

**Analysis of House Price Spillover Effect
--- Evidence from the Yangtze River Delta Economic Zone in
China**

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Abstract

This paper examines the house price spillover effect and the dynamic linkages among municipalities and capital cities of Yangtze River Delta Economic Zone in China. A VAR is estimated for four cities' house prices index (Shanghai, Hangzhou, Nanjing, Hefei) on the basis of quarterly data over the period 2001-2014. We employ the Granger causality test, impulse response and variance decomposition to find out the characteristic of spillover among cities. The results suggest house price spillovers in the Yangtze River Delta Economic Zone because of high market integration, but the direction and speed of spillover are different. The results of the Granger causality test show that Granger causalities of house price between cities are closely associated with similarity of industrial structure. The higher the industrial structure similarity is, the closer connection of the city house price will be. The house price in Shanghai and Hefei is affected less by other cities, while the house price in Hangzhou and Nanjing is affected more.

Key words: HOUSE PRICE; SPILLOVER EFFECT; YANGTZE RIVER DELTA ECONOMIC ZONE; VAR MODEL

1. Introduction

Real estate industry in China has been developing rapidly with the rising of real estate price since the real estate had market dealing as large scale commodity after cancellation of welfare-oriented public housing distribution system in 1998. The average selling price of

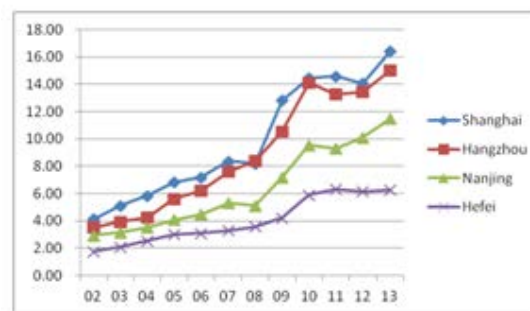
national commercial residential building has increased from ¥2291 in 2002 to ¥6238 in 2013. As the leading region of development of the national economy, the increase speed of house price in Yangtze River Delta Economic Zone far higher than the national average increase speed.

The average selling price of housing in Shanghai is as high as ¥16420 by 2013, rising by nearly 4 times. The rapid increase of house price has drawn scholars' attention. Some scholars pay attention to the regional characteristics of the real estate. The differences in regional economy level result in different development of regional real estate market. The differences in regional real estate market will lead to spillover effect between different markets. The outward manifestation is the interaction and spillover of house price.

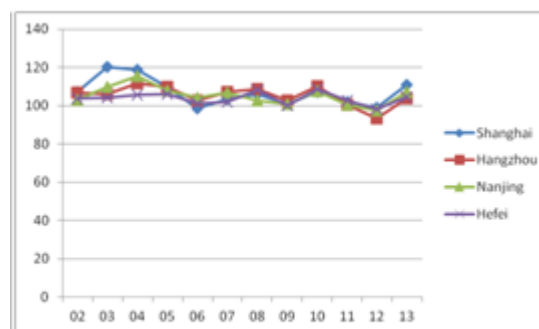
The Yangtze River Delta Economic Zone includes Shanghai City and 30 cities in Jiangsu¹, Zhejiang and Anhui Province with Shanghai as the center. The Yangtze River Delta Economic Zone is the economic center with the strongest comprehensive strength, an important international gateway in the Asian-Pacific region and the most advanced manufacturing industry base in the world, creating 22% of the national gross domestic product (GDP) with 2.2% of the land area and becoming the top six city group. The economic status of the Yangtze River Delta Economic Zone determines the relatively maturity of development of the real estate market and is of typical importance for the study of real estate market development principle in Yangtze River Delta Economic Zone.

According to the research findings by Chinese Academy of Social Sciences, the Yangtze River Delta Economic Zone has realized comprehensive integration in the fields of comprehensive economy, traffic system, marketing system and industrial system. The core cities in Jiangsu, Zhejiang and Anhui have driven the economic development of the surrounding cities. The gap among regions is further reduced during 2000 to 2010 and the integration degree of comprehensive economy is further deepened, showing obvious converging effect. With the integration of development of Yangtze River Delta region, development of real estate product market is gradually converged and inner-city house price shows synchronous situation. As is shown in Figure 1, during 2002 and 2013, the house price in Shanghai, Hangzhou, Nanjing and Hefei within the Yangtze River Delta economic circle show up and down, especially after 2004, house price adjustments are nearly close, which directly shows the convergence effect of house price within Yangtze River Delta.

