

Correlation model analysis on the land price fluctuations in Beijing and Tianjin City in China

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Abstract

According to the indexes of the city land price, the co-integration analysis, the Granger causality test, the impulse response function and the variance decomposition method were used in this paper to analyse the correlation model of the land price fluctuations in Beijing and Tianjin city in China. The results showed that the land prices in Beijing and Tianjin city had a long-term co-integration relationship. The Granger test model showed that the land prices in Beijing and Tianjin city was in line with positive correlation bidirectional causality. In addition, the raise of 1% land price in Beijing city caused a raise of 0.96% in Tianjin city. Conversely, a raise of 1% in Tianjin city caused a raise of 1.03% in Beijing city. By comparing the mutual influence degree, the land price fluctuations in Beijing city had a greater influence on that in Tianjin city.

Keywords: Land price fluctuation model, Co-integration test, Granger causality model, Impulse response function

1 Introduction

The continuously rising about land price in large and medium-sized cities in China causes public concerns. Urban land prices represent regional markets with obvious heterogeneity. However, such prices do not exclude the spatial relevance about the land price of regional cities in China. The research about the regional relevance model of urban land prices plays an important role in helping city governments to implement regulatory policies in housing markets.

Abundant studies have been done to regarding the internal relationship model between regional housing prices and price conduction. In 1982, Mcavinchey and MacLennan studied the expansion rate of the regional housing price in the United Kingdom [1]. In the 1990s, according to Holmans' study, the changes in house prices in the southeast region of the UK lead to changes in the house prices in other regions and this phenomenon, in terms of price fluctuations, is referred to in academic circles as the "Ripple Effect" [2]. Currently, a large number of studies support this viewpoint. Giussani and Hadjimatheou studied the relative changes of housing prices in the southeast and the northwest regions in UK [3]. By the Engle-Granger test method and the Johansen co-integration test, MacDonald and Taylor studied the co-integration relationship of regional housing prices in the UK [4]. Alexander and Barrow (1994) validated the existing co-integration relationships in regional housing prices in the UK [5]. The price of urban housing in the southeast region of the UK follows the Granger theory of fluctuation of urban housing prices, with the ripple effect

spreading to the southern region. Based on a spatial econometrics and co-integration theory, Meen studied the regional housing prices in the UK, which indicates that the rate of price fluctuations will stabilize in the long term even though housing prices fluctuate in the short term, [6]. Cook pointed that regional housing prices in the UK are convergent, and when the housing prices in the southern region of the UK fluctuated, the equilibrium state would be returned quickly [7, 8], which in turn verified the existence of a stable long-term relationship in regional housing prices. By the method of unit root tests of panel data, Holmes studied the variations in regional housing prices in the UK and found that the most regional housing prices were convergent [9]. Based on the changes in regional housing prices in the northeast and mid-east regions of America, Pollakowski and Ray found that the housing prices in adjacent metropolitan areas were conductive [10]. Gupta and Miller used the ripple effect theory to analyse the relationship of housing prices in some American cities through time-series data [11]. Oikarinen and Liu investigated the changes in regional housing prices in the interval between Finland and Australia, respectively [12, 13]. At present, no consensus has been reached on the reasons of the regional price fluctuation. The most notable research is the one conducted by Meen [14]. According to existing Literatures, the family migration, wealth transfer, transaction and search costs, spatial arbitrage and exogenous shock with spatial time-lag effect should be included to resolve this phenomenon.

In China, scholars pay more attention to the influence factors on urban and national housing prices. However,

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less attention was paid to the relevance of housing price fluctuations model between different cities. Only a few scholars have successively did research into the ripple effect of housing prices based on some related foreign studies. Liang et al. [15] compared the fluctuations of housing prices in various cities and found obvious regional imbalances. In order to explore the formative reasons, they further studied the differences in the regional fluctuation of housing prices by constructing a model of panel data. Hong studied the linkage of real estate prices about various Chinese cities [16]. With the methods of the Johansen co-integration regression test and the multi-variable Granger test of causality and impulse response function (IRF), Wang et al. drew on the ripple theory and analysed the interactive relationship model between housing prices in the cities of five major Chinese regional markets [17]. These studies indicated that the significant differences exist in short-term fluctuations in urban housing prices, while a stable competitive relationship could be observed in the longer term fluctuations.

