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Ripple Effect of Housing Prices Fluctuations among Nine Cities of China

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Abstract: This paper applies cointegration test, error correction model, vector error correction model, impulse response analysis and variance decomposition to examine the ripple effect of housing prices fluctuations among Chinese cities during the period of first quarter of 1999 to third quarter of 2008. Empirical analysis indicates that housing prices fluctuations among nine Chinese cities do have ripple effect. We divide the cities into three layers: Beijing, Shanghai as the first layer; Shenyang, Tianjin and Xi'an as the second; and Qingdao, Chongqing, Guangzhou and Dalian as the third one. Empirical results show that: (1) housing prices of municipalities directly under the central government such as Beijing and Shanghai representing the first layer have strong influence and still be the main regulatory objects; (2) cities in the second layer can transmit the fluctuations of housing prices and should be concerned; (3) intense fluctuations of housing prices of cities in the third layer should be avoided. So, the government should make targeted regulatory policies to cities in different layers, which is a more efficient way to control the whole system of housing prices, maintain housing prices in a reasonable range, and eventually achieve the goal of building a harmonious society.
Key Words: housing prices; ripple effect; cointegration test; error correction model; vector error correction model

INTRODUCTION

Subprime crisis triggered by U.S. real estate has led to a hundred-year global financial crisis. Real estate bubble is not only a very important cause of the financial crisis, but also fundamentally shakes the stability of the financial system. China's real estate plays an important role in the national economy development. Real estate market with health and stability is not only a trade issue, in fact, high price implies enormous financial and even social risks: on the one hand, Chinese Floor Space of Vacant Commercial House takes a jump in 2008, from 135 million square meters by the end of 2007 to 164 million square meters. Increasing

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range reaches to 21.8%, which creates a 15 year high, much higher than 10% of the internationally recognized warning line, and the fund tied up is over 250 billion yuan; on the other hand, the mortgage loans proportion of most homebuyers is about 20%, so if house price falls sharply by more than 20%, it will cause a lot of mortgage defaults. They like a " Sword of Damocles" hanging in the bank's head, because China's commercial house developers and buyers mostly rely on bank loans, hence the soaring house price appears that only common people can not afford houses. In essence, the cumulative risk of the bank is the scourge of society.

Foreign scholars centralized researches in regional housing price fluctuations effect: Englund and Ioannides (1997) compared the dynamics of housing prices in fifteen OECD countries and revealed a remarkable degree of similarity across countries (Englund & Yannis, 1997). Meen (1999) argued in Britain house prices exhibited a distinct spatial pattern over time, rising first in a cyclical upswing in the south-east and, then, spreading out over the rest of the country, which was known as the ripple effect (Meen, 1999). Cook (2003) examined the possibility of a ripple effect being present in the UK housing market. The results showed the ripple effect hypothesises that changed in house prices occurred earlier and more extensively in the South East of England than in other regions of the UK (Cook & Thomas, 2003). Berry and Dalton (2004) argued that population density, immigration speed, and geographic location are the main factors leading to house price fluctuations in the view of area coverage (Berry & Dalton, 2004). Cook (2005) used a joint test method to prove the ripple effect existing in house prices of regions in England (Cook, 2005). Zhengqing LUO, etc. (2007) adopted housing price data from 1990 to 2004 and used cointegration method to research on housing price fluctuation effect of eight cities in Australia. The results showed that a 1-1-2-4 diffusion pattern existed within these cities. Sydney was on the top tier with Melbourne in the second; Perth and Adelaide were in the third level and the other four cities lied on the bottom (LUO et al., 2007). Larraz-Iribas and Alfaro-Navarro (2008) investigated regional housing prices in Spain using variable co-integration techniques. It analyzed the asymmetric behavior in real house prices among the Spanish regions (Beatriz & Jose-Luis, 2008). Foreign studies on real estate price generally used econometric models and conducted cointegration test and Granger causality test, but these are based on foreign markets. Because real estate has strong regional characteristics so their results can not be suitable for Chinese condition.