¹ Nanjing is capital of Jiangsu province, Hangzhou is capital of Zhejiang province, Hefei is capital of Anhui province



a. Average price of Real Estate



b. Price Index of Real Estate Sales

Figure 1. Price trend graph of real estate in Yangtze River Delta

Yangtze River Delta on one hand can help the government understand the house price interaction relations of the cities within this region, predict the change trend of local house prices according to the spillover characteristics and construct early warning mechanism of house price. On the other hand, it can help the real estate investors and consumers make their own investment and consumption policies according to the spillover characteristics of real estate price. The central government can analyze the development differences of real estate price, find the leader of house price and formulate the differential regulation policies to promote the coordinative development of city real estate market and then drive the coordinated development of national real estate market. Finally, for cities in other regions, they can learn the successful experience of city real estate development law and spillover characteristics of house price to promote the healthy development of real estate market.

The second part of this paper is the retrospection of related literature. The third part constructs vector auto regression VAR pattern reflecting spillover effect of city real estate price within the Yangtze River Delta. The fourth part is

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the empirical test results. The fifth part is the conclusion and policy suggestions.

2. Related literature

At present, many scholars pay attention to the regional characteristics of real estate market and carry out a large amount of research around the topic, including regional house price differences, regional house price interaction, spillover effect and convergence effect of regional house price.

It is found in Downs (1993) study that real estate regional price differences are caused by differences in the basic conditions in the market. Regional internal population and the growth speed of the company show positive correlation with regional house price [1]. Charles H. Wurtzbaach (1991) thinks that the differences of land surrounding environment lead to the differences in regional house price differences [2]. Ortalo-Magné, F., Rady, S. (2004) think that the regional differences of house price is related with differences in demand of house price [3]. Liang Y.F. and Gao T.M. (2007) find that there are obvious regional differences in east, central and west regional house price fluctuations and there are obvious differences in the impact of monetary policy on the three major regional prices fluctuation [4]. Zhang H. and Li Y. (2013) discuss the differentiation response degree on monetary policy by regional house price and the differentiation influence on the development of macro-economy [5].

Based on research on regional differences of house price, some scholars think that regional house price will lead to regional industrial structure transition, movement of population, space arbitrage and even the spillover effect of house price. British scholar first discovers that there exists obvious regional transmission from southeast to other regions of house price in Britain. Meen (1999) calls this phenomenon "ripple effect" of house price [6]. Oikarinen (2008) examines the center city house price in Finland and its leading lagging relations with the surrounding cities. The results show that house price changes in Finland's main economic center first spread to regional economic center and finally to the smaller cities. But diffusion direction of house price is opposite within the regional economic center. Changes of house prices in suburban district will lead to house price adjustment in the downtown area [7]. Vansteenkiste (2011) find that house price spillover effect within the euro zone countries is very limited [8]. Chen, P.F., Chien, M.S., Lee, C.C. (2011) study the diffusion effect in Taipei

City, Taipei County, Taichung and Kaohsiung. There exists bidirectional diffusion effect of the house price in Taipei City and Taichung and unidirectional diffusion effect of the house price in Taipei County and Taichung [9]. Brady, R. R. (2014) discover that there was obvious spatial diffusion effect of house price in USA interstate during 1975-2011 and there were obvious house price spatial diffusion effect within these four regions [10]. But after 1999, the diffusion effect becomes more obvious. Chen L.N. and Wang H. (2012) find that there are obvious space hysteresis effect and time hysteresis effect of the interaction of China's real estate prices. The influence degree of house price in adjoining areas is larger than that in non adjacent areas. The mutual influence of house price with similar economic characteristics is smaller than that with different economic characteristics [11].

The existence of regional house price spillover effect eventually leads to convergence of regional prices tend. Meen (1999) points out that there exists domino effect of house price in different regions and regional house price will tend to weaken or disappear from the perspective of long run equilibrium. Cook (2003) proves that there exists extensive convergence effect of different regional house price in Britain. The house price in southeast weakens and the convergence rate becomes faster. The house price in other region has convergence acceleration after growth. It is also pointed out that the research results by some scholars fail to prove the existence of convergence effect because of the ignorance of asymmetry. Kim, Y. S. and J. J. Rous (2012), Montañés, A. and L. Olmos (2013) prove the existence of convergence effect of house price in various states in USA [12, 13]. Wu W.B. (2012) proves that there exists β convergence of the price of commercial housing of provinces, municipalities and municipalities directly under the central government from 1994 to 2010 [14]. Yang Z. and Xie S.N. (2014) believe that there is no absolute convergence tendency of China's regional prices but conditional convergence trend [15].