Based on the studies conducted by scholars in China and other countries, it could be argued that the scholars in other Countries have done relatively extensive studies on the fluctuations of regional housing prices. Although the time for these researches was relatively short, the contexts of the foreign studies cover a wide range of factors and focus more on the theoretical exploration. Scholars in other countries adopted an econometric method to quantitatively analyse the relevance of the fluctuations of regional prices.

Based on the research methods from scholars in other countries, and taking the actual situation in China into consideration, scholars in China conducted their studies about the fluctuation of regional urban housing prices. The results verified the existence of the ripple effect, and the reasons were preliminarily discussed. According to the existing references, the studies specializing in the relevance model of land prices in China's mega-cities are rare. In this paper, the land prices in the mega-cities of Beijing and Tianjin were selected as the main research objects. The relevance model study about land price for different cities is of great significance. For China, the acquisition of a linkage mechanism of the land prices between cities can provide a reference point for governments to make decisions to establish differentiated regulatory policies.

2 Data Resources and Study Methods

Urban housing price can reflect the urban land prices. In this paper, the aggregative indexes of urban housing prices in Beijing and Tianjin are selected for analysis. Selection for price index can reduce heteroscedasticity among data, increase the stationarity of series and eliminate the effect on the results. The data obtained from monthly monitoring data was selected from 2005 to August of 2012, which is from the China Index Research

Center, the Beijing Bureau of Statistics and the Real Estate Information NET.

The fluctuation of urban land prices will bring corresponding changes to the urban land prices of adjacent regions. The key for studying the relevance of the fluctuation of regional urban land prices is to discuss how and why the regional land prices fluctuate. By using Eview 6.0 analysis software and adopting co-integration analysis, the Granger causality test, the impulse response function and the variance decomposition method, the relevance mechanism on the fluctuation of urban land prices was analysed and the model is built as follows [18-25]:

$$HPB_t = C + \alpha \times HPA_t + \varepsilon_t, \quad (1)$$

where, HPB_t represents the land price index of B city, i.e., the affected city; HPA_t represents the land price index of A city, i.e., the land price of this city changes first; C is a constant; α is the coefficient; ε_t is the random variable.

3 Empirical Analysis

3.1 CORRELATION MODEL ANALYSIS ON THE URBAN LAND PRICES BETWEEN BEIJING AND TIANJIN CITY

From Figure 1 and Figure 2 the change trends about the urban land prices of Beijing and Tianjin city show relatively high consistency.

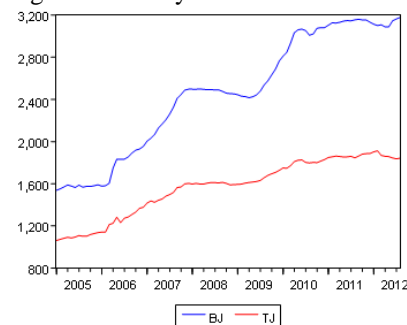


FIGURE 1 Sequence correlation diagram of land prices in Beijing and Tianjin

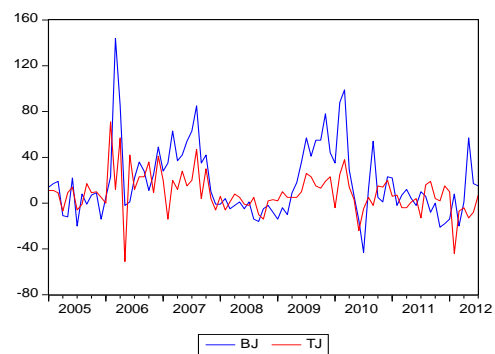


FIGURE 2 Changing sequence correlation diagram of land prices in Beijing and Tianjin

The changes amplitude of the urban land prices in Beijing city is higher than that in Tianjin city. Therefore, it can be concluded that the changes of urban land prices in Beijing and Tianjin embody a relevance model.

3.2 DATA STATIONARITY TEST

A co-integration test requires the same integration order for different variables. In order to apply the co-integration theory to test the long-term relationship between the variables of the urban land prices in Beijing and Tianjin city, the stationarity of the variables is tested firstly. The “stationarity of time series” generally refers to the fact

that the statistical rule of time series changes little along with time. In other words, the process of generating random variable does not change along with time. The ADF model is adopted to conduct a unit root test on the time series of land prices for the two cities, and the results are shown in Table 1. The results indicate that the time series of an urban price index are not stationary, but by ordinary differential analysis, each time series is stationary and can be seen as a first order integrated series I(1). Based on the unit root test, the co-integration relationship between the time series of the urban land prices in both cities could be tested by I (1).