Domestic researches on real estate price were concentrated in a single city or China's overall real estate market with the main purpose of studying the influence factors of house price and the house price’s impact on other economic factors. Representative researches are as follows: “Research on Real Estate Fluctuation Rule of Shang Hai” Seminar (2003) proved that the cobweb model of Shanghai real estate price was not convergent showing the divergent characteristic of positive reaction type. Any supply and demand fluctuations deviatiing from market equilibrium would result in greater fluctuations over time and the relation of supply and demand would be more and more unstable (2003). Gu Wei (2005) applied micro-economics theory to compare Shanghai with United States in real estate price. The results showed that house price in Shanghai had exceeded the average house price in United States and it was more than house prices of New York and Chicago, so they brought up the idea that house price in Shanghai had been overheating (GU, 2005). Liang Yun-fang, etc. (2006) applied the co-integration theory and H-P filter, and concluded that real estate price deviation existed in some regions of China. In other words, the bubble was regional. The interest rate lacked elasticity pointing to the ineffectiveness of efforts to adjust the real estate market through interest rates. But changes in credit scale had great influence on investment in real estate(LIANG et al., 2006). Pi Shun and Wu Kang-ping (2006) found that there was two-way linear Granger Causality between the real estate market and financial market of China, but not nonlinear Granger Causality (PI & WU, 2006). Liang Yun-fang and Gao Tie-mei argued that price fluctuations of commercial buildings and offices in China's current real estate market were relatively stable, while the instability of the market was mainly caused by housing price fluctuation. In various supply factors, the changes of land transaction price had greater impact on changes of housing price in the same direction (LIANG &GAO, 2006). Liang Yun-fang, Gao Tie-mei (2007) dynamically analyzed the factors, which determined real estate price fluctuation, based on error correction model and panel data model. In these models, they considered the impact of monetary policy on house price specially. They suggested that relevant departments could take policies according to local conditions in order to effectively control the increase of house prices (LIANG &GAO, 2007). Bai Shuang (2008) adopted Panel data of economic fundamentals and real estate prices of 31 provinces (cities, districts) excluding Hong Kong, Macao and Taiwan from “China Statistical Yearbook of 2007”, and used regression analysis method to study the determinant factors of real estate price. The results showed that the main factors affecting real estate price were consumer purchasing power, product cost, number of the enterprise, per capita hold of resources, investment condition and tax policy (BAI, 2008). Wang Song-tao, Yang Zan, Liu Hong-yu (2008) applied "ripple effect" theory and used Johansen cointegration test, multivariable Granger causality test and impulse response function method to analyze the interaction of house price among China's five major regional markets but because of data limitations not all related variables are included in regional house price model (WANG et al., 2008). Domestic researches on real estate price can not include all the related variables to the model because of data limitations, or centralize in researching relations of house price and other macroeconomic variables and then less in studying the interaction of house prices with lack of corresponding empirical analyses.

The paper based on relations of real estate prices comprehensively applies cointegration test, vector error correction model, impulse response analysis and variance decomposition method. Through the empirical analysis of real estate selling price indexes of nine cities during the period from first quarter of 1999 to third quarter of 2008, the paper studies the interaction of house prices among cities and the corresponding policy implications.

METHODOLOGIES AND PROCESSES

1. Data resources and processing

This paper selects the quarterly data of Real estate selling price index of nine cities which consist of four municipalities including Beijing, Shanghai, Tianjin, Chongqing and five representative sub-provincial cities including Guangzhou, Shenyang, Qingdao, Dalian and Xi'an in China from first quarter of 1999 to third quarter of 2008. Data are obtained from "China Price Yearbook" and the web site of National Statistics Bureau (www.stats.gov.cn). Econometric analysis software Eviews5.0 is uesd.

X-11 method is emplyed to do seasonal adjustments because of quarterly data. To reduce heteroscedastic effect, we get the nature logs of all data. Each variable is named after the first letter of Pinyin name of each city, which are denoted as follows: Beijing (*lnbj*), Chongqing (*lncq*), Dalian (*lndl*), Guangzhou (*lngz*), Qingdao (*lnqd*), Shanghai (*lnsh*), Shenyang (*lnsy*), Tianjin (*lntj*), Xi'an (*lnxa*).

2. Unit root test

First, to ensure the stationary of time series, we conduct unit root test. Commonly DF (Dickey-Fuller) test, ADF (Augmented Dickey-Fuller) test and PP (Phillips-Perron) test are used. In this paper, we adopt ADF to test the stationary of series.

Unit root test is conducted to test real estate selling price index series of nine cities. Lag order is selected by SIC (Schwarz Info Criterion). Results are shown in Table 1.

Table 1: Results of Augmented Dickey-Fuller Unit Root Test

Variable	Type (C, T, L)	ADF statistic	Critical Value α=1%	Critical Value α=5%	Critical Value α=10%	Conclusion
lnbj	(C,T,1)	-2.602944	-4.226815	-3.536601	-3.200320	Nonstationary
dlnbj	(0,0,0)	-3.962071	-2.628961	-1.950117	-1.611339	Stationary
lncq	(C,0,0)	-1.885183	-3.615588	-2.941145	-2.609066	Nonstationary
dlncq	(0,0,0)	-4.594318	-2.628961	-1.950117	-1.611339	Stationary
lndl	(C,0,0)	-1.850160	-3.615588	-2.941145	-2.609066	Nonstationary
dlndl	(0,0,0)	-9.017889	-2.628961	-1.950117	-1.611339	Stationary
lngz	(C,T,0)	-1.704479	-4.219126	-3.533083	-3.198312	Nonstationary
dlngz	(0,0,0)	-7.853103	-2.628961	-1.950117	-1.611339	Stationary
lnqd	(C,0,0)	-2.167527	-3.615588	-2.941145	-2.609066	Nonstationary
dlnqd	(0,0,0)	-8.383176	-2.628961	-1.950117	-1.611339	Stationary
lnsh	(C,0,1)	-2.176587	-3.621023	-2.943427	-2.610263	Nonstationary
dlnsh	(0,0,0)	-4.399316	-2.628961	-1.950117	-1.611339	Stationary
lnsy	(C,0,0)	-1.754345	-3.615588	-2.941145	-2.609066	Nonstationary

