shock, when different policy measures have to be adopted depending on the degree of persistence (Himmelberg, Mayer and Sinai, 2005). The motivation for the present research is the following: First,persistence is a measure of the extent to which short term shocks in current market conditions lead to permanent future changes (MacDonald and Taylor, 1993; Malpezzi, 1999). By a shock we mean an event which takes place at

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a particular point in the series, and which is not confined to the point at which it occurs. A shock is considered to have a temporary or short term effect if, after a number of periods, the series returns to its original performance level. On the other hand, a shock is considered to have a persistent or long term impact if its short run impact is carried over forward to set a new trend in performance.

Alexander and Barrow (1994), Cook and Vougas (2009) and Gupta and Miller (2012), among many others, have provided good summaries on the importance of persistence analysis, especially in terms of its direct impact on policy implications in housing. In fact, when real estate agents have prior knowledge of the persistence behavior of house prices they can reap the benefit of positive effects, or avoid the drawbacks of a negative effect. Depending on the degree of persistence, different policy measures can also be adopted, and this degree of dependence is determined by the nature of the model underlying the data. For instance, in the case of a unit root, shocks will be permanent and the series will be very persistent. On the other hand, if the series is stationary, shocks will be temporary and the series will be mean reverting and less persistent than in the previous case. In a context where a shock is positive and the series is mean reverting, strong policy measures must be adopted to maintain the series at the higher level. In the same way, if a shock is negative and the series contains, for instance, a unit root, the effect of that shock will be permanent, and again strong measures should be adopted to bring the series back to its original trend. On the other hand, if the series is mean reverting and the shock is negative, there is no need for strong policy measures since the series will return to its original trend sometime in the future. Therefore it is important to analyze house price persistence (see, e.g. Himmelberg *et al.,* 2005). Second, house intermediaries rely on price series to manage their activity, therefore investigating the statistical characteristics of prices is of paramount importance for their management (Garcia and Raya, 2011). Finally, the presence of speculative bubbles will also be investigated within this framework.

CONTEXTUAL SETTING

After three decades of reforms, the residence space per capita in China has increased from 6.7 square meters to 31.6 in the urban areas, and from 8.1 square meters to 34.1 in the rural ones. Certainly, the level of social welfare has improved with regard to dwellings. However, the road to a market economy has always been haunted by government interventions in prices, including the housing sector. Meanwhile, it is characterized by the dualistic structure of land property rights in China, i.e. the full urban state-owned land property rights and the limited rural collective land property rights, where only the former is allowed to be auctioned in the market for the rights of use[4] (Xun *et al.*, 2010).

[4] According to current property rights regulations, the use right is specified to 40 or 70 years with an up-front payment.

The prosperity of the real estate market follows the rapid development and the urbanization in China. Before the "Open and Reform" policy launched in 1978, there was a centrally planned economy in China and housing was provided by the government as welfare within the socialist system in urban areas (Wang and Murie, 1996), which in essence was considered as "unified management and distribution, maintained with rent collections". There was no market for dwellings anywhere in the country. Population movement was limited by the household register (also called "Hukou"), which significantly reduced housing demand in urban areas. However, without the one-child policy that was implemented in the 1980s, the surge of population quickly changed this situation and caused a severe housing shortage, especially when the supply of residences was limited by insufficient funds (Wang and Murie, 1996).

During the period from 1978 to 1992, the government began a series of pilot reform experiments[5] in appointed cities, including selling off public houses at a subsidized price, the commercialization of housing and rent reforms for public housing. Thus the real estate market recovered gradually, a recovery, which was synonymous with the privatization of the housing system (Chen *et al.*, 2011). Later these reforms were expanded from "point to surface" (Heilmann, 2008). In 1994, the State Council promulgated a document to urge the shift from the welfare provision to market supply with complementary measures, which consisted of developing the system of Housing Accumulated Funds (HAF)[6] and real estate finance. The welfare housing provision system was not annulled until 1998, which was nearly 40 years after it was first set up (Wang, 2001). This coincided with the Asian financial crisis, Chinese exports were in decline, and the government intended to stimulate the economy with this reform. Thereafter, the real estate market entered into another era of development, in which rising prices, growth and harsh government intervention lingered on. Even without taking the excessive speculation into consideration, these can be partly explained by the drasticurbanization[7] in these years and the migrant workers swarming into the big cities from countryside (Chen *et al.*, 2011) for more work opportunities, without suffering from the regulations of the "Hukou System" anymore.

In recent years, despite the severe global financial crisis there have been significant increases in housing prices across China (see Graph 1), especially in the big cities like Beijing, Shanghai and

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[5]Gradualism features strongly in the reform in China, which was very different from that experienced in Russia and East European Countries and described as "crossing the river by groping the stones".

[6] It is a compulsory saving accumulated through contribution from the employee and employer and managed by the Accumulation Fund Management Center, which authorizes commercial banks to lend the fund to working and retired contributors who wish to purchase, build, rebuild, or repair their residence at low interest rate.

[7] The urban population accounted for 10.64% of the total population of China in 1949; 17.92% in 1978; and 47% in 2011.

Guangzhou. The suspicion about the existence of bubbles in the housing market of China has never died away. It has even triggered arguments and condemnation of the social problems brought out by the soaring prices of real estate. Meanwhile, the measures taken by the government never managed to tame it and, until 2011, there was no evidence to suggest that they had begun to be effective at all in managing to push prices back (see Graph 2). Some researchers, however, concluded that it was just a temporary response to the quantity limits on housing sales and mortgage loans[8], and the local governments continual propping up of the market, in order to raise funds from sales of land and expand their financial budget[9].

Fifteen years have passed since the real estate sector turned to privatization. However, it is hard to reach the conclusion that the market is effective and far from chaos. Furthermore, it covers such a vast area and one which is quite unevenly developed in China[10] (Huang, 2004). The institutions in the real estate sector are very different compared with other countries and sometimes seem flawed. Housing prices across the different provinces started to diverge in 2005 (see Graph 1), which makes this research necessary and significantly important, in order to discover price movements and their features across the country during the last decade.

LITERATURE REVIEW

Research on house prices include Englung *et al.* (1998) who analyzed the course of Swedish house prices considering the aggregation of housing sales reported in continuous time to discrete periods for the computation of indexes of house prices, investment returns, and the volatility of returns. They also investigated the properties of repeat sales estimators and hybrid estimators of the price indexes. More in line with the present research, MacDonald and Taylor (1993) and Alexander and Barrow (1994) investigated cointegrating relationships between UK regional house prices, testing whether or not UK regional house prices were tied together in the long-run. The existence of a long-run equilibrium relationship between UK regional house prices has also been examined by authors such as Giussani and Hadjimatheou (1991, 2006); Drake (1995); Meen (1996); Ashworth and Parker (1997); Cook (2003, 2005); Cook and Thomas (2003) and Holmes and Grimes (2005) among many others. Adopting the threshold autoregressive methods of Enders and Siklos (2001), Cook (2005) investigated the UK regional house price linkages from an asymmetric adjustment process. His findings show that allowing asymmetric reversion (adjustment) significantly increases

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[8] In January 26, 2011, the State Council of China issued a regulation that required the local government to set restrictions on purchasing extra houses.

[9] The revenue from land is the primary consideration of local government. It was even called the “second public finance” (Zhu, 2012).

[10] The cites in China have been divided into four tiers, according to their development. The first tier includes Beijing, Shanghai, Guangzhou and Shenzhen, all located in the coastal or eastern area of China.

the number of long-run relationships and dramatically changes the overall results of long-run relationships in UK regional house prices. On the other hand, Holmes and Grimes (2008) employed a new test that combines principal components with unit root testing to examine long-run relationships in the UK regional house prices. They found that the series are driven by a single common stochastic trend, which is regarded as strong convergence in the long-run.