TABLE 1 Unit root test on the time series of land prices in Beijing and Tianjin city

Variate	Test Type (c,t,n)	ADF statistical magnitude	1% critical value	5% critical value	Inspection results
BJ	c,0,0	-1.0798	-3.5047	-2.8939	nonstationary
TJ	c,0,0	-2.4314	-3.5039	-2.8936	nonstationary
D(BJ)	c,0,1	-4.7010	-3.5047	-2.8939	steady
D(TJ)	c,0,1	-4.8275	-3.5056	-2.8943	steady

Notes: D(BJ) and D(TJ) are the original sequence of first order difference. (c,t,n) are respectively constant term, trends, and lag order number.

3.3 JOGANSEN CO-INTEGRATION TEST

The main principle of the Johansen test is that if the co-integration vector matrix contains a non-zero characteristic root and how many non-zero characteristic roots are contained. The existence of non-zero characteristic roots can indicate that there is a co-integration relationship among various time series. The Trace Statistic and Max-Eigen Statistic could be applied

to conduct this test. The test shows that the system has no linear trend, and the co-integration equation has intercept terms but no trend terms. The results in Table 2 indicate that under the level of 5%, the Trace Statistic and Max-Eigen Statistic exists a co-integration relationship, and a long-term equilibrium relationship exists between the urban land prices in Beijing and Tianjin city.

TABLE 2 Johansen test between urban land prices in Beijing and Tianjin city

Original hypothesis cointegration equation	Eigenvalue	Trace Test	Trace Test C.V.	Maximum Eigenvalue	Maximum Eigenvalue C.V.
None *	0.16269	21.9879	20.2618	15.9810	15.8921
At most 1	0.06456	6.0069	9.1645	6.0069	9.1645

Notes: “*” is that refused to the original assumption under the 0.05% significant level.

3.4 GRANGER CAUSALITY TEST

The co-integration test illustrates that there is a long-term equilibrium among variables. However, further testing needs to be done to ensure if the causality exists. Granger proposed a simple test program, which is habitually called as the Granger causality test. Granger used the relationship between time series to define the causality, and proposed an econometrical definition of causality as follows. If y could be used to estimate another quantity x, the y would be regarded as being able to cause x. The test model for this theory is as follows:

$$Y_t = \sum_{i=1}^m \alpha_i X_{t-i} + \sum_{i=1}^m \beta_i Y_{t-i} + \mu_{1t} \tag{2}$$

$$X_t = \sum_{i=1}^m \lambda_i Y_{t-i} + \sum_{i=1}^m \phi_i X_{t-i} + \mu_{2t} \tag{3}$$

By constructing F statistics, the null hypothesis of F test without Granger causality is used.

$$H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = L = \beta_i = 0, i = 1, 2.$$

The test results could be obtained by comparing the F statistics and the size of critical value. If F is greater than the critical value, he null hypothesis that “Y is not the cause of X” should be rejected. In other words, Y is the cause of X. If F is smaller than the critical value, the null hypothesis could not be rejected, which means that X is not the cause of Y.

According to the above ADF test results, the first order differences of the urban land price indexes in Beijing and Tianjin city are both stationary series, therefore, the test of Granger causality can be conducted. As far as the Ganger causality test, the lagged difference shall be set artificially. The lagged order could exert a significant influence on the results, and a lower order would result in some of the important variables being

ignored. A higher order would reduce the degree of freedom of the model, and a larger standard deviation occurs to parameter estimation, and thus, the level of precision is decreased. In this paper, the determination of lag period establishment was carried out according to the

lag length criteria. From Table 3, the minimum lag period provided by each of the five evaluation indexes should be represented by “*”. According to AIC and SC minimum criteria, the optimal lag period is selected as the second period.

TABLE 3 Criteria to determine VAR lag length and appropriate lag order number

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1147.113	NA	4.22e+08	25.53584	25.59139	25.55824
1	-803.6885	663.9536	223546.3	17.99308	18.15973	18.06028
2	-779.1029	46.43956*	141505.6*	17.53562*	17.81338*	17.64763*

The diffusing directions of the two variable land prices in Beijing and Tianjin city are investigated, and the Granger causality test is applied. The results in Table 4 show that a bi-directional causality exists between the

land prices in Beijing and Tianjin city. In other words, changes in the land prices in Tianjin cause changes in the land prices in Beijing, and vice versa.

