Regional House Prices and the Ripple Effect in the Yangtze River Delta Region

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Abstract: In this study, liner unit root tests and panel unit root tests to the ratio of city to regional house price were applied to examine the ripple effects across 28 cities in the Yangtze River Delta region. Then invert LM unit root tests with two structural breaks for 10 representative cities were conducted. The results showed that there is overwhelming evidence of the existence of ripple effect in the Yangtze River Delta region, while segmentation is restricted to a small group of cities in which there is no long-run relationship with the Yangtze River Delta region average; compared to no- and one-break case, there is overwhelming evidence of a ripple effect with the LM test with two structural breaks. Furthermore, the results of the Granger causality test showed that changes in house prices in Shanghai, Nanjing and Hangzhou have led to changes in house prices in other cities. The findings of this research make certain contributions to the improvements of research system of ripple effect among regional house prices in the Yangtze River Delta Region, and could be referenced by other markets of other cities.

Key words: House prices, Ripple effects, Structural break, Yangtze River Delta, Real estate

1. INTRODUCTION

More and more attention has been paid to the ripple effect of regional house prices. The implication of ripple effect is the existence of a long-run constancy or stationarity (Meen, 1998). House price shocks in a city were probable to have transitory or permanent influence on house prices of its neighboring cities (Pollakowski and Ray, 1997). The housing market is a regional market. The residential prices of some cities especially in some areas of the central city would first fluctuate, and then would play a role as leader in the surrounding cities driving its consequent fluctuations, which is called ripple effect (Balcilar, 2013).

The Yangtze River Delta region is geographically composed of three provinces and one municipality: Jiangsu, Zhejiang, Anhui and Shanghai. The Yangtze River Delta region is one of the important economic centers and the most active property markets in China. On the background of city cooperation, the construction of intercity transportation system and the implementation of regional planning, it has been gradually formed the development pattern in the Yangtze River Delta region that Shanghai acts as a leader, Nanjing and Hangzhou as the two wings and the other core cities to focus on the coordinated development of a city. The development pattern has speeded up the capital flows in this region, which promote the development of the regional housing markets, and make the regional residential market more closely linked. Although there is a big difference between house prices of the cities in the Yangtze River Delta region, each city house price fluctuation has the common trend, which reflects the spatial correlation in housing markets in the Yangtze River Delta region. This paper aims to explore the ripple effect on the residential market in Yangtze River Delta region.

The paper makes the following contributions. Firstly, this study contributes to the theory on ripple effects in the Chinese house market. As we know, most of studies that have employed to test the ripple effect of house prices in Britain (Meen, 1998; Cook, 2003, 2005; Cook and Thomas, 2003; Holmes and Grimes, 2008) and America (Clapp and Tirtiroglu, 1995; Clark and Coggin, 2009; Barros, 2011; Holmes, 2011; Gupta and Miller, 2012a and 2012b; Canarella, 2012). Secondly, it contributes to the theory on ripple effect on regional house prices. Most of the studies were standing in the angle of a state rather than a region to examine the interactive relationship among some major cities. Moreover, most of scholars focus on the causal relationship of house prices among the capital cities or the major cities, but neglect the city which takes the lead in the fluctuation of the house price. Finally, it makes a methodological contribution on testing the ripple effect on house prices. Most of the studies use univariate unit root tests that don't accommodate a structural break to test for a ripple effect on house prices. In this study, the univariate unit root tests with none, one or two structural breaks were used.

2. LITERATURE REVIEW

The literature on ripple effect on house prices is quite extensive in Britain and America. At the beginning of the study, scholars used the structural model, Granger causality test, cointegration test, unrelated regression and panel model to study the ripple phenomenon of the real estate market respectively, and proved the existence of ripple effect of regional price. There is a widespread consensus that a ripple effect of house prices exists in the British real estate market beginning in the southeast and proceeding towards the north-west. MacDonald and Taylor (1993), Alexander and Barrow (1994), and Petersen et al. (2003) detected the long-run equilibrium relationship between different regional house prices in Britain. Cook (2005) demonstrated the existence of a ripple effect via the use of the DF-GLS test and the Kwaitkowski–Phillips–Schmidt–Shin (KPSS) stationarity test. Holmes and Grimes (2008) found that the regional house prices in Britain were driven by a single common stochastic trend. In 1990s, scholars gradual paid their attention to the ripple effect of the regional house prices in the American real estate market (Clark and Coggin, 2009; Gupta and Miller, 2012; Holmes, 2011).