Dealing with US data, Zohrabyan *et al.* (2008) employed cointegration techniques to investigate the dynamic relationships between the house prices of US regions. These authors concluded that the real estate market in the US seems to be led by regions that are influential in financial and economic aspects. In another recent paper, Gupta *et al.* (2011) employed a 10-variable dynamic structural general equilibrium model to forecast the US real house price index. They use various Bayesian and classical time series models concluding that the Bayesian methods outperform the other models. Fratantoni and Schuh, (2003) studied the effects of monetary policy on regions in the US for the time period 1966-98. They found that the response of housing investment to monetary policy varies by region. Other papers dealing with US housing prices are Blanchflower and Oswald (2004), Luttmer (2005), Del Negro and Otrok (2007), Disney, Gathergood (2009) and Holly *et al.* (2010), and house prices and rents in Spain are examined in Ayuso and Restoy (2007). Other papers on housing dynamics are Ayala and Navarro (2007) and Igan *et al.* (2011), the latter examining housing price cycles and its relation with real activity over the long term. The existence of bubbles in housing prices has been examined in DiPasquale and Wheaton (1994), Bourassa *et al.* (2001), Black *et al.* (2006), Coleman *et al.* (2008) and Caliman (2009).

As for the housing market of China, there is not much literature covered on this topic until recent years, the majority of them intending to explain the soaring price of the real estate in China. Wang (2011) points out that the housing reform that had removed the misallocation in China has increased house consumption as well as prices. Deng *et al.* (2011) argued that the stimulus of government has fueled the real estate bubble in recent years. Zhang (2008), Zhang *et al.* (2013) and Du *et al.* (2011) suggested that the policy of restricting land uses help to increase the price of residences. Meanwhile, Chen *et al.* (2011) regard the demographic influences as the more significant factors contributing to higher housing prices. Liu and Shen (2005), Liang and Cao (2007), Zhang *et al.* (2012) and Zhang (2013) recognized several key monetary and price variables that determine housing price dynamics. Some literature also stretches other topics, such as housing affordability (Mak *et al.* 2007; Wu *et al.* 2012); housing bubbles (Ren *et al.* 2012; Hou, 2010); hedonic house prices (Barros *et al.* 2013; Liao and Wang, 2012) etc.From the review of the above literature, it is clear to us that the issues of fractional integration and long memory in housing have not been investigated much. Therefore, this paper innovates in this context. In line with this, while previous papers used integer degrees of differentiation, this paper adopts methods based on fractional integration, permitting a more accurate evaluation of the series, and a more complete analysis of the effects of a shock in the series.

THEORETICAL FRAMEWORK AND HYPOTHESIS

There are multiple forces that may affect housing prices, some of them due to supply, others to demand, and ultimately due to the interaction of demand and supply, which are supported by microeconomic theory, Varian (1983). On the demand side we have, first, income since rising income enables people to spend more on buying a house. Second, long term interest rates also play a role since interest rates affect the cost of paying for a mortgage. Interest rates are very important as mortgage repayments are usually the biggest part of a home owner's monthly spending. Third, lending policies and with bank deregulation and the consequent increased competition resulting in an increase in the number of mortgage products. Products such as interest rate, self certification mortgages and mortgages up to six times of income have enabled more people to get mortgages, thereby increasing demand for housing. Fourth, consumer confidence, as during times of high consumer confidence, people are more willing to take out risky mortgages to buy a house. Fifth, population shifts such as the number of households. The number of households can rise faster than the population if the average family size declines and there are more single people living alone. Sixth, prices of rented houses because of the substitution effect between buying a house or renting it. Seventh, speculation in the house market, since an increasing number of property investors buy houses to try and make both capital gains and income from renting. This buy to let investor is typically more volatile, they will buy when house prices are rising and sell when the market appears to turn. Thus, speculators will buy in a boom and sell in a bust. The number of buy to let investors has risen in the past decade. Eight, inherited wealth to buy houses which might explain why there have been rising ratios of house price to income. It is also becoming more common for parents to lend children a deposit to help them get their first house. Finally, unemployment, since low unemployment environments are often associated with rising demand for houses.

On the supply side, the housing supply is fixed in the short term because it takes time to build houses. Therefore in the short run, demand affects prices more than supply. However if the supply of housing is inelastic then an increase in demand will lead to a high increase in prices. Based on this theoretical framework the following two hypotheses are defined:

Hypothesis 1**:** Housing prices in China are persistent. Persistence is a measure of the extent to which short term shocks in current market conditions lead to permanent future changes. By a shock we mean an event which takes place at a particular point in the series, and which is not confined to the point at which it occurs. A shock is known to have a temporary or short term effect, if after a number of periods the series returns to its original performance level (for example, housing prices in China might increase due to a marketing initiative, but drop back after the stimulus is withdrawn). On the other hand, a shock is known to have a persistent or long term impact if its short run impact is carried over forward to set a new trend in performance. For example, a persistent drop in housing prices might result from an economic downturn or inflation, (see, e. g.

Taylor and Sarno, 2002; Candelon and Palm, 2010; Dufrenot *et al.* 2008). In the case of a unit root, shocks will be permanent and the series will then be very persistent.

Hypothesis 2: Housing prices in China present mean reverting behaviour, suggesting that shocks inthe series are transitory, disappearing relatively fast, Barros *et al.* (2012).

These hypotheses are tested below using fractional integration methods. These two hypotheses are not mutually exclusive noting that, if, for example, a process is I(d) with d sufficiently large but still below 1, the process will be highly persistent though still mean reverting with shock disappearing in the very long run.

STATISTICAL METHODS

One characteristic of many economic and financial time series is the nonstationary nature. There exists a variety of models to describe such nonstationarity. Until the 1980s a standard approach was to impose a deterministic (linear or quadratic) function of time, thus assuming that the residuals from the regression model were stationary. Later on, and especially after the seminal work of Nelson and Plosser (1982), there was a general agreement that the nonstationary component of most series was stochastic, and unit roots (or first differences) were commonly adopted. However, the unit root or I(1) approach is merely one particular model to describe such behavior. In fact, the number of differences required to get stationarityI (0)[8] may not necessarily be an integer value but could be any point in the real line. In such a case, the process is said to be fractionally integrated or I(d). The I(d) models with d > 0 belong to a wider class of processes called long memory, which are characterized because the spectral density function is unbounded at some frequency in the interval [$0, \pi$). Most of the empirical literature has concentrated on the case where the singularity or pole in the spectrum takes place at the 0-frequency. This is the case of the standard I(d) models of the form:

$$(1 - L)^d x_t = u_t, \qquad t = 0, \pm 1, ..., \tag{1}$$

Where L is the lag-operator ($Lx_t = x_{t-1}$) and u_t is I(0). Note that, for any real value d, the polynomial in the left hand side of equation (1) can be expressed in terms of its Binomial expansion such that:

[8]An I (0) process is defined as a covariance stationary process with spectral density function that is positive and finite at all frequencies.

$$(1 - L)^d = \sum_{j=0}^{\infty} \binom{d}{j} (-1)^j L^j = 1 - d L + \frac{d(d-1)}{2} L^2 - .., \qquad (2)$$

This implies that the higher the value of d is, the higher the degree of association is between observations distant in time. Thus, the parameter *d* plays a crucial role in determining the degree of persistence of the series. If $d = 0$ in (1), clearly $x_t = u_t$, the process is short memory, it is covariance stationary, and it may be weakly (ARMA) autocorrelated, with the values in the autocorrelation function decaying exponentially fast. If *d* belongs to the interval (0, 0.5), x_t is still covariance stationary though the autocorrelations will take longer to disappear than in the previous case of I(0) behaviour; if d belongs to [0.5, 1) the process is no longer covariance stationary though is still mean reverting in the sense that shocks will tend to disappear in the long run. Finally, if $d \geq 1$, x_t is nonstationary and not mean reverting. Processes of the form given by (1) with positive non-integer d are called fractionally integrated, and when u_t is ARMA(p, q) x_t is known as a fractionally ARIMA (or ARFIMA) model. This type of model provides a higher degree of flexibility in modelling low frequency dynamics which is not achieved by non-fractional ARIMA models.