TABLE 4 Granger causality test

Null Hypothesis:	F-Statistic	Prob.	Results
D(TJ) does not Granger Cause D(BJ)	4.2753	0.0170	Accept
D(BJ) does not Granger Cause D(TJ)	7.8177	0.0007	Accept

3.5 ANALYSIS ON THE IMPULSE RESPONSE AND CONTRIBUTION

The above research analysed the long-term equilibrium relationship between land prices in Beijing and Tianjin city was, and the causality between them was also discovered. To further understand the change rule within a certain period and the impact on their long-term equilibrium relationship, both impulse response analysis

and variance decomposition based on co-integration analysis are required.

3.5.1 Impulse response analysis

Impulse response analysis is generally conducted by observing the graph of impulse response function. This function depicts the response to great or small error changes.

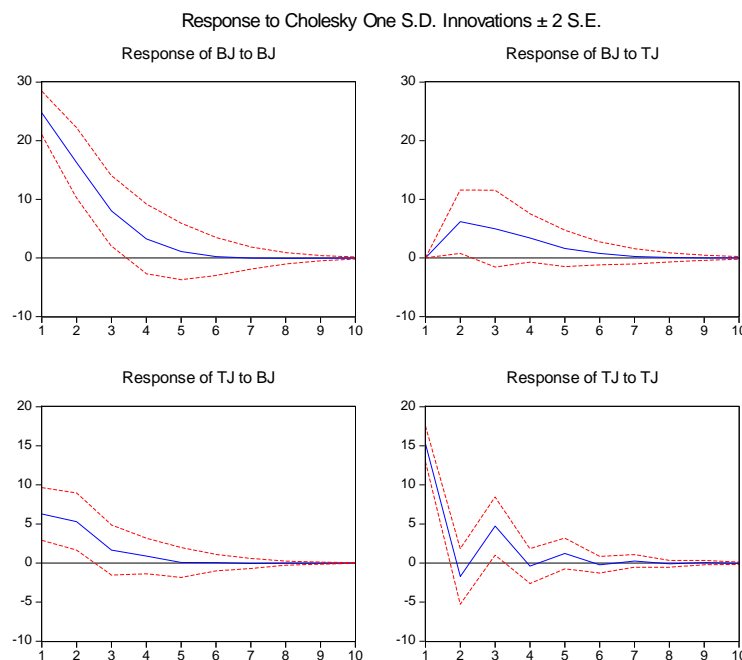


FIGURE 3 Impulse response function of land prices in Beijing and Tianjin

Supposing the random disturbance term is impacted by a standard deviation, the variables will always be affected both currently and for several years after the initial deviation, i.e., the influence of change or the

impact of each endogenous variable on itself and other endogenous variables. Figure 3 indicates the investigation of the response paths of the two variables – land prices in Beijing and Tianjin - within 10 units of time for the

impact on price when the given land price impact is 1%. The solid lines represent the change traces of BJ and TJ after being impacted; the dotted lines represent the values of BJ and TJ adding and subtracting twice the standard deviation, indicating the maximum range possibly influenced by BJ and TJ after being impacted, i.e., the attained upper and lower limits.

Figure 3 shows that after a random disturbance on one of its standard deviations, the land price in Beijing shows an immediate strong reaction by rising about 25 grades of intensity. Its impulse curve reveals a decline in the first four months, then gradually climbs back, basically keeping a position near to zero and then practically disappearing in the seventh month. All these influences are positive. After the land price in Beijing affected by a standard deviation, the land price in Tianjin is also impacted, which is not a direct price rise in the same month, but a maximum influence in the next month with an increase in intensity of five grades? Then the increase rate gradually falls back and practically disappears in the eighth month, and also, all these influences are positive. This indicates that if the land price in Beijing rises due to the influence of certain factors, the stimulatory effect will not last too long. This in turn indicates that when the land price itself undergoes a smooth development, the residents' purchasing power will be relatively stable. Even the factors or events prompt centralized consumption by residents over a certain period of time,

an increase in long-term consumption will not follow.

After a random disturbance caused by one of its standard deviations, the land price in Tianjin also shows a relatively strong reaction with a rise of 15 grades of intensity. Its impulse curve presents a diminishing waveform with two months as a cycle, and practically disappears in the eighth month. Tianjin imposed a smaller level of disturbance on Beijing, and such disturbance gradually descends and practically disappears in the fifth month.