To be continued

Continued

Variable	Type (C, T, L)	ADF statistic	Critical Value α=1%	Critical Value α=5%	Critical Value α=10%	Conclusion
dlnsy	(0,0,0)	-5.980343	-2.628961	-1.950117	-1.611339	Stationary
lntj	(0,0,2)	0.365960	-2.630762	-1.950394	-1.611202	Nonstationary
dlntj	(0,0,1)	-3.914589	-2.630762	-1.950394	-1.611202	Stationary
lnxa	(C,T,0)	-2.026344	-4.219126	-3.533083	-3.198312	Nonstationary
dlnxa	(0,0,0)	-5.174389	-2.628961	-1.950117	-1.611339	Stationary

Remarks: 1．*Dlnbj* is the first difference of *lnbj*, Others are in a simlar way.

2．C: intercept term; T: trend term; L: lag order; α: significance level

ADF statistic is t statistic of the dependent variable after regression. If t statistic is less than the critical value, the null hypothesis is rejected. From Table 1, we can see t statistical value of *lnbj* is -2.602944 and it is larger than the critical value of 10% significance level, so the null hypothesis can not be rejected, that is, the serial has a unit root and it is non-stationary. But for the first difference of *lnbj*, t statistical value is -3.962071, which is less than the critical value of 1% significance level, indicating that in at least 99% confidence level the null hypothesis is rejected, so *dlnbj* doesn't have a unit root and it is a stationary serial. Similarly *lncq*, *lndl*, *lngz*, *lnqd*, *lnsh*, *lnsy*, *lntj* and *lnxa* are nonstationary series, while the first differences of them are stationary. So it can be supposed that *lnbj*, *lncq*, *lndl*, *lngz*, *lnqd*, *lnsh*, *lnsy*, *lntj* and *lnxa* are integrated of order one. The next step is to test whether there are cointegration relationships among house prices of nine cities.

3. Cointegration test

Cointegration test is mainly to analyze whether there are long-term equilibrium relationships among variables. Cointegration theory and method proposed by Engle and Granger in 1987 offer another way for modeling non-stationary series. The paper adopts cointegration test method proposed by Engle and Granger. If the series x_t and y_t are integrated of order d, the regression of x_t to y_t is

$$y_t = \alpha + \beta x_t + \varepsilon_t .$$

$\hat{\alpha}$ and $\hat{\beta}$ are estimated values of regression coefficients, so residual estimated value of the model is

$$\hat{\varepsilon} = y_t - \hat{\alpha} - \hat{\beta} x_t .$$

If $\hat{\varepsilon}$ ~I (0), there is a cointegration relation between x_t and y_t .

Cointegration test to house prices of 9 cities is conducted between every two cities. Taking Beijing and Chongqing for example the following paper is to describe the steps of cointegration test.

The first step is cointegrating regression. The regression equation of *lncq* and *lnbj* is estimated by Ordinary Least Squares (OLS), shown as equations (1) :

$$lnbj = 2.4254 + 0.4766 lncq \qquad (1)$$

(3.1840) (2.9140)

R^2＝0.1867, adjusted R^2＝0.1647.

The second step employs ADF method to test the stationarity of residual *e*. Lag order is selected by SIC. Results are shown in Table 2.

Table 2: Stationary Test on the Residual

Variable	Type (C, T, L)	ADF statistic	Critical value α=1%	Critical value α=5%	Critical value α=10%	Conclusion
e	(0,0,0)	-1.004710	-2.627238	-1.949856	-1.611469	Nonstationary

From Table 2, ADF statistic value is - 1.004710 more than the critical value - 1.611469 of 10% significance level, therefore residual serial *e* is non-stationary. This indicates that there is no equilibrium relationship between *lncq* and *lnbj* and cointegration relationships between other two variables can be drawn in the same way. The residual derived from the regression with *lnbj* as the dependent variable and *lncq* as independent variable is denoted as *ebjcq*, while the residual derived from the regression with *lncq* as the dependent variable and *lnbj* as independent variable is denoted as *ecqbj*. Other residuals are denoted in the same way. The paper tests the stationarity of all residuals of cointegrating regressions and select lag orders by SIC. Results are shown in Table 3.