In this study, we estimate the fractional differencing parameter d using the Whittle function in the frequency domain (Dahlhaus, 1989). We also employ a testing procedure developed by Robinson, (1994) that permits us to test the null hypothesis H_o: $d = d_o$ in equation (1) for any real value d_o, where x_t can be the errors in a regression model of form:

$$y_t = \beta^T z_t + x_t, \qquad t = 1, 2, ..., \qquad (3)$$

where y_t is the time series we observe, β is a (kx1) vector of unknown coefficients and z_t is a set of deterministic terms that might include an intercept (i.e. $z_t = 1$), an intercept with a linear time trend ($z_t = (1, t)^T$), or any other type of deterministic processes[9].

THE DATA

City house prices indexes in China aim to provide the sector with statistics they need for monitoring the house market. We have removed only one city Yangzhou due to some lack of available data for this city. China house prices are gathered by the National Development and

[9] See Gil-Alana and Robinson (1997) and Gil-Alana and Henry (2003) for applications involving Robinson's (1994) tests.

Reform Commission (NDRC); National Bureau of Statistics of China (NBS)[10]. Three monthly indexes are analyzed in the paper: a general housing price index, the index of newly constructed buildings and the price index of second hand buildings. All these indexes are presented aggregated, and also disaggregated by cities. It is important to distinguish between these cases in order to determine if the effect of the shocks is different in the newly constructed buildings and in the second hand buildings. This will allow us to implement different policies depending on the type of building.

Table-1 displays the growth rates of each series for the sample period 2005m7 – 2010m12. We observe that some values are positive while others are negative. Starting with the general index we see that the highest increase takes place in Dali (4.37%) followed by Shanghai (3.18%) and Yueyang (3.04%), while the highest decreases occur in Sanya (-2.34%) and Changchun (-2.52%). The same cities in China present the highest increases and decreases at the first and second hand markets. Overall, the highest increase in prices corresponds to Dali in the newly constructed buildings (6.61%) and the highest decrease at Zunyi in the second hand buildings (-7.07%).Despite the rapid urbanization and massive rural-urban migration have played a vitally important role in affecting housing price dynamics in China (Chen *et al.* 2011), the situation substantially varies from one city to another. Cities located in eastern part of China, which went through the "open-door" policy and reform much earlier[11], are more developed than the ones in middle and western part and attracts more migration and investment. Thus, it finally brings out the different demand and supply conditions as well as the price dynamics of housing across China.

Table 1: Growth rates for the sample period

Cities	Gen.	First	Second	Cities	Gen.	First	Second
1. Beijing	-1.57	-1.47	-4.56	36. Tangshan	0.90	0.20	4.16
2. Tianjin	0.19	-0.09	-0.29	37 Qinhuangdao	0.60	0.29	0.20
3. Shijiazhuang	0.39	0.69	-0.09	38. Baotou	-0.29	-0.59	-0.20
4. Taiyuan	-1.47	-2.24	-1.37	39. Dandong	1.30	2.94	-1.28
5. Huhhot	-1.18	-1.17	-2.14	40. Jinzhou	-0.09	-1.66	1.41
6. Shenyang	-1.37	-0.98	-0.79	41. Jilin	0.69	1.09	-0.19
7. Dalian	-0.89	-0.79	-1.86	42. Mudanjiang	1.00	1.70	1.00
8. Changchun	-2.52	-2.34	-1.85	43. Wuxi	-0.69	0.50	-2.15
9. Harbin	0.20	0.10	0.30	44. Xuzhou	-1.86	0.00	-2.34

[10] The statistics have been published monthly since July 2005 by NDRC. Before, they were reported quarterly. Since 2009, they were published by NBS and later, in January 2011 the method for the indicator was adjusted by NBS, the indicator being no longer being directly comparable.

[11]Since 1980, the central government of China has successively approved the establishment of Special Economic Zones (SEZ) in Shenzhen, Zhuhai, Shantou, Xiamen, Hainan, Shanghai, Tianjin and etc., which function as the reform experiment zones and entitled broad discretion powers (Heilmann, 2008).

10. Shanghai	3.18	2.97	4.03	45. Wenzhou	0.80	0.60	1.10
11. Nanjing	0.00	-0.09	0.20	46. Jinhua	-1.08	-0.09	-5.21
12. Hangzhou	0.20	-0.10	1.00	47. Bengbu	0.19	0.40	-0.59
13. Ningbo	-0.79	-1.28	0.59	48. Anqing	0.89	0.99	1.09
14. Hefei	0.69	0.59	1.31	49. Quanzhou	0.30	0.20	0.40
15. Fuzhou	-1.18	-1.38	-0.79	50. Jiujiang	-1.27	-0.78	-3.00
16. Xiamen	-0.39	-0.10	-1.66	51. Ganzhou	-0.09	-0.19	-0.30
17. Nanchang	0.60	0.50	-0.09	52. Yantai	-0.69	-0.39	-0.59
18. Jinan	0.50	0.50	0.80	53. Jining	1.61	0.80	1.19
19. Qingdao	-1.08	-0.49	-1.75	54. Luoyang	0.00	0.20	0.50
20. Zhengzhou	-0.79	-0.79	1.72	55 Pingdingshan	0.90	1.30	0.00
21. Wuhan	-0.39	-0.29	-1.47	56. Yichang	-1.08	0.80	-3.93
22. Changsha	1.10	2.33	-0.78	57. Xiangfan	0.29	0.40	1.20
23. Guangzhou	0.09	1.58	-0.59	58. Yueyang	3.04	5.26	-2.30
24. Shenzhen	0.69	0.39	1.60	59. Changde	0.19	0.09	0.30
25. Nanning	-0.49	-1.28	0.09	60. Huizdou	0.00	0.30	-0.30
26. Haikou	-0.79	-2.72	2.44	61. Zhanjiang	1.00	1.31	-0.30
27. Chengdu	0.09	0.40	-0.89	62. Shaoguan	-0.09	0.30	-1.08
28. Guiyang	-0.49	0.29	-4.29	63. Guilin	1.60	2.83	0.50
29. Kunming	1.61	1.92	2.75	64. Beihai	1.11	2.14	-0.59
30. Chongqing	-0.19	0.19	-1.67	65. Sanya	-2.34	-2.90	-1.47
31. Xian	-1.67	-1.67	0.09	66. Luzhou	0.30	-0.69	-0.69
32. Lanzhou	0.19	-0.39	1.50	67. Nanchong	1.20	0.90	-0.49
33. Xining	-0.78	-1.47	0.60	68. Zunyi	0.89	-1.65	-7.07
34. Yinchuan	-0.29	0.00	-0.89	69. Dali	4.37	6.61	0.50
35. Urumqi	-1.18	-2.24	0.40	**GENERAL**	**-0.09**	**-0.30**	**0.89**

EMPIRICAL RESULTS

Tables 2 – 4, we present the Whittle estimates of d (and their corresponding 95% confidence intervals of the non-rejection values of d using Robinson's (1994) method) in the following model:

$$y_t \;=\; \beta_0 + \beta_1 t + x_t, \quad (1-L)^{d_o} x_t \;=\; u_t, \quad u_t \;=\; \rho u_{t-12} \;+\; \varepsilon_t \qquad (4)$$

The equation-4 is incorporating potential deterministic trends, fractional integration and seasonal autoregressions for the monthly seasonal effects.Table-2 refers to the general housing price index, while Table-3 and 4 present the estimates of d for the newly constructed and second hand buildings respectively. Remember that the estimates of d will indicate the degree of dependence in the time series, and the higher the value of d is, the higher the persistence is. Moreover, if d is statistically equal to or higher than 1, it means that bubbles may be present in the data, with shocks having permanent effects and thus requiring strong measures to induce the series to recover from the exogenous shocks. On the other hand, estimates of d statistically below 1 mean that the series are mean reverting, with transitory effects of the shocks and disappearing by themselves in the long run.