3.5.2 Contribution analysis

When a certain variable of the system suffers from one unit of impact, the degree of the interaction between variables could be reflected by a variance in the percentage of prediction errors of the variables, which is the variance decomposition. This variance decomposition could offer relatively important random information. To be specific, the change of each endogenous variable is decomposed into components associated with various random disturbance terms, according to the cause of the change, so that the relative importance of each innovation to the endogenous variables of the model can be understood. The variance decomposition analysis is required to investigate the factors influencing the fluctuation of land prices in Beijing and Tianjin.

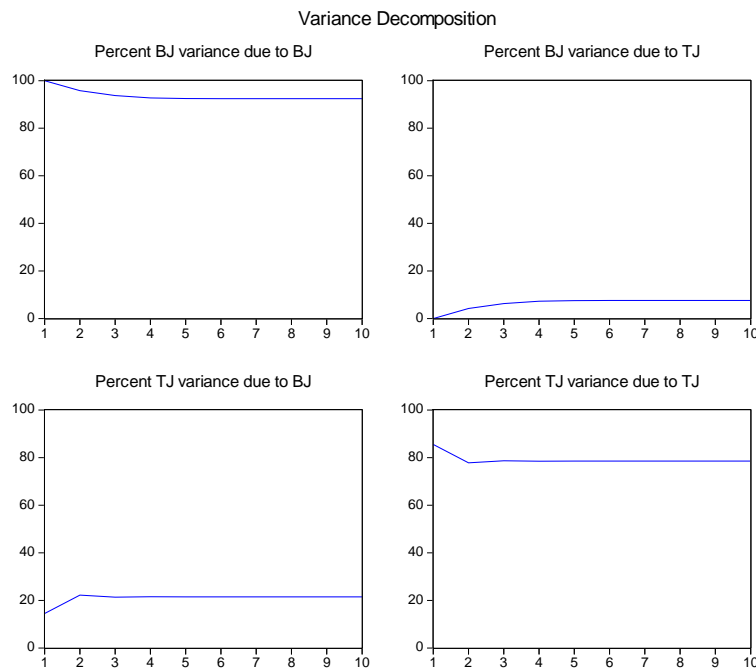


FIGURE 4 Variance decomposition of land prices in Beijing and Tianjin

According to Figure 4, with an initial increase in the in Beijing gradually decreases, while the influence on the land price changes in Tianjin gradually increases. Up to the fourth predictive period, the information shares of the land prices in Beijing and Tianjin tend to be relatively stable. The information shares of the land prices in

predictive period, the influence of the land price changes Beijing and Tianjin are 92.51% and 7.49%, respectively. In the same way, the influence of the land price in Tianjin gradually decreases initially, while the influence on the land price in Beijing gradually increases. The trend is not stabilizing until the second predictive period,

when the information shares of Beijing and Tianjin are 80.00% and 20.00%, respectively. According to the contribution analysis, the influencing share of the land price change in Beijing on the land price fluctuation in Tianjin only accounts for 7.49%, while the influencing share of the land price change in Tianjin on the land price fluctuation in Beijing reaches 20.00%. These figures suggest that during an interaction between land price changes in Beijing and Tianjin, the degree of any land price fluctuation in Tianjin caused by a land price fluctuation in Beijing will be lower than the degree of any land price fluctuation in Beijing caused by a land price fluctuation in Tianjin.

3.6 MODEL ANALYSIS ON LAND PRICE FLUCTUATION OF BEIJING AND TIANJIN CITY

Eview6.0 analysis software is used to build the analysis model of the land prices in Beijing and Tianjin city, and the results obtained by the model are as follows:

$$HP_{TJ} = C + \beta \times HP_{BJ} + \varepsilon_t, \quad (4)$$

$$HP_{BJ} = C + \delta \times HP_{TJ} + \varepsilon_t. \quad (5)$$

TABLE 5 Coefficient and conduction direction of land prices in Beijing and Tianjin

Conduction factor	Beijing → Tianjin		Tianjin → Beijing	
	coefficient	Adjusted R ²	coefficient	Adjusted R ²
HP	0.9579 (β) (30.0836)	0.9858	1.0292 (δ) (30.0836)	0.9858

According to Table 5, the high regression coefficient of the model is 0.98, which indicates a good-fitting result of the model. When the land price in Beijing city rises by 1%, the land price in Tianjin city will rise by 0.96%. When the land price in Tianjin rises by 1%, the land price in Beijing will rise by 1.03%. These are consistent with the variance decomposition results.