Table 3: Stationary Test on All Residuals

Variable	Conclusion	Variable	Conclusion	Variable	Conclusion	Variable	Conclusion
ebjcq	nonstationary	*edlgz*	stationary	*eqdsh*	stationary	*esytj*	stationary
ebjdl	stationary	*edlqd*	stationary	*eqdsy*	stationary	*esyxa*	nonstationary
ebjgz	nonstationary	*edlsh*	nonstationary	*eqdtj*	stationary	*etjbj*	stationary
ebjqd	nonstationary	*edlsy*	stationary	*eqdxa*	stationary	*etjcq*	stationary
ebjsh	nonstationary	*edltj*	stationary	*eshbj*	stationary	*etjdl*	stationary
ebjsy	nonstationary	*edlxa*	nonstationary	*eshcq*	stationary	*etjgz*	stationary
ebjtj	nonstationary	*egzbj*	stationary	*eshdl*	nonstationary	*etjqd*	stationary
ebjxa	stationary	*egzcq*	stationary	*eshgz*	stationary	*etjsh*	stationary
ecqbj	stationary	*egzdl*	stationary	*eshqd*	stationary	*etjsy*	stationary
ecqdl	stationary	*egzqd*	stationary	*eshsy*	nonstationary	*etjxa*	stationary
ecqgz	stationary	*egzsh*	stationary	*eshtj*	nonstationary	*exabj*	stationary
ecqqd	stationary	*egzsy*	stationary	*eshxa*	stationary	*exacq*	nonstationary
ecqsh	stationary	*egztj*	stationary	*esybj*	nonstationary	*exadl*	nonstationary
ecqsy	stationary	*egzxa*	nonstationary	*esycq*	stationary	*exagz*	nonstationary
ecqtj	stationary	*eqdbj*	stationary	*esydl*	stationary	*exaqd*	nonstationary
ecqxa	stationary	*eqdcq*	stationary	*esygz*	stationary	*exash*	nonstationary
edlbj	stationary	*eqddl*	stationary	*esyqd*	stationary	*exasy*	nonstationary
edlcq	stationary	*eqdgz*	stationary	*esysh*	stationary	*exatj*	nonstationary

In Table 3, the stationary residuals mean that there are long-term stable equilibrium relations between house prices of the two cities. To further research the direction of the influence between house prices of two cities we establish error correction model below.

4. Error Correction Model (ECM)

According to Granger representation theorem, if there is cointegration between two variables, there is at least one direction Granger causality between them, and a set of variables with cointegration is sure to build a error correction model. Therefore, we can build error correction models of house prices of every two cities to judge their Granger causality relationships.

Error Correction Model is given as follows:

$$\Delta y_t = \beta_0 + \beta_1 \Delta x_t + \lambda ecm_{t-1} + \varepsilon_t .$$

In the equation Δy_t and Δx_t is the first difference of y_t and x_t, λ is adjustment coefficient, and ecm_{t-1} is error correction term when the long-term equilibrium relation is $y_t = \alpha + \beta x_t + \varepsilon_t$, $ecm_{t-1} = y_{t-1} - \alpha - \beta x_{t-1}$.

Then using OLS method does regression on the equation above, and we can get β_1 and λ of each error correction model. Results are shown in Table 4.

Table 4: β_1 and λ of Error Correction Model

Δx		Δy		
		lnbj	*lncq*	*lndl*
lnbj	β_1		--	0.048478
	λ		--	-0.149626**
lncq	β_1	0.585001		0.138063
	λ	-0.214581**		-0.183245***
lndl	β_1	0.463370	0.041636	
	λ	-0.394245**	-0.232336**	
lngz	β_1	0.628756	0.016466	0.057448
	λ	-0.289874**	-0.175975**	-0.282276**
lnqd	β_1	0.391823	0.106048	0.054656
	λ	-0.222349**	-0.282694**	-0.202149***
lnsh	β_1	0.088299	0.534397	--
	λ	-0.103610	-0.076891	--
lnsy	β_1	--	0.528188	0.115262
	λ	--	-0.288929**	-0.163924
lntj	β_1	0.145470	0.351705	0.067327
	λ	-0.072892	-0.164254	-0.081308
lnxa	β_1	0.257969	--	--
	λ	-0.269305**	--	--
lnbj	*β1*	--	--	--
	λ	--	--	--
lncq	*β1*	0.013360	0.011685	0.142388
	λ	-0.195710***	-0.330378*	-0.321113*
lndl	*β1*	0.061576	-0.076474	--
	λ	-0.345514*	-0.214515**	--
lngz	*β1*		0.039622	-0.055448
	λ		-0.183833**	-0.166405**
lnqd	*β1*	0.177245		0.062195
	λ	-0.204948***		-0.501022*
lnsh	*β1*	-0.143979	0.090614	

To be continued

Continued

Δx		Δy		
		lngz	*lnqd*	*lnsh*
	λ	-0.099349	-0.263332**	
lnsy	β_1	0.001067	0.184467	0.152623
	λ	-0.141050	-0.329990*	-0.274555**
lntj	β_1	0.143791	0.002092	0.053623
	λ	-0.078301	-0.204387*	-0.185786**
lnxa	β_1	--	--	--
	λ	--	--	--
Δx		Δy		
		lnsy	*lntj*	*lnxa*
lnbj	β_1	--	--	0.395490
	λ	--	--	-0.051917
lncq	β_1	0.418865	0.738122	1.382646
	λ	-0.403897*	-0.406469*	-0.244483**
lndl	β_1	0.063328	0.057282	--
	λ	-0.229785**	-0.284051**	--
lngz	β_1	-0.065329	0.127556	--
	λ	-0.219768**	-0.252589**	--
lnqd	β_1	0.358023	0.220874	-0.185348
	λ	-0.321871**	-0.273633***	-0.192887***
lnsh	β_1	--	--	0.984375
	λ	--	--	-0.091601
lnsy	β_1		0.929515	--
	λ		-0.501714*	--
lntj	β_1	0.276636		0.513711
	λ	-0.385978*		-0.071341
lnxa	β_1	--	--	
	λ	--	--	

Remarks: *, ** and *** denote λ is repectively significant at the 1%, 5% and 10% significant level.