In the real estate mark of other regions, Berg (2002) found that the price change of the second-hand housing market in the Stockholm has a ripple effect on six other areas. Elias (2006) pointed that house price changes diffuse first from the metropolitan area to the regional centers and then to the peripheral areas. Now the research of co-ordination, causality, response, and leading / lagged relationship between regional housing prices are increasingly. For example, Holmes (2011) used probabilistic test statistical methods to study the house prices of the USA, showing the presence of convergence, and the rate of adjustment of house prices was inversely proportional to the distance between states and states. Balcilar (2013) used the standard linear unit root test with structural mutations to analyze the ripple effect between housing prices among five major cities in South Africa, then found that Cape Town dominated the price of medium-sized housing while Durban dominated the prices of large and small houses.

In China, with the political and economic exchanges between cities becoming more and more frequent, the study of regional housing prices interactive has increased in recent years. Chien (2010) found the evidence for the long-run relationship between all regions except Taipei City. Zhao (2012) finds that the conduction path of house prices in the Changsha Zhuzhou Xiangtan area is in line with the housing price diffusion from the center city to the surrounding areas, diffusing from Changsha Zhuzhou and Xiangtan to other cities. In spite of this, the researchers focused more on the linkage effect of house prices across the country, while few literatures focused on the linkage effect of house prices among several cities which are geographically close especially among cities in the Yangtze River Delta Region. Therefore, the study of this paper will make up for this gap, which has certain practical significance.

3. METHODS

3.1. Data

The monthly house price data published by the Chinese Bureau of Statistics and Bureau of Statistics of 28 cities in the Yangtze River delta region were used in this study. The sample covers the period from June 2010 to February 2015 for 28 cities and from January 2006 to February 2015 for representing 10 cities, which is dictated by data availability. The relevant variable is the ratio of the city house price to the regional house average prices.

3.2. Unit Root Tests

Six linear unit root tests were used to test the null hypothesis: the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test, the Dickey–Fuller (DF) test with Generalized Least Squares Detrending (DF-GLS); the Kwiatkowski Phillips Schmidt and Shin (KPSS) test; the Elliot, Rothenberg and Stock (ERS) test and the Ng–Perron (NP) test. These tests have been widely used in various applications by detecting ripple effects. Conventional unit root tests, which assume structural stability and linear adjustment, can interpret departures from linearity and structural instabilities as permanent stochastic disturbances. The panel unit root tests are similar but not the same with univariate unit root tests. Compared with the univariate unit root test, the panel unit root tests has a stronger ability to reject the unit root null.

3.3. Univariate Lagrange Multiplier (LM) Unit Root Tests

A lot of evidence implied that house prices are characterized by structural breaks (Cook and Vougas, 2009; Canarella, 2012; Chien, 2010). It is well known that structural breaks distort the results of conventional unit root tests. Therefore, one and two structural breaks were used in the univariate LM unit root tests. The univariate LM unit root test is developed by Lee and Strazicich (2004) represents a methodological improvement over ADF-type endogenous-break unit root tests.

In the event that no-break case and one-break case give different results, we prefer the one-break case if the break is statistically significant; and if one-break case and two-case break case give different results, we prefer two-break case if the second break is statistically significant. This rule has been employed in previous study (Lean and Smyth, 2007). We first present the Schmidt & Phillips(1992) LM unit root test with no structural breaks in order to provide a point of comparison for the univariate LM unit root tests with structural breaks. The reason for so doing is that it makes more sense to provide tests from the same family of unit root tests from no break case through to two breaks.