Starting with the general house price index, in Table 2, we observe that the estimated value of d for the overall series is 0.948 and the unit root null cannot be rejected suggesting the existence of bubbles in the index. However, a deeper detailed analysis for each of the cities indicates that this phenomenon is clearly caused by three main cities: Shanghai, Shenzhen and Sanya, where the unit root null hypothesis cannot be rejected. In all the other individual series, the values are significatively smaller than 1, implying mean reversion. There are six cities (Taiyuan, Xian, Lanzhou, Baotou, Luoyang and Xiangfan) where the hypothesis of I(0) behaviour cannot be rejected. For the remaining cities the estimated values of d are constrained between 0 and 1 implying long memory (d > 0) and mean reversion behavior (d < 1). As a conclusion, the general housing price index in China is very persistent with shocks having permanent effects, and this is due to the contribution of the cities of Shanghai, Shenzhen and Sanya, which are among the cities of highest housing price in China. Furthermore, the distinctive properties of these cities actually determine the rigidity of the housing price. Shanghai is the largest cities as well as the financial and technological center in China, and its GDP has amounted to 2.01 trillion Yuan in 2012.The dramatic development in recent decades has triggered the rapid urbanization, and attracted a large amount of immigration and investment from the world, which finally leads to the flourish housing demand. The situation in Shenzhen is much similar. It is the fourth biggest city in China and the GDP has reached 1.15 trillion Yuan in 2012. Meanwhile, it is one of the four cities that approved to be the SEZ in 1980 to develop the market economy, and thus tempted lots of entrepreneurs pouring in and became the biggest immigration city in China.

Table 2: Estimates of d for the general housing price index

1. Beijing	0.489 (0.27, 0.87)	36. Tangshan	0.461 (0.31 0.71)
2. Tianjin	0.333 (0.13, 0.60)	37. Qinhuangdao	0.213 (0.06, 0.43)
3. Shijiazhuang	0.463 (0.29, 0.71)	38. Baotou	0.034 (-0.11, 0.23)
4. Taiyuan	0.128 (-0.08, 0.41)	39. Dandong	0.204 (0.00, 0.49) t
5. Huhhot	0.497 (0.33, 0.73)	40. Jinzhou	-0.142 (-0.31, 0.09)
6. Shenyang	0.146 (0.02, 0.31)	41. Jilin	0.628 (0.38, 0.99)
7. Dalian	0.450 (0.30, 0.67)	42. Mudanjiang	0.377 (0.24, 0.55)
8. Changchun	0.448 (0.23, 0.96)	43. Wuxi	0.379 (0.21, 0.59) t
9. Harbin	0.485 (0.32, 0.71)	44. Xuzhou	0.404 (0.24, 0.67)
10. Shanghai	0.817 (0.40, 1.17)	45. Wenzhou	0.238 (0.09, 0.44)
11. Nanjing	0.442 (0.22, 0.71)	46. Jinhua	0.439 (0.22, 0.89)
12. Hangzhou	0.625 (0.43, 0.86)	47. Bengbu	0.304 (0.13, 0.54)
13. Ningbo	0.595 (0.38, 0.92)	48. Anqing	0.286 (0.12, 0.52)
14. Hefei	0.416 (0.18, 0.69)	49. Quanzhou	0.377 (0.26, 0.54)
15. Fuzhou	0.455 (0.31, 0.67) t	50. Jiujiang	0.553 (0.32, 0.89)
16. Xiamen	0.543 (0.37, 0.78)	51. Ganzhou	0.522 (0.38, 0.73)
17. Nanchang	0.509 (0.32, 0.81)	52. Yantai	0.292 (0.09, 0.60) t
18. Jinan	0.328 (0.19, 0.51)	53. Jining	0.507 (0.33, 0.75)
19. Qingdao	0.342 (0.22, 0.49) t	54. Luoyang	0.017 (-0.21, 0.31)
20. Zhengzhou	0.321 (0.19, 0.52)	55. Pingdingshan	0.128 (-0.09, 0.32)
21. Wuhan	0.589 (0.43, 0.80)	56. Yichang	0.342 (0.13, 0.64)
22. Changsha	0.402 (0.24, 0.64)	57. Xiangfan	-0.102 (-0.26,0.09) t
23. Guangzhou	0.497 (0.37, 0.67)	58. Yueyang	0.558 (0.31, 0.90)
24. Shenzhen	0.963 (0.70, 1.24)	59. Changde	0.445 (0.27, 0.67)
25. Nanning	0.501 (0.34, 0.77)	60. Huizdou	0.387 (0.28, 0.55)
26. Haikou	0.503 (0.23, 0.88)	61. Zhanjiang	0.222 (0.06, 0.43)
27. Chengdu	0.622 (0.37, 0.94)	62. Shaoguan	0.127 (0.00, 0.28)
28. Guiyang	0.354 (0.22, 0.55)	63. Guilin	0.281 (0.11, 0.51)
29. Kunming	0.706 (0.48, 0.99)	64. Beihai	0.364 (0.14, 0.67)
30. Chongqing	0.307 (0.08, 0.63)	65. Sanya	0.698 (0.33, 1.26)
31. Xian	0.026 (-0.15, 0.24)	66. Luzhou	0.562 (0.36, 0.92)
32. Lanzhou	-0.066 (-0.21, 0.14)	67. Nanchong	0.331 (0.21, 0.51)
33. Xining	0.194 (0.03, 0.43) t	68. Zunyi	0.181 (0.00, 0.42)
34. Yinchuan	0.298 (0.14, 0.48)	69. Dali	0.237 (0.04, 0.60)
35. Urumqi	0.512 (0.36, 0.75)	GENERAL	0.948 (0.68, 1.30)

Note: t indicates the need of a time trend

Table 3: Estimates of d for the index of newly constructed buildings

1. Beijing	0.577 (0.31, 0.94)	36. Tangshan	0.228 (0.03, 0.47) t
2. Tianjin	0.244 (0.05, 0.49)	37. Qinhuangdao	0.209 (0.06, 0.41)
3. Shijiazhuang	0.336 (0.17, 0.56)	38. Baotou	-0.055 (-0.17, 0.10)
4. Taiyuan	-0.187 (-0.36, 0.07)	39. Dandong	0.129 (-0.08, 0.43) t
5. Huhhot	0.437 (0.28, 0.72)	40. Jinzhou	0.135 (-0.08, 0.64)
6. Shenyang	0.194 (0.05, 0.42)	41. Jilin	0.322 (0.05, 0.72)
7. Dalian	0.367 (0.23, 0.57)	42. Mudanjiang	0.222 (0.07, 0.43)
8. Changchun	0.259 (0.03, 0.63)	43. Wuxi	0.369 (0.17, 0.60)
9. Harbin	0.311 (0.15, 0.52)	44. Xuzhou	0.425 (0.26, 0.65)
10. Shanghai	0.999 (0.67, 1.29)	45. Wenzhou	0.361 (0.18, 0.59)
11. Nanjing	0.422 (0.23, 0.63)	46. Jinhua	0.227 (-0.04, 0.53) t
12. Hangzhou	0.603 (0.42, 0.84)	47. Bengbu	0.221 (0.04, 0.44)
13. Ningbo	0.606 (0.39, 0.91)	48. Anqing	0.239 (0.09, 0.46)
14. Hefei	0.395 (0.21, 0.64)	49. Quanzhou	0.368 (0.25, 0.54)
15. Fuzhou	0.422 (0.27, 0.64) t	50. Jiujiang	0.232 (0.02, 0.53)
16. Xiamen	0.396 (0.24, 0.60)	51. Ganzhou	0.503 (0.34, 0.72)
17. Nanchang	0.335 (0.17, 0.59)	52. Yantai	0.346 (0.13, 0.65) t
18. Jinan	0.249 (0.10, 0.44)	53. Jining	0.446 (0.29, 0.66)
19. Qingdao	0.259 (0.11, 0.49)	54. Luoyang	0.068 (-0.09, 0.31)
20. Zhengzhou	0.415 (0.27, 0.66)	55. Pingdingshan	0.083 (-0.06, 0.28)
21. Wuhan	0.594 (0.44, 0.81)	56. Yichang	0.147 (-0.05, 0.41)
22. Changsha	0.326 (0.14, 0.62)	57. Xiangfan	-0.257 (-.39, -.07) t
23. Guangzhou	0.561 (0.37, 0.80)	58. Yueyang	0.611 (0.40, 0.83) t
24. Shenzhen	0.565 (0.36, 0.85)	59. Changde	0.330 (0.12, 0.59)
25. Nanning	0.615 (0.44, 0.88)	60. Huizdou	0.391 (0.28, 0.54)
26. Haikou	**0.627 (0.34, 1.02)**	61. Zhanjiang	0.113 (-0.07, 0.34)
27. Chengdu	0.573 (0.33, 0.88)	62. Shaoguan	0.051 (-0.07, 0.22)
28. Guiyang	0.313 (0.18, 0.49)	63. Guilin	0.137 (-0.05, 0.39)
29. Kunming	0.510 (0.27, 0.88)	64. Beihai	0.410 (0.19, 0.70)
30. Chongqing	0.249 (0.03, 0.55)	65. Sanya	0.624 (0.28, 1.15)
31. Xian	0.025 (-0.15, 0.23)	66. Luzhou	0.265 (0.12, 0.48) t
32. Lanzhou	0.022 (-0.13, 0.23)	67. Nanchong	0.387 (0.25, 0.59)
33. Xining	0.057 (-0.13, 0.34)	68. Zunyi	0.140 (-0.03, 0.39)
34. Yinchuan	0.245 (0.13, 0.39)	69. Dali	0.203 (0.02, 0.61)
35. Urumqi	0.383 (0.25, 0.57)	GENERAL	1.128 (0.85, 1.50)