Excluding error correction models of which λ is not significant we can get Granger causality relations of house prices of every two cities. Granger causalities of city house prices are shown in Figure 1.

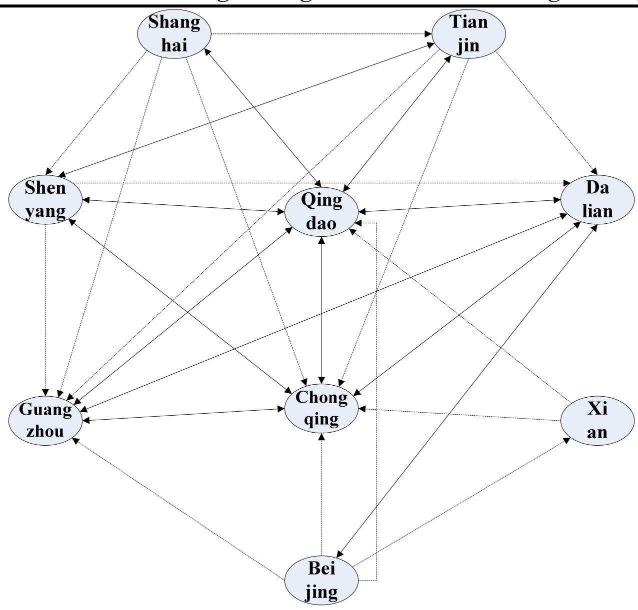

Figure 1: Granger Causalities among Housing Prices of Cities

Remarks: Dashed lines denote one-way Granger causality relations, and real lines denote two-way Granger causality relations. For example, there is a two-way Granger causality relation between Beijing and Dalian, but there is a one-way Granger causality relation between Beijing and Xi'an and the direction is house price of Beijing Granger causes house price of Xi'an.

5. Vector Error Correction Model (VECM)

Here we take Beijing and Dalian for example to concretely analyze the interaction of house prices of two cities.

1) Cointegration test

For unit root test has been conducted to prove *lnbj* and *lndl* series are integrated of order one, so we can directly carry out cointegration test. Due to the establishment of vector error correction model, here Johansen cointegration test method is adopted to test whether there is a long-term equilibrium relationship between two variables. According to unconstrained Vector Autoregression (VAR) model and kinds of information criterions, the optimal lag order is 9. For the lag order of cointegration test is that of first difference of variables so it is equal to the optimal lag order of unconstrained VAR model minus one, then the lag order of cointegration test is 8.

The obesrved serial has a linear deterministic trend and the cointegration equation has intercept term. Results are shown in Table 5.

Table 5: Johansen Cointegration Test

Null hypothesis	eigenvalue	Trace statistic	5% critical value	Probability value**
None*	0.609666	28.31920	15.49471	0.0004
At most 1	0.003215	0.096612	3.841466	0.7559

Remarks：* denotes null hypothesis is rejected at 5% significant level.

From Table 5, at 5% significant level there is only one cointegration relation, which indicates there is a long-term equilibrium relation between *lnbj* and *lndl*. Cointegration equation is shown as follows:

$$lnbj = 1.235666 lndl - 1.088607 \qquad (2)$$

When Real estate selling price index of Dalian changes 1%, it causes a change 1.24% in that of Beijing. There is a positive equilibrium relation between the two.

2) VECM

As we already verified there is a cointegration relationship between two variables, so a VECM will be established next to research the long-term and short-term relations of two variables in the system. The lag order of VECM is the optimal lag order determined by unconstrained VAR model and kind of information criterions minus one, then the lag order of VECM is 8. Estimated results are seen in equation (3).

$$\Delta lnbj = -0.3341(lnbj(-1) - 1.2357lndl(-1) + 1.0886) + 0.4636\Delta lnbj(-1) - 0.1626\Delta lnbj(-2) + 0.1215\Delta lnbj(-3) - 0.2232\Delta lnbj(-4) + 0.1934\Delta lnbj(-5) - 0.1348\Delta lnbj(-6) - 0.0968\Delta lnbj(-7) - 0.6206\Delta lnbj(-8) - 0.1963\Delta lndl(-1) - 0.2509\Delta lndl(-2) - 0.1317\Delta lndl(-3) - 0.2791\Delta lndl(-4) - 0.2157\Delta lndl(-5) - 0.0546\Delta lndl(-6) - 0.0579\Delta lndl(-7) - 0.0249\Delta lndl(-8) + 0.0063 \quad (3)$$

$R^2 = 0.74$, adjusted $R^2 = 0.36$.