4 Conclusions

The price relevance model of the land price indexes from 2005 to 2012 in Beijing and Tianjin city was studied, and the fluctuation model of the land prices of the two cities was investigated by the methods of the co-integration test, the causality test, the impulse response function and the variance decomposition.

The co-integration test result indicates that a long-term co-integration relationship exists between the land prices in Beijing and Tianjin city. Even the land prices are externally impacted, they will soon return to a state of equilibrium.

The Granger causality test result indicates that the land prices in Beijing and Tianjin city exist bi-directional causality. The influence on land prices of the two cities is mutual.

According to the quantitative analysis on the fluctuation of land prices in Beijing and Tianjin city, a positive correlation relationship model exists. When the land price in Beijing rises by 1%, the land price in Tianjin will rise by 0.96%; when the land price in Tianjin rises by 1%, that increase will cause the land price in Beijing to rise by 1.03%.

According to the contribution analysis, the land price changes in Beijing city can cause only 7.49% fluctuations in Tianjin city. However, the land price changes in Tianjin can cause 20% fluctuations in Beijing city. During the interaction of land price changes in Beijing and Tianjin, the degree of any land price fluctuation in Tianjin caused by a land price fluctuation in Beijing is lower than that in Beijing caused by a land price fluctuation in Tianjin city. This is consistent with the quantitative analysis on the land price fluctuation of the two cities.

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References

- [1] McAviney I D, Maclennan D 1982 *Urban Studies* **19**(1) 43-57
- [1] Holmans A E 1994 *Economic Modelling* **11**(2) 157-99
- [2] Giussani B, Hadjimatheou G 1991 *Papers in Regional Science* **70**(2) 201-19
- [3] MacDonald R, Taylor M P 1993 *Scottish Journal of Political Economy* **40**(1) 43-55
- [4] Alexander C, Barrow M 1994 *Urban Studies* **31**(10) 1667-89
- [5] Meen G 1996 *Housing Studies* **11**(3) 345-72
- [6] Cook S 2003 *Urban Studies* **40**(11) 2285-94
- [7] Cook S 2005 *International Review of Applied Economics* **19**(1) 107-18
- [8] Holmes M J 2007 *Journal of Economic and Social Research* **9**(1) 1-17
- [9] Pollakowski H O, Ray T S 1997 *Journal of Housing Research* **8**(1) 107-24
- [10] Gupta R, Miller S M 2012 *The Annals of Regional Science* **48**(3) 763-82
- [11] Oikarinen E 2004 *Journal of Housing Research* **15**(1) 3-28
- [12] Liu C L, Luo Z Q, Ma L, Picken D 2008 *International Journal of Strategic Property Management* **12**(4) 237-50
- [13] Meen G 1999 *Housing Studies* **14**(6) 733-53
- [14] Liang Y F, Gao T M 2007 *Economic Research Journal* (8) 133-42 (in Chinese)
- [15] Hong T, Xi B, Gao B 2007 *Statistical Research* **24**(8) 64-7 (in Chinese)
- [16] Wang S T, Yang Z, Liu H Y 2008 *Research on Financial and Economic Issues* (6) 122-7 (in Chinese)
- [17] Zhang X T 2009 *Use guidelines and examples of Eviews China* Machine Press: Beijing chapter 7 (in Chinese)

- [18] Gao T M 2006 *Econometric analysis method and modelling-reviews application and instance* Qinghua University Press: Beijing chapter 4-5 (in Chinese)
- [19] Zhang Q Y 2008 *China Land Science* 22(12) 68-76 (in Chinese)
- [20] Zhong W 2010 *Study on the housing price diffusion of pole cities in the pearl river delta*, Doctoral Dissertation of Huazhong University of Science and Technology, China (in Chinese)
- [21] Gao J 2010 *The research of Chinese real estate price fluctuation* Doctoral Dissertation of Beijing Technology and Business University, China (in Chinese)
- [22] Zhao T T 2012 *Transmit characteristics and influential factors of housing price in Changzhutan urban agglomeration* Doctoral Dissertation of Hunan Normal University, China (in Chinese)
- [23] Ai J G, Ding L Y, He S B 2008 *Urban Studies* 15(1) 77-83 (in Chinese)
- [24] Zang B, Yang Q Y, Zhou T 2011 *China Land Science* 25(5) 79-84 (in Chinese)

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