On the basis of the Schmidt and Phillips test, Lee and Strazicich (2004) developed two versions of the LM unit root test with one break, commonly known as model A and C. Model A allows for one structural break in the intercept. Model C allows for one break in both the intercept and slope of the city to regional house price ratio. Lee and Strazicich (2003) developed a version of LM unit root test which contains two structural breaks, which are commonly known as model AA and model CC. Model AA and model CC differ in terms of whether the break is restricted to the intercept or extends to the intercept and slope of the house ratio.

3.4. Multivariate Granger causality test

Granger (1969) defined a causal relationship from a prediction angle if an event X helps to predict another event Y, then event X is the Granger cause of event Y, which means that event X is the ahead of event Y. If and only if:

$$Y_{t+h|\mathrm{n}_t} = Y_{t+h|n_{\frac{t}{X}}}, \quad \mathrm{h} = 1, \ 2 \ldots$$

The event X is not the Granger cause of the event Y, where $Y_{t+h|\mathrm{n}_t}$ represents the optimal predictor of the advance h step of the time of t, Ω_t represents all available information sets at the time of t, Ω_t/X represents the information set obtained by excluding the information of X at the time of t. If the above equation is not true for any h, then the past event X is included in the information set to improve the prediction of event Y, that is, event X is the Granger cause of event Y, and its process is defined as Granger causality test.

At present, only a small number of scholars who have studied the local regional market prices between the causal effect of the city. For example, Gupta & Miller (2012) used a set of cointegration tests and causal tests to infer the causal relationship between housing prices in Los Angeles, Las Vegas and Phoenix. Anarella (2012) who used unit root test, cointegration analysis, causal analysis and pulse corresponding function found that the housing price ripple effect between the US metropolis. As for Chinese researchers, Zhong (2010) studied the price transmission mechanism of housing prices in the Pearl River Delta region from three research perspectives. He found that there was a significant conduction relationship between the prices of "core city" in the individual cities of the Pearl River Delta. Zheng (2011) found that the housing prices of the Yangtze River Delta city existed the spatial correlation, and the size of the conduction intensity between the two cities.

4. RESULTS AND DISCUSSION

Based on the results of ADF test, the unit root nulls of house prices in 22 cities were rejected; according to the results of DF-GLS test, the unit root null of house prices in 26 cities were rejected; according to the results of PP test, the unit root null of house prices in 25 cities were rejected; based on KPSS test, the unit root null of house prices in 4 cities were rejected; based on ESR test, the unit root null of house prices in 23 cities were rejected; based on NP test, the unit root null of house prices in 21 cities were rejected. The results showed that the ripple effect exist in the housing market in the Yangtze River delta region.

At the same time, the results of linear unit root tests support the existence of ripple effect on the house prices in the Yangtze River delta region except Shanghai, Huaian and Suqian. In the long run, the house prices of these cities will deviate from regional average house prices. Shanghai, the main economic center in the Yangtze River delta region, has the highest house prices and a different trend-path from other cities in the Yangtze River delta region. There is no long-term equilibrium relationship between the housing market in Huaian and Suqian. Firstly, because of the poor development of the two cities, the economic fluctuation has less influence on their house price fluctuation. Secondly, the immigrant population is more than the emigration population, which leads to the decrease of housing demand, the relative elasticity of the supply of the land market. Thirdly, Suqian and Huaian are located in the northern part of the Yangtze Delta, have less contact with other cities. The fluctuations in house prices in the Yangtze River Delta cannot spread to them.

It is well known that the linear unit root test has low power consumption when the sample size is small (Shiller and Perron, 1985). The panel unit root tests were applied to solve the problem. Panel data usually contains more freedom and more degree of sample variation than time series data, thus improving the efficiency of econometric analysis. Although panel data does not provide evidence of individual behavior, it provides strong validation evidence that the entire panel and sub panel are convergent. The results of panel unit root tests were reported in Table 1. There is ample evidence of the convergence of these panels based on LLC, Breitung t-stat, IPS, ADF-Fisher, PP-Fisher test. Compared to the linear unit root tests, there is overwhelming evidence of the ripple effect with the panel tests.