It can be seen from the error correction model that the fluctuation of explained variable *lnbj* is caused by two parts, one is the direct impact of first differences of *lnbj* and *lndl* in the short-term, and the other one is the adjustment of long-term equilibrium relation. Error correction coefficient in Equation (3) is -0.3341 indicating the convergence mechanism which prevents deviating from long-run equilibrium is at work. When the short-term fluctuation of real estate selling price index of Beijing deviates from long-run equilibrium, the economic system will draw non-equilibrium state back to equilibrium state with the adjustment of 0.3341.

3) Impulse response function

The basic idea of the impulse response function is to analyze the impact of the impulse of random disturbance unit standard deviation on the current and future values of each endogenous variable. When the generalized impulse response method is adopted, if a positive impact is on *lndl*, we can get the generalized impulse response function of *lnbj* which is shown in Figure 2. Similarly, if a positive impact is on *lnbj*, we can get the generalized impulse response function of *lndl* which is shown in Figure 3.

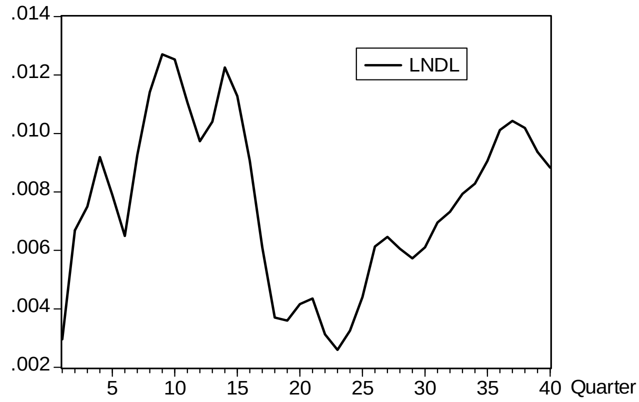

Figure 2: Response of *lnbj* to Generalized One S.D. *lndl* Innovation

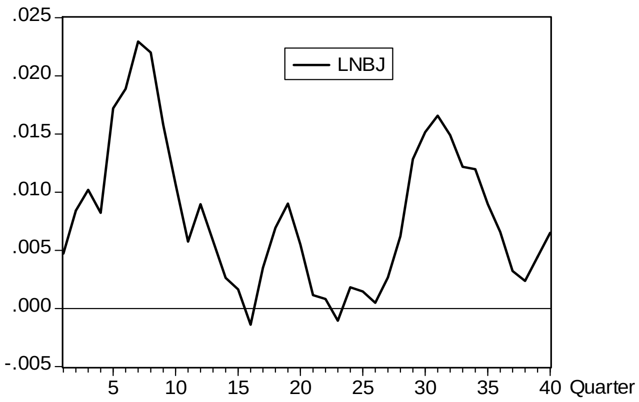

Figure 3: Response of *lndl* to Generalized One S.D. *lnbj* Innovation

In Figure 2, the horizontal axis denotes the lag period of impulse (Unit: quarter), and the vertical axis denotes the response of real estate selling price of Beijing impulsed by real estate selling price of Dalian. It can be seen from Figure 2 that when real estate selling price in Dalian is received a positive impulse in the current period, real estate selling price in Beijing will have a great positive change in the short term which continues and in the ninth period reaches the maximum value 0.012709. Although the response has violent volatilities since then, it always maintain positive indicating that when real estate selling price in Dalian shocked by external conditions, it will transfer the effect to real estate selling price in Beijing rapidly and bring homodromous shock to Beijing.

Similarly, in Figure 3 the horizontal axis denotes the lag period of impulse (Unit: quarter), and the vertical axis denotes the response of real estate selling price in Dalian impulsed by real estate selling price in Beijing. It can be seen from Figure 3 that when real estate selling price in Beijing is received a positive impulse in the current period, it will make a continued and positive impact on real estate selling price in Dalian which reaches the maximum value 0.022949 in the seventh period.

Results of impulse response analysis show that real estate selling prices of Beijing and Dalian have interactions, while the effect of house prices of Beijing to Dalian is bigger than the effect of that of Dalian to Beijing and the time to achieve the maximum value is also shorter indicating that the conduction velocity of the impulse from real estate market of Beijing to Dalian is faster. All these argue that real estate selling price of Beijing has much greater influence on that of Dalian.

4) Variance decomposition

Variance decomposition is to decompose fluctuation of every endogenous variable in the system into parts which are associated with random disturbance terms of equations according to causes and in order to understand the relative importances of random disturbance terms to endogenous variables in the model.

Variance Decompositions of *lnbj* and *lndl* are carried out, of which the results are shown in Figure 4 and Figure 5.