Note: t indicates the need of a time trend

Table 4: Estimates of d for the price index of second hand buildings

1. Beijing	0.353 (0.23, 0.54) t	36. Tangshan	0.431 (0.25, 1.05)
2. Tianjin	0.149 (0.07, 0.47) t	37. Qinhuangdao	-0.004 (-0.15, 0.21)
3. Shijiazhuang	0.229 (0.10, 0.41)	38. Baotou	0.059 (-0.12, 0.30)
4. Taiyuan	0.516 (0.30, 0.84)	39. Dandong	0.196 (0.02, 0.42)
5. Huhhot	0.328 (0.11, 0.66)	40. Jinzhou	-0.297 (-.46, -.08) t
6. Shenyang	-0.108 (-.24, 0.06) t	41. Jilin	0.639 (0.43, 0.90)
7. Dalian	0.447 (0.25, 0.73)	42. Mudanjiang	0.013 (-0.11, 0.19)
8. Changchun	0.506 (0.28, 0.84)	43. Wuxi	0.495 (0.27, 0.76) t
9. Harbin	0.291 (0.14, 0.51)	44. Xuzhou	0.362 (0.17, 0.64) t
10. Shanghai	0.551 (0.31, 1.02)	45. Wenzhou	0.155 (0.01, 0.36)
11. Nanjing	0.331 (0.09, 0.65)	46. Jinhua	0.168 (-0.06, 1.14)
12. Hangzhou	0.375 (0.13, 0.68)	47. Bengbu	0.136 (0.03, 0.30)
13. Ningbo	0.418 (0.23, 0.74)	48. Anqing	0.256 (0.09, 0.49)
14. Hefei	-0.092 (0.26, 0.15)	49. Quanzhou	0.483 (0.36, 0.66)
15. Fuzhou	0.208 (0.05, 0.42) t	50. Jiujiang	0.490 (0.30, 0.85)
16. Xiamen	0.499 (0.36, 0.78)	51. Ganzhou	0.394 (0.26, 0.58)
17. Nanchang	0.478 (0.31, 0.70)	52. Yantai	0.197 (0.00, 0.45) t
18. Jinan	0.399 (0.25, 0.61)	53. Jining	0.279 (0.08, 0.55)
19. Qingdao	0.224 (0.11, 0.37) t	54. Luoyang	0.128 (0.00, 0.28) t
20. Zhengzhou	-0.059 (-0.28, 0.24)	55. Pingdingshan	0.723 (0.54, 0.99)
21. Wuhan	0.245 (0.11, 0.45)	56. Yichang	-0.052 (-0.19, 0.14)
22. Changsha	0.257 (0.10, 0.46) t	57. Xiangfan	-0.047 (-0.21, 0.17)
23. Guangzhou	0.139 (0.00, 0.36)	58. Yueyang	0.396 (0.21, 0.79)
24. Shenzhen	0.837 (0.50, 1.29)	59. Changde	0.393 (0.18, 0.70)
25. Nanning	-0.291 (-0.52, -0.04)	60. Huizdou	0.022 (-0.14, 0.28)
26. Haikou	0.181 (-0.06, 0.56)	61. Zhanjiang	0.352 (0.23, 0.53)
27. Chengdu	0.374 (0.18, 0.76)	62. Shaoguan	0.343 (0.16, 0.63) t
28. Guiyang	-0.179 (-.33, 0.09) t	63. Guilin	0.103 (0.06, 0.33)
29. Kunming	0.053 (-0.16, 0.33)	64. Beihai	0.169 (0.00, 0.43)
30. Chongqing	0.044 (-0.14, 0.32) t	65. Sanya	-0.143 (-.32, 0.11) t
31. Xian	0.003 (-0.20, 0.25)	66. Luzhou	0.124 (-.08, 0.44) t
32. Lanzhou	-0.224 (-.35, -.04) t	67. Nanchong	-0.258 (-.41, -.03) t
33. Xining	0.065 (-0.11, 0.30) t	68. Zunyi	-0.199 (-.31, -.05) t
34. Yinchuan	0.334 (0.11, 0.60)	69. Dali	0.270 (0.05, 0.55)
35. Urumqi	0.557 (0.37, 0.84)	GENERAL	0.392 (0.20, 0.66)

Note: t indicates the need of a time trend

Sanya is located in the Hainan province and it is one part of the important SEZ to promote the development of tourism. This special policy made by the central government and the unique tourism resources of the city did boom its housing market and prices.Next we look at the differences between New Buildings and Second Hand price indices (Table-3 and 4). Looking at the overall estimate of d (last row) for the new buildings index we observe a value of 1.128, which is even higher than the one obtained in Table-2, and suggesting that the bubble is mainly created by the new buildings price index. Here again the contribution to the high degree of persistence is mainly produced by Shanghai (0.999) and Sanya (0.624) along with Haikou (0.627), but for Shenzhen (0.565) the unit root is now rejected in favor of d < 1. However, for the second hand properties, the overall estimate of d is 0.392, indicating lack of bubbles in this index and a fast recovery of the shocks. Evidence of unit roots is found in the cases of Shanghai, Shenzhen, Tangshan and Jinhua though in some cases the intervals are very wide.

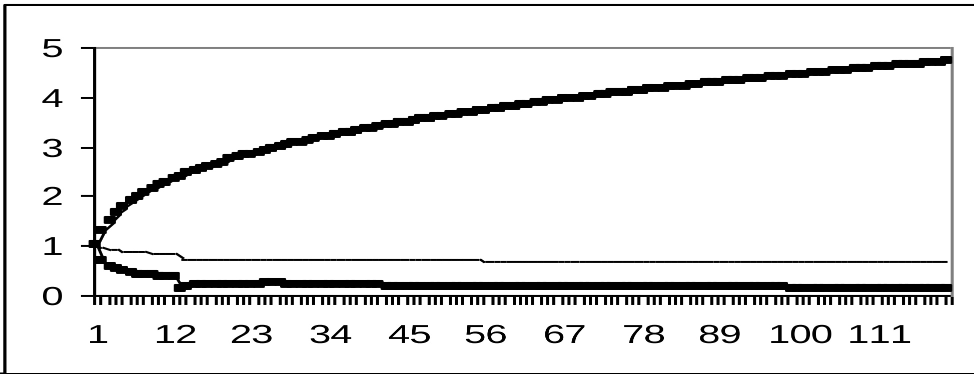
These results clearly indicate that the housing prices in China are highly persistent and non-mean-reverting, and this result is mainly justified throughout the new constructed building index in Shanghai, Shenzhen, Haikou and Sanya. In China, people prefer new residences to second-hand ones, especially during and after the baby-boomers in the 1980s with people coming to marriage and purchase new houses. This special background in these cities still makes the housing prices stickier than in other cities. On the other hand, mean reversion seems to happen in practically all series corresponding to second hand buildings and also in many others for new buildings too. Figure-1 displays the first 120 impulse responses for the three aggregate indices. The lack of mean reversion in the general index is clearly observed and also in the new constructed building index, as is the fast reversion to the mean in the case of the second hand buildings index.