Table 1. panel unit root results

	LLC	Breitung t-stat	IPS	ADF-Fisher	PP-Fisher
Inter	-6.03***	-0.23***	-9.30***	223.78***	292.79***
Trend and inter	-9.73***	-0.79***	-13.23***	284.467***	329.74***

Note: *** denote significance levels of 1 percent respectively, at which the null hypothesis of unit root is rejected

Due to the limited data, we choose Shanghai, Nanjing, Hangzhou, Wuxi, Xuzhou, Yangzhou, Ningbo, Wenzhou, Jinhua and Hefei as the research objects. According to Schmidt and Phillips (1992) LM unit root test are reported in Table 2. The results provide mixed evidence of the existence of the ripple effect in in the Yangtze River Delta region. Based on data on Z (τ), the unit root nulls of house prices in 6 cities were rejected.

Table 3 presents the results of LM unit root test with one break in model A. Table 4 presents the results for LM unit root test with one break in model C, which shows the same number of rejection with model A, but differs on individual cities. As Sen (2003a) argued that model C is preferable to model A when the break date is treated as unknown, and will yield more reliably estimates the break point. Comparing model A with the no-break case, if the intercept and slope of the interruption are significant, then the C model should be preferred.

Table 2. Results for the LM unit root test with no break

Cities	Z(ρ)	Z(τ)
HF	-16.81	-2.87
HZ	-23.47***	-3.97***
JH	-22.23**	-3.83***
NB	-25.28***	-4.18***
NJ	-21.03**	-3.69**
SH	-7.61	-2.02
WX	-18.56**	-3.40**
WZ	-14.09	-2.86
XZ	-16.16	-2.81
YZ	-28.45***	-4.56***

Note: *, **, *** denote significance levels of 10 percent, 5 percent, 1 percent respectively, at which the null hypothesis of unit root is rejected

Table 3. Results for LM unit root test with one break in Model A

Cities	TB	K	S_{t-1}	B_t
HF	07M10	1	-0.67***	-0.16***
HZ	08M12	0	-0.60***	0.03
JH	09M04	0	-0.67***	-0.07***
NB	12M12	1	-0.95***	-0.08***
NJ	08M11	0	-0.56**	0.04
SH	08M09	0	-0.22	0.01
WX	12M01	4	-0.69**	0.13***
WZ	09M02	0	-0.66***	0.01
XZ	08M10	0	-0.34	-0.03
YZ	08M03	1	-0.76***	0.15***

Note: TB as the date of the structural break; K is the lag length; S_{t-1} is the LM test statistic; B_t is the dummy variable of the structural break in the intercept. *, **, *** denote significance levels of 10 percent, 5 percent, 1 percent respectively, at which the null hypothesis of unit root is rejected

Table 4. Results for LM unit root test with one break in the Model C

Cities	TB	K	$\mathbf{S_{t-1}}$	$\mathbf{B_t}$	$\mathbf{D_t}$
HF	08M12	0	-0.75**	0.04**	0.03**
HZ	07M11	0	-0.76***	-0.04**	0.04***
JH	11M09	1	-0.39	-0.01	-0.004
NB	08M04	4	-0.95***	-0.03	-0.01
NJ	08M03	0	-0.68**	0.03	0.007
SH	07M08	3	-0.38	0.02	0.01
WX	09M04	2	-0.98***	-0.07***	-0.03**
WZ	07M12	0	-0.94***	-0.08***	0.01
XZ	08M12	0	-0.80***	0.09***	-0.01
YZ	12M12	1	-1.01***	-0.07***	0.03***

Note: TB is the date of the structural break; K is the lag length; $S_{t-1}$is the LM test statistic; $B_t$is the dummy variable for the structural break in the intercept.*, **, *** denote significance levels of 10 percent, 5 percent, 1 percent respectively, at which the null hypothesis of unit root is rejected

Table 5 and 6 present the results of model AA and model CC respectively. Consistent with the no-break and one-break cases, model AA and model CC contain a large number of rejections of the unit root null. Model C is preferable to model A in the one-break case, but no clear-cut claims in the two-break case (Sen, 2003a, 2003b). In general, we prefer the results of model CC over model AA, because model CC is more in line with the general case and contains model AA.