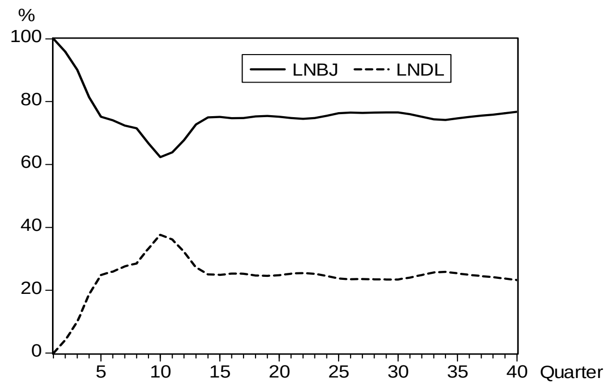

Figure 4: Variance Decomposition of *lnbj*

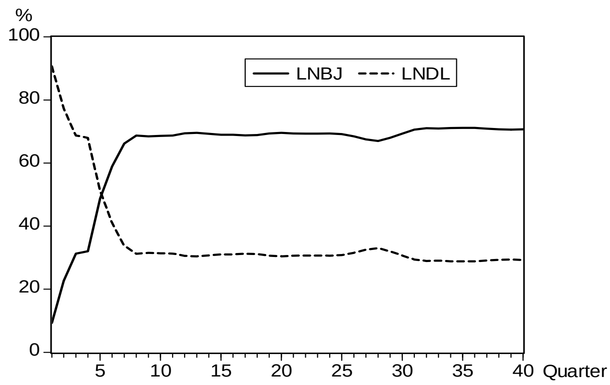

Figure 5: Variance Decomposition of *lndl*

In Figure 4, the horizontal axis denotes the lag period (Unit: quarter), and the vertical axis denotes the contribution rate of two variables to real estate selling price in Beijing (unit: percentage). As can be seen from Figure 4, in the short term, the contribution rate of real estate selling price of Beijing to itself accounts for much and the average contribution rate is about 74.1% in the long term. In addition to Beijing's own contribution rate, the contribution rate of Dalian to Beijing remained at around 25.9% in the long term. Similarly, In Figure 5, the horizontal axis denotes the lag period (Unit: quarter), and the vertical axis denotes the contribution rate of two variables to real estate selling price in Dalian (unit: percentage). As can be seen from Figure 5, in the short term, the contribution rate of real estate selling price of Dalian to itself accounts for much, but over time, the contribution rate of Beijing to Dalian is gradually increasing and in the long term the average rate is 69.5%.

Results of variance decomposition show that for real estate selling price of Beijing, its own contribution rate is bigger while for real estate selling pric of Dalian, the contribution of Beijing is more obvious. From this it can be seen that Beijing's real estate selling price is more dominated by itselves, while real estate selling price of Dalian are much impacted by Beijing.

Through the above analysis it can be drawn that in the long run there is a stable equilibrium relationship of house prices between Beijing and Dalian, and when Real estate selling price index of Dalian changes 1%, it causes a change of 1.24% in that of Beijing. Through impulse response and variance decomposition it can be drawn that house prices of Dalian and Beijing influence each other, but the impact of house price of Beijing on Dalian is greater than the impact of house price of Dalian on Beijing.

All the relationships of house prices between every two cities can be obtained through the above steps. Taking Shanghai and Qingdao for example, it can be drawn house price of Shanghai is much affected by house price of Qingdao, and house price of Qingdao contributes much to Shanghai's house price, so house price of Shanghai and Qingdao influence each other while the influence of house price of Qingdao to Shanghai is larger than the influence of house price of Shanghai to Qingdao. Analyses for other cities are not listed here.

ANALYSIS ON EMPIRICAL RESULTS AND DISCUSSIONS

We can get the relations of house prices of cities from Figure 1 so the outdegree and indegree of each city can be counted. Results are shown in Table 6.

Table 6: Statistics on Outdegree and Indegree

City	Out-degree	In-degree	Sum	City	Out-degree	In-degree	Sum	City	Out-degree	In-degree	Sum
Beijing	5	1	6	Guang-zhou	3	7	10	Shenyang	5	4	9
Chong-qing	4	8	12	Qingdao	6	8	14	Tianjin	5	3	8
Dalian	4	6	10	Shanghai	5	1	6	Xi'an	2	1	3

Remarks: One city's outdegree denotes the number of cities whose house price is influenced by that city. One city's indegree denotes the number of cities whose house price iinfluences that city. Taking Beijing for example, it's outdegree is 5 which denotes house price of Beijing Granger causes house prices of 5 cities and it's indegree is 1 which house price of only one city Granger causes house price of Beijing.

The influence of house prices of cities can be obtained from the statistics of outdegrees and indegrees. Results are shown in Table 7.

From Table 7, in the most influential cities, Beijing, Shanghai and Tianjin on behalf of municipalities show their influences on house prices of other cities and play a guidance role. While the direct links of house prices among these three municipalities are not obvious, it shows the relative independence of each. Shenyang is one of the most influential cities and a inland provincial capital, which may be associated with its geographic location. Qingdao reflects the influence of coastal cities to other cities in house price, on the one hand it is in the Central Plains of China so it has radiometric force, on the other hand Qingdao is suitable for living in and it is a tourist city combined with large activities like Qingdao Olympic Sailing to enhance its international and domestic influence, thus it improves the whole city's influence.