In conclusion, the majority of house price regional effect and steric effect research are based on the national level and there are few researches on a certain economic region and megalopolis. China is a vast landscape and various economic regions are divided according to the city economic structure and geopolitical structure. But currently, there are few researches about spillover effect of the house price and the city house price relation in the Yangtze River Delta Economic Zone. Wei

Z.Y. and Yang Z.Z. (2007) discover that there exists certain spillover effect in Shanghai, Jiangsu and Zhejiang by using the monthly data of house price in the Yangtze River Delta[16]. As the some of the cities in Anhui Province joined the Yangtze River Delta in 2010 and 2013, there are great changes of city structure in the Yangtze River Delta. The interaction relation and spillover effect of the city house price in the Yangtze River Delta need to be further analyzed.

3. Data and empirical model

3.1 Variables and data specification

This paper selects the housing sales price index HP as the price variable of real estate for horizontal comparison among cities, which takes the index variables and absolute values of variables influence on the basic value which can be removed. Currently, the Yangtze River Delta Economic Zone includes Shanghai and 30 cities in Zhejiang, Jiangsu and Anhui. Considering the procurability of the data and the representativeness of the city, this paper selects the municipality directly under the Central Government and provincial capital in Yangtze River Delta Economic Zone, such as real estate price index in Shanghai, Hangzhou, Nanjing and Hefei as HP₁, HP₂, HP₃, and HP₄.

China began to publish the housing sales price index of 35 large and medium-sized cities from the first quarter of the year 1998. In the first quarter of the year 2011, real estate price index statistical caliber is adjusted and the housing sales price index is refined to the newly-established housing sales price index and second-hand housing sales price index. Therefore, housing sales price index is replaced by arithmetic mean value of newly-established housing sales price index and second-hand housing sales price index from the first quarter in 2011. The data used in the research is the quarterly data in the first quarter of 2001 and the fourth quarter of 2014 and all the data are from the website of State Statistical Bureau.

3.2 Stability test of variable series

This paper use ADF to test the variable series of this model and then selects the VAR model according to the stability of the series. According to the characteristics of variable data, auxiliary equation includes intercept and non trend term. The lagging order will be selected according to the SC standards and inspection form (C,T,P) show whether the auxiliary equation includes intercept, non trend term and lagging order. Table 1 gives variable units root test results. It can be seen that housing sales price index of the 4 cities in sample period is stable series, which can directly construct econometric

model of city house price index in the Yangtze River Delta Economic Zone.

Table 1. Variable units root test results

Variable	Test form	ADF	Critical value (5%)	P-value
HP ₁	C,0,1	-3.08	-2.92	0.0339
HP ₂	C,0,1	-3.65	-2.92	0.0078
HP ₃	C,0,1	-3.16	-2.92	0.0279
HP ₄	C,0,3	-5.34	-2.92	0.0000

3.3 Vector autoregressive (VAR) model

Considering the spatial spillover mechanism in current theoretical circles is still in exploration stage and a complete consistent point of view has not been formed. This paper adopts unstructured model--- Vector Auto-regression (VAR) put forward by Sims (1980) to study the spillover effect of house price in the Yangtze River Delta Economic Zone and its dynamic relations and avoid the difficult definition of theoretical relation [17]. Its general form is as follows.

$$Y_t = \alpha + B_1 Y_{t-1} + B_2 Y_{t-2} + \dots + B_p Y_{t-p} + C_0 X_t + \dots + C_r X_{t-r} + \varepsilon_t \quad t=1,2,\dots,n \quad (1)$$

Among them, Y_t is the variable vector in K dimension. Y_{t-i} (i=1, 2, ...p) is the lagging variable and X_{t-i} (i=0, 1, ...r) is the exogenous variable of d dimension or lagging exogenous variable vector. P and R are respectively the lagging order of endogenous variable and exogenous variable. B_i is the endogenous variable coefficient matrix in k×k dimension and C_i is the exogenous variable coefficient matrix of k×d dimension. These matrixes are the parameter matrixes to be estimated. α is the intercept and ε_t is vector of random error term in k dimension. The elements are correspondingly related but cannot be related with their own lagging item and variable on the right side of the model.

This paper will construct a 4×1 dimension vector auto regression model which includes the house price index of the four cities and the exogenous variable is excluded. Considering the sample capacity of the research in not large and there are 4 endogenous variables, so the lagging order shall be determined according to the determination method of small sample data lagging order by Carlino,G and R.Defina (1999), $p = \sqrt[4]{56} \approx 2.7$ is no more than 3 [18]. The lag order number 2 is determined in this paper based on the principle of estimated model parameters to be estimated reasonably. It specific form is as follows.

$$\begin{bmatrix} HP_1 \\ HP_2 \\ HP_3 \\ HP_4 \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} \end{bmatrix} \begin{bmatrix} HP_1 \\ HP_2 \\ HP_3 \\ HP_4 \end{bmatrix}_{t-1} + \begin{bmatrix} \lambda_{11} & \lambda_{12} & \lambda_{13} & \lambda_{14} \\ \lambda_{21} & \lambda