Table 5. Results for LM unit root test with two breaks in the intercept

Cities	TB1	TB2	K	$\mathbf{S_{t-1}}$	$\mathbf{B_t}$	$\mathbf{D_t}$
HF	08M06	12M03	1	-0.77***	-0.04	-0.15***
HZ	07M09	11M11	0	-0.64**	0.03	0.02
JH	09M01	12M11	0	-0.77***	-0.02	-0.06***
NB	08M03	12M07	3	-1.01***	-0.08***	0.04
NJ	07M12	12M06	0	-0.75***	0.03	0.04
SH	07M08	12M12	0	0.27	0.02	0.03
WX	09M03	14M06	2	-0.55**	0.10***	-0.02
WZ	08M10	11M04	1	-0.56	-0.03	-0.04
XZ	09M05	14M05	0	-0.62**	-0.06	-0.02
YZ	09M01	14M01	0	-0.78***	-0.00	0.08***

Note: TB_1 and TB_2 are the dates of the structural breaks; K is the lag length; $S_{t-1}$is the LM test statistic;

B_{t1} and B_{t2} are the dummy variables for the structural breaks in the intercept. *, **, *** denote significance levels of 10 percent, 5 percent, 1 percent respectively, at which the null hypothesis of unit root is rejected

Table 6. Results for LM unit root test with two breaks in the intercept and trend

Cities	TB1	TB2	K	S_{-1}	B_{t1}	B_{t2}	D_{t1}	D_{t2}
HF	08M04	13M03	0	-0.98**	0.08***	0.07***	-0.02	0.11***
HZ	07M07	11M07	0	-1.48***	0.04	-0.01	0.01	0.04***
JH	09M06	12M08	1	1.13***	0.09***	0.01	-0.04***	-0.05***
NB	08M06	11M09	0	-1.12***	-0.08***	-0.02	-0.04***	-0.07***
NJ	08M06	12M02	1	-1.41***	-0.04	-0.05**	-0.05***	-0.04***
SH	07M05	12M09	0	-0.94	0.02	-0.01	-0.03***	-0.02***
WX	09M04	14M08	0	-1.07***	-0.04	0.06**	-0.04***	-0.02
WZ	08M06	11M05	2	-1.52***	-0.12***	-0.11***	0.08***	-0.05***
XZ	09M01	14M06	0	-1.40***	0.02	-0.07***	-0.05***	0.03***
YZ	08M10	12M02	0	-2.48***	0.05***	-0.04**	-0.04***	-0.06***

Note: TB_1 and TB_2 are the dates of the structural breaks; K is the lag length; S_{t-1} is the LM test statistic; B_{t1} and B_{t2} are the dummy variables for the structural breaks in the intercept. *, **, *** denote significance levels of 10 percent, 5 percent, 1 percent respectively, at which the null hypothesis of unit root is rejected.

Comparing the model C with the model CC, and if the two methods give different results, the model CC should be preferred when the intercept and slope of the second interrupts are significant. The second break provides more evidence that there is a ripple effect in the house market in the Yangtze River Delta region. What should be especially pointed out is that the use of LM unit root to test residential prices and regional price ratio of Shanghai is not stable, which means that the split or long-term differences, that is, the housing price of Shanghai far away from the housing prices of other cities.