Xi'an and Guangzhou are two cities with least influence. Xi'an as the capital of less developed province, is relatively weak in economic influence, so the influence of house price on other cities is also weak. Guangzhou doesn't not reflect the influence of cities in south of the Yangtze.

The most vulnerable cities are Qingdao and Dalian as the representatives of coastal cities and Chongqing on behalf of inland cities. Qingdao and Dalian are typical coastal tourist cities, and their climatic conditions are suitable for pepole, so they can attract a large number of outlanders to live in or invest to them. Therefore their prices are easily influenced by house prices of other cities. Chongqing as an inland city influences poorly on other cities but is relatively more influenced by other cities. Guangzhou is also easily influenced so it's house price doesn't have independence.

Beijing and Shanghai are most unaffected cities so their house prices are relatively independent.

Qingdao as the most influential city and at the same time the most vulnerable city indicates it is the most volatile city in the system. Xi'an is not easily influenced by other cities and also less affects other cities, so it is in a relatively marginal position in the system, which is related with its economic development level and geographical location.

In addition, the study also finds some special cases. For example, real estate selling price of Beijing is only influenced by Dalian, and real estate selling price of Shanghai is only influenced by Qingdao and so on. These suggest that the influences of the coastal open cities are increasing and their house prices fluctuations in some extent even can affect the volatility of house prices of large cities.

Through the above analysis of empirical results and discussions, house prices fluctuations among nine Chinese cities do have ripple effect. And the study divides 9 cities into three layers: Beijing and Shanghai in the first layer playing the guiding roles on the other cities; Shenyang, Tianjin and Xi'an are in the second layer, house prices of which are influenced by the first layer cities and they can also transfer the impacts to the next layer; Qingdao, Chongqing, Guangzhou and Dalian in the third layer are vulnerable to the impact of other cities, thus their house prices fluctuate more easily, while it is able to feedback the fluctuations to the upper two layers.

Table 7: Influence of Cities

Item	City
The most influential cities	Qingdao, Beijing, Shanghai, Shenyang, Tianjin
The least influential cities	Xi'an, Guangzhou
The most vulnerable cities	Qingdao, Chongqing, Guangzhou, Dalian
The most unaffected cities	Beijing, Shanghai, Xi'an
The most volatile cities	Qingdao
Relatively independent cities	Xi'an

CONCLUSIONS

Contributions of this paper lie in applying econometric methods such as cointegration test, error correction model, vector error correction model, impulse response analysis and variance decomposition to analyze the relations of real estate selling prices among nine cities in China, getting the influence power of house price of each city and providing empirical evidences to reasonably control house prices in China. Through empirical analysis we divide the cities into three layers: Beijing, Shanghai as the first layer; Shenyang, Tianjin and Xi'an as the second; and Qingdao, Chongqing, Guangzhou and Dalian as the third one.. The fluctuation direction is from the first layer to the third layer. Conclusions of the paper are as follows:

1. House prices of municipalities still be the main regulatory objects

From the analysis Beijing and Shanghai as representatives of municipalities have strong influences on other cities, therefore, it will play a significant role in the system to control house prices of municipalities. The study also finds that house prices in Beijing and Shanghai do not have direct correlation so they both are relative independent. The regulation will not have to adopt the same policy, but can be targeted according to geographical characteristics and radiation ranges of the two cities.

2. Cities in the second layer should be concerned;

In the past regulations, Shenyang as a inland provincial capital was not very concerned, but through empirical analysis although house price in Shenyang does not change first when house prices are rising, but Shenyang as the city in the second layer still has a strong influence. On the one hand it may be associated with its location, on the other hand it may relate with the city's cultural heritage. Although the influence of Xi'an is weak, but still the city can be a bond to transfer fluctuations. Therefore, Shenyang, Xi'an and Tianjin should be the main targets of regulations and they should play a certain role in the control.

3. Intense fluctuations of house prices of cities in the third layer should be avoided.

House pricess of cities in the third layer are most volatile because they subject to the fluctuations transferred from the first layer, the second layer and the interaction of the same layer. Such fluctuations can also be responsed to the previous two layers. Especially Qingdao as the most influential city and most vulnerable city in house price is in an active position in the whole system. Policies should be strengthened to concern with such cities and flexible regulatory policies should be adopted to avoid sharp price fluctuations, so as to achieve the purpose of stabilizing house prices of the whole system.

These are obtained from empirical analysis. Through classification of nine cities it not only provides objective evidences for controlling the house price system, but also lays the foundation for further research on relations of Chinese house prices. So, the government should make targeted regulatory policies to cities in different layers, which is a more efficient way to control the whole system's house prices, maintain house prices in a reasonable range, ease people's survival pressure and eventually achieve the goal of building a harmonious society.

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