Across Tables 2 – 4, we refer with the letter "t" to the existence of linear trends in the model. This happens for seven series in the general index in Table-2; for eight cities in the new buildings index (Table-3) and for twenty cities in Table-4 for the second hand market. This phenomenon would imply that there exist "ripple effects" among different housing markets for some cities, whose housing price dynamics are pushed by common trends. Nevertheless, this property should be checked in further research. The coefficients for the time trends are positive in the majority of the cases. Nevertheless, this does not mean that prices go up deterministically forever, since the time trend disappears for values of d above 0. Note that the first two equalities in (4) can be rewritten as:

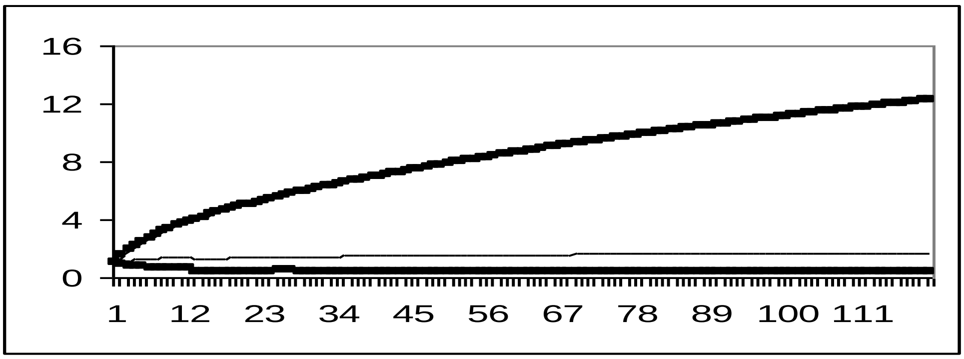
$$y_t^* = \beta_0 1_t^* + \beta_1 t_t^* + u_t \qquad (5)$$

where $y_t^* = (1-L)^d y_t$; $1_t^* = (1-L)^d 1_t$; and $t_t^* = (1-L)^d t_t$; and this last term disappears in the long run for $0 < d < 1$, and tends to a constant for $1 \leq d \leq 2$.

i) Housing Price Index



ii) Newly Constructed Buildingous



iii) Second Hand Buildings

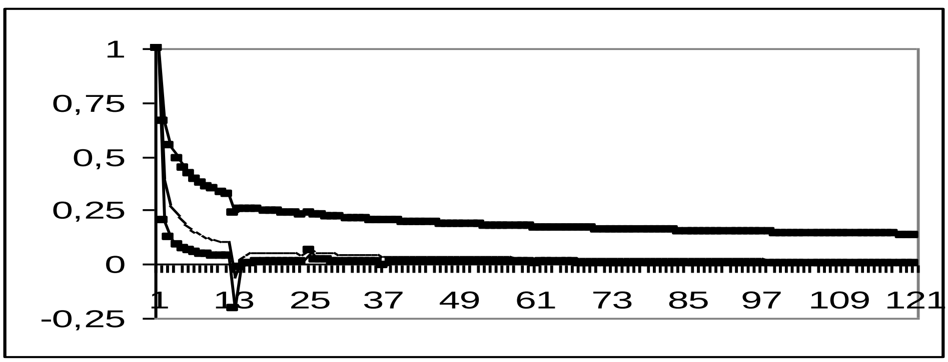


Figure 1: Impulse responses and 95% confidence band

Note: The thick lines refer to the 95% confidence interval of the responses.

DISCUSSION AND CONCLUSIONS

In this paper we have investigated time series dependence and other implicit dynamics in house prices in China, providing evidence for three aggregate indices and for 69 cities. A model specification is presented, based on fractional integration at the long run or zero frequency along with seasonal (monthly) autoregressions. The results are the following: first, we notice that the standard methods employed in the literature, based on stationary I(0) or non-stationary I(1) models are rejected in many cases in favor of fractional degrees of integration, Malpezzi (1999). This is not surprising noting the greater flexibility allowed by the fractional models and the low power of the unit root tests in the context of fractional integration[12]. Second, the results indicate that persistence is of paramount importance in housing series, since it was observed that the order of integration of 1 cannot be rejected in the general housing price index, due to the contribution of three provinces: Shanghai, Shenzhen and Sanya, signifying that shocks will be permanent and the series will be very persistent, requiring active measures to bring the series back to its original trend. However, for some cities in China the order of integration was found to be lower than one and therefore mean reverting, although taking considerable time to return to its original level. This is also the case in most of the series corresponding to the second hand building price index. Therefore shocks related to the long run evolution of the housing series are persistent and therefore require active housing policies. However, the persistence should be allocated to each series separately since distinct policy measures have to be formulated based on the degree of persistence identified. Hypothesis 1 (persistence) is accepted for the general housing price index and for the newly constructed buildings price index, and also for the individual series corresponding to the cities of Shanghai, Shenzhen, Haikou and Sanya. In all these cases the null hypothesis of a unit root cannot be rejected suggesting that bubbles may exist in the Chinese housing market in these cities. On the other hand, Hypothesis 2 (mean reversion) is accepted in the majority of the cities for the three indices and also in the overall second hand building index.

Thus, the series corresponding to the general housing price index indicates lack of reversion and a permanent nature of the shocks signifying that shocks related to the long run evolution of the index lasts forever unless policy measures are implemented. As a consequence, disruptions in house prices will have a persistent impact on the economic activity as such shocks will be transmitted to other sectors of the economy. Note however that this contribution is mainly due to the effect of four cities: Shanghai, Shenzhen, Haikou and Sanya so especial care must be taken in these cases. Therefore, it is crucial for policymakers to distinguish the nature of the shock (i.e. transitory or persistent) since the policy actions may differ with regard to the type of shock. Additionally, for the newly constructed buildings price index the persistence is strong, but again with distinct values for each city. Finally the price index of second hand buildings is clearly mean reverting, with the effect of the shocks disappearing relatively fast.It mainly lies in the consumption preference for the newly built houses in China and the undeveloped market for the second hand houses. More importantly, this discovery has never been noticed in the literature and worth noting by policymakers.

[12] See Diebold and Rudebusch (1991), Hassler and Wolters (1994) and Lee and Schmidt (1996) among others.

What are the contributions to the literature and the industry of our research? The study first contributes to the literature by providing more accurate evidence on the persistence behaviour of housing prices, while most previous studies have used the traditional integrated I(0)/I(1) models (MacDonald and Taylor, 1993; Malpezzi, 1999). Models based on fractional integration are more general than the classical models based on integer degrees of differentiation and thus allow for a much richer degree of flexibility in the dynamic specification of the series. In fact, as stated before, when housing authorities or real estate agents have a *priori* knowledge of the persistence of housing prices, they can reap the benefit of positive effects, or avoid being victimized by a negative effect. As we provide evidence from 69 cities in China, the results are also expected to assist housing businesses that operate in other Chinese cities. Specifically, we expect that the results will most benefit real estate agents that possess a significant market share in the industry, as these are more likely to monitor the long trend movement of house prices. In contrast to small real estate dealers, large real estate dealers are also expected to be more interested in the analysis of industry data given that in most cases they have multiple geographical presences.

REFERENCES

Alexander, C. and Barrow, M. (1994). Seasonality and Cointegration of Regional House Prices in the UK. *Urban Studies*, Vol. 31, No. 10, pp. 1667-689.

Ashworth, J. and Parker, S. C. (1997). Modeling Regional House Prices in the UK. *Scottish Journal of Political Economy*, Vol. 44, No. 3, pp. 225-246.

Ayala, L. and C. Navarro (2007). The dynamics of housing deprivation. *Journal of Housing Economics*, Vol. 16, No. 1, pp. 72-97.

Ayuso, J. and F. Restoy (2007). House prices and rents in Spain. Does the discount factor matter? *Journal of Housing Economics*, Vol. 16, No. 3-4, pp. 291-308.

Barros, C. P., Gil-Alana, L. and Payne, J. (2012). Comovements among U.S. state housing prices: Evidence from fractional cointegration. *Economic Modelling*, Vol. 29, No. 3, pp. 936-942.

Barros, C. P., Chen, Z. & Gil-Alana, L. A. (2013). Duration of housing project sales in urban Beijing. Habitat International, Vol. 39, pp. 36-42.

Black, A. P., Fraser and M. Hoseli, (2006). House prices, fundamentals and bubbles. *Journal of Business Finance and Accounting*, Vol. 33, pp. 1535-1555.

Blanchflower, D. G. and A. J. Oswald (2004). Well being over time in Britain and the USA. *Journal of Public Economics*, Vol. 88, pp. 1359-1386.

Bourassa, S., P. Hendershott and J. Murphy, (2001). Further evidence on the existence of housing market bubbles. *Journal of Property Research*, Vol. 18, pp. 1-19.

Caliman, T. (2009). The risk of falling house prices in Italy, *International Review of Economics*, Vol. 36, pp. 401-423.

Candelon, B. and Palm, F. (2010). Banking and Debt Crises in Europe: the Dangerous Liaisons? *De Economist*, Vol. 158, No. 1, pp. 81-99.

Chen, J., Fei Guo and Ying Wu (2011). One decade of urban housing reform in China: Urban housing price dynamics and the role of migration and urbanization, 1995-2005. *Habitat International*, Vol. 35, pp. 1-8.

Coleman, M., M. La Cour-Little and K. Vandell, (2008). Suprime lending and the housing bubble. Tail wags dog? *Journal of Housing Economics,* Vol. 17, pp. 272-290.

Cook, S. (2003). The Convergence of Regional House Prices in the UK. *Urban Studies,* Vol. 40, No. 11, pp. 2285-2294.

Cook, S. (2005). Detecting Long-Run Relationships in Regional House Prices in the UK. *International Review of Applied Economics*, Vol. 19, No. 1, pp. 107-118.

Cook, S. and Thomas, C. (2003). An Alternative Approach to Examining the Ripple Effect in UK House Prices. *Applied Economics Letters,* Vol. 10, No. 13, pp. 849-851.

Cook, S. and Vougas, D. (2009). Unit Root Testing against an ST-MTAR Alternative: Finite-Sample Properties and an Application to the UK Housing Market. *Applied Economics*, Vol. 41, pp. 1397-1404.

Dahlhaus, R. (1989). Efficient parameter estimation for self-similar process. *Annals of Statistics,* Vol. 17, pp. 1749-1766.

Del Negro, M. and C. Otrok (2007). Monetary policy and the house price boom across US states. *Journal of Monetary Economics*, Vol. 54, No. 7, pp. 1962-1985.

Deng, Y., Morck, R., Wu, J. & Yeung, B. (2011). Monetary and Fiscal Stimuli, Ownership Structure, and China's Housing Market (No. w16871). National Bureau of Economic Research.

Diebold, F. and G. D. Rudebusch (1991). On the power of Dickey-Fuller test against fractional alternatives. *Economics Letters*, Vol. 35, pp. 155-160.

DiPasquale, D. and W. C. Wheaton (1994). Housing market dynamics and the future of housing prices. *Journal of Urban Economics*, Vol. 35, No. 1, pp. 1-27.

Disney, R. and J. Gathergood (2009). House price volatility and household indebtedness in the United States and United Kingdom, Technical Report, Center for Finance and Credit Markets.

Drake, L. (1995). Testing for Convergence between UK Regional House Prices. *Regional Studies*, Vol. 29, No. 4, pp. 357-366.

Du, H., Ma, Y. & An, Y. (2011). The impact of land policy on the relation between housing and land prices: Evidence from China. *The Quarterly Review of Economics and Finance*, Vol. 51, No. 1, pp. 19-27.

Dufrenot, G., Grimaud, E., Latil, E. and Mignon, V. (2008). Modelling the slow mean-reversion of the Central and Eastern European countries' real exchange rates. *Manchester School*, Vol. 76, No. 1, pp. 21-43.

Enders, W. and Siklos, P. L. (2001). Cointegration and Threshold Adjustment. *Journal of Business and Economic Statistics,* Vol. 19, No. 1, pp. 166-176.

Englung, P., Quigley, J. M. and Redfearn, C. (1998). Improved price indexes for real estate: Measuring the course of Swedish housing prices. *Journal of Urban Economics*, Vol. 44, pp. 171-196.

Fratantoni M. and S. Schuh (2003). Monetary policy, housing and heterogeneous regional markets. *Journal of Money Credit and Banking*, Vol. 35, pp. 557-589.

Garcia, J. and Raya, J. M. (2011). Price and Income Elasticities of Demand for Housing: Characteristics in the City of Barcelona. *Regional Studies*, Vol. 45, No. 5, pp. 597-608.

Gil-Alana, L. A. and B. Henry (2003). Fractional integration and the dynamics of UK. unemployment. *Oxford Bulletin of Economics and Statistics*, Vol. 65, pp. 221-240.

Gil-Alana, L. A. and Robinson, P. M. (1997). Testing of unit roots and other nonstationary hypotheses in macroeconomic time series. *Journal of Econometrics,* Vol. 80, pp. 241-268.

Giussani, B. and Hadjimatheou, G. (1991). Modeling Regional House Prices in the UK. *Papers in Regional Science*, Vol. 70, No. 2, pp. 201-219.

Giussani, B. and Hadjimatheou, G. (2006). House prices: an econometric model for UK. *Journal of Housing and the Built Environment*, pp. 31-58

Gupta, R., A. Kabundi and S. M. Miller (2011). Forecasting the US real house price index. Structural and non-structural models with and without fundamentals. *Economic Modelling* Vol. 28, No. 4, pp. 2013-2021.

Gupta, R. and Miller, S. M. (2012). The Time-Series Properties of House Prices: A Case Study of the Southern California Market. *Journal of Real Estate Finance and Economics*, Vol. 44, No. 3, pp. 339-361.

Hassler, U. and J. Wolters (1994). On the power of unit root tests against fractional alternatives. *Economics Letters*, Vol. 45, pp. 1-5.

Heilmann, S. (2008). Policy Experimentation in China's Economic Rise. *Studies of Comparative International Development*, Vol.43, pp. 1–26.

Himmelberg, C., Mayer, C. and Sinai, T. (2005) Assessing High House Prices: Bubbles, Fundamentals, and Misperceptions. *Journal of Economic Perspectives*, Vol. 19, No. 4, pp. 67-92.

Holly, S., Pesaran, M. H. & Yamagata, T. (2010). A spatio-temporal model of house prices in the USA. *Journal of Econometrics*, Vol. 158, No. 1, pp. 160-173.

Holmes, M. J. and Grimes, A. (2005). Is There Long-Run Convergence of Regional House Prices in the UK? Motu Economic and Public Policy Research. Working Paper 5-11.

Holmes, M. and Grimes, A. (2008). Is There Long-run Convergence among Regional-House Prices in the UK? *Urban Studies*, Vol. 45, pp. 1531-1544.

Hou, Y. (2010). Housing price bubbles in Beijing and Shanghai? A multi-indicator analysis. *International Journal of Housing Markets and Analysis*, Vol. 3, No. 1, pp. 17-37.

Huang Y. (2004). Housing markets, government behaviors, and housing choice: a case study of three cities in China. *Environment and Planning*, Vol. 36, pp. 45-68.

Igan, D., A. Kabundi, F. Nadal de Simone., M. Pinheiro and N. Tamirisa (2011). Housing, credit, and real activity cycles. Characteristics and comovement. *Journal of Housing Economics*, Vol. 20, No. 3, pp. 210-231.

Lee, D. and Schmidt, P. (1996). On the power of the KPSS test of stationarity against fractionally integrated alternatives. *Journal of Econometrics*, Vol. 96, pp. 285-302.

Liang, Q. & Cao, H. (2007). Property prices and bank lending in China. *Journal of Asian Economics*, Vol. 18, No. 1, pp. 63-75.

Liao, W. and Wang, X. (2012). Hedonic house prices and spatial quantileregression. *Journal of Housing Economics*, Vol. 21, No. 1, pp. 16-27.

Liu, H. & Shen Y. (2005). Housing Prices and General Economic Conditions: An Analysis of Chinese New Dwelling Market. *Tsinghua Science & Technology*, Vol. 10, No. 3, pp. 334-343.

Luttmer, E. F. (2005). Neighbors as negatives. Relative earnings and well being. *The Quarterly Journal of Economics*, Vol. 120, pp. 963-1002.

MacDonald, R. and Taylor, M. P. (1993). Regional House Prices in Britain. *Scottish Journal of Political Economy*, Vol. 40, No. 1, pp. 43-55.

Mak, S. W., Choy, L. H. & Ho, W. K. (2007). Privatization, housing conditions and affordability in the People's Republic of China. *Habitat International*, Vol. 31, No. 2, pp. 177-192.

Malpezzi, S., (1999) A Simple Error-Correction Model of Housing Prices. *Journal of Housing Economics*, Vol. 8, pp. 27-62.

Meen, G. (1996). Spatial aggregation, spatial dependence and predictability in the UK housing market. *Housing Studies*, Vol. 11, No. 3, pp. 345-372.

Nelson, C. R. and C. I. Plosser, (1982). Trends and random walks in macroeconomic time series. *Journal of Monetary Economics*, Vol. 10, pp. 139-162.

Ren, Y., Xiong, C. & Yuan, Y. (2012). House Price Bubbles in China. *China Economic Review*, Vol. 23, No.4, pp. 86–800.

Robinson, P. M. (1994). Efficient tests of nonstationary hypotheses. *Journal of the American Statistical Association*, Vol. 89, pp. 1420-1437.

Taylor and Sarno, (2002). Purchasing Power Parity and the Real Exchange Rate, IFM Staff Papers. *Palgrave MacMillan*, Vol. 49, No. 1, pp. 1-5.

Varian (1983). Microeconomic Analysis, 3rd edition, N. Y., W. W. Norton & Company

Wang, S. Y. (2011). State misallocation and housing prices: Theory and evidence from China. *The American Economic Review*, Vol. 101, No. 5, pp. 2081-2107.

Wang, Y. P. (2001). Urban Housing Reform and Finance in China: A Case Study of Beijing. *Urban Affairs Review*, Vol. 36, pp. 620-645.

Wang, Y. P. and A. Murie (1996). The Process of Commercialisation of Urban Housing in China. *Urban Studies*, Vol. 33, No. 6, pp. 971-989.

Wu, J., Gyourko, J. & Deng, Y. (2012). Evaluating conditions in major Chinese housing markets. *Regional Science and Urban Economics*, Vol. 42, No. 3, pp. 531-543.

Xun, L., Xu, Xianxiang and Li, Zhigang (2010). Land Property Rights and Urbanization in China. *The China Review*, Vol. 10, No. 1, pp. 11–38.

Zhang, C. (2013). Money, housing, and inflation in China. *Journal of Policy Modeling*, Vol. 35, No. 1, pp. 75-87.

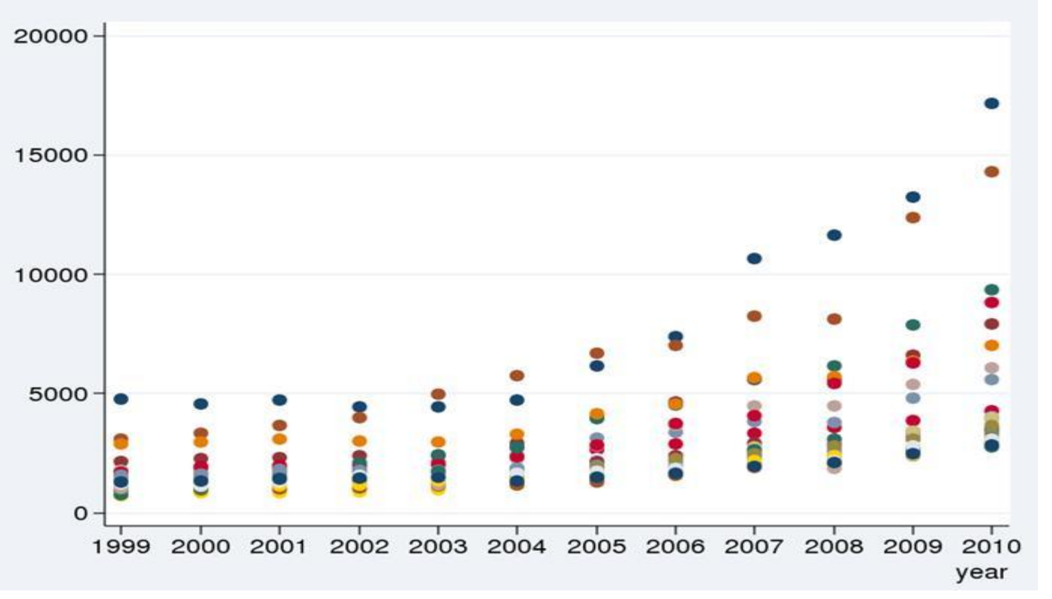
Zhang, D., Cheng, W. and Ng Yew-Kwang (2013). Increasing returns, land use controls and housing prices in China. *Economic Modelling*, Vol. 31, No. 3, pp. 789-795.

Zhang, Y., Hua, X. & Zhao, L. (2012). Exploring determinants of housing prices: A case study of Chinese experience in 1999–2010. *Economic Modelling*, Vol. 29, No. 6, pp. 2349-2361.

Zhang, H. (2008). Effects of urban land supply policy on real estate in China: an econometric analysis. *Journal of Real Estate Literature*, Vol. 16, No. 1, pp. 55-72.

Zhu J. (2012). The Shadow of the Skyscrapers: real estate corruption in China. *Journal of Contemporary China*, Vol. 21, No. 74, pp. 243-260.

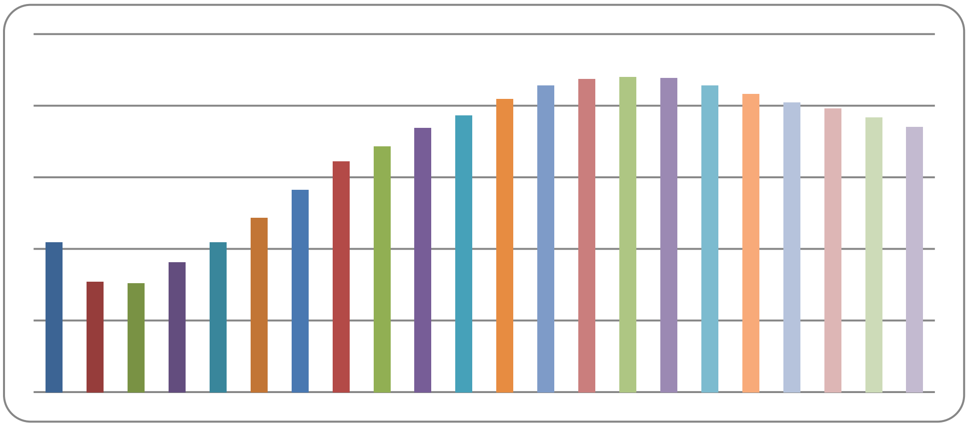
Zohrabyan, T., D. Leatham and D. Bessler (2008). Cointegration analysis of regional house prices in US. Proceedings: 2007 Agricultural and Rural Finance Markets in Transition, Regional Research Committee NC-1014 St Louis, Missouri.



Graph 1: The average price of residential buildings in China (Yuan/square meter)

Sources: the National Bureau of Statistics of China (www.stats.gov.cn).

Notes: The samples are nominal average price of 31 provinces (centrally administered municipalities).



Graph 2: The average price of housing in China (Yuan /square meter)

Source: CREIS 100-city real estate prices indices. These indices have been released monthly by China Index Academy (industry.soufun.com) since July, 2010.