Ideally, we would prefer to consider the location of the structural breaks over a longer period if the data were available. Although the study involved a relatively short period of time, in terms of what structural breaks are being picking up, in the past 10 years, there are several possible structural breaks affect the house price in the Yangtze River Delta region. The location of breaks in this study relates to the economic downturn, the subsequent economic recovery and the deepening and slowing of administrative controls. The first set of breaks occurs in the sub-prime crisis that precipitated the global financial crisis (2007-2008). During this period, house prices in the Yangtze River Delta dropped sharply and rebounded after the crisis. A second set of breaks in concentrated in the deepening of the national real estate control stage (2011-2012). This period introduced a policy of stabilizing housing prices. House prices have fallen sharply in the Yangtze River Delta under a series of regulatory policies.

Granger causality tests were used to detect which cities can drive or guide ripple effects (See Table 7). Shanghai leads the pack, which Granger causes 10 of 11 house prices including the regional house price. Nanjing and Hangzhou come in second Granger causing 8 of 11 house prices including the regional house price. The results indicate that Shanghai, Nanjing and Hangzhou drive the house market.

The finding is consistent with the common perception that in short term, house price in few developed cities lead the house price cycle and diffuse to other cities in the Yangtze River Delta region. Shanghai, Nanjing and Hangzhou are the most developed cities in the Yangtze River Delta region. Their house prices soared in the period prior to the global financial crisis, fell sharply during the global financial crisis and recovered in the aftermath of the crisis. In addition, as a municipality or provincial capital, its housing prices were significantly affected by the policy.

Table 7. Results for Granger causality tests

	SH	NJ	WX	XZ	YZ	HZ	NB	WZ	JH	HF	AVE
SH		6.571***	13.704***	8.115***	14.524***	6.676***	6.263***	2.958*	3.731**	13.977***	3.901**
NJ	0.514		16.636***	16.966***	7.768***	4.605**	3.550**	3.678**	4.375**	10.891***	2.712*
WX	0.884	1.572		6.768***	10.241***	4.555**	1.129	1.929	3.940**	9.154**	4.869**
XZ	0.427	2.254	2.780*		2.907*	1.150	6.122***	7.748***	1.124	7.593***	1.318
YZ	1.393	1.726	5.139**	4.180**		0.972	0.954	3.271*	2.011	10.066***	0.961
HZ	0.475	1.372	3.300*	2.634*	4.219**		10.377***	4.075**	3.649*	9.294***	7.631***
NB	0.050	0.649	2.738*	0.267	7.937***	6.312**		2.287	5.669**	13.384***	1.480
WZ	0.179	0.187	0.677	1.049	0.739	0.938	2.144		2.406*	2.124	3.653*
JH	0.705	0.393	0.839	1.194	3.995*	3.895*	2.963*	12.042***		3.842*	0.539
HF	1.330	0.626	2.662	1.172	3.554*	1.050	5.020**	2.039	1.182		0.475
AVE	0.129	2.728*	9.382***	6.669***	9.203***	5.161**	2.531*	5.329**	4.653**	16.995***	

Note: the vertical means Granger cause; the transverse means being Granger caused; *, **, *** denote significance levels of 10 percent, 5 percent, 1 percent respectively, at which the null hypothesis of unit root is rejected

5. CONCLUSION

The study has tested the ripple effect in the Yangtze River Delta region by linear unit roots tests, panel unit root tests and univariate LM unit root tests with two structural breaks to the ratios of city to regional house prices. The main conclusions are as follows. Firstly, there is overwhelming evidence of the existence of the ripple effects in the Yangtze River Delta region. Secondly, the segmentation is restricted to a small group of the cities, and there is no long-run relationship with the average data of Yangtze River Delta region. Thirdly, the empirical results also illustrate that there are two structural breaks in the development of housing market in the Yangtze River Delta region. The first breakpoint occurred in 2007-2008 for all cities. The second break occurred in 2011-2012 for all cities. These structural breaks in housing market were caused by financial crisis and real estate policies. Finally, based on Granger causality tests, we identify Shanghai, Nanjing and Hangzhou as the cities that drive the house market in the Yangtze River Delta region. One of the limitations of this paper is that the time analysis cycle is a little short, in order to obtain more reliable conclusions, generally the research need to be based on long-term equilibrium. Therefore, in later studies, the amount of data can be increased to ensure the reliability of the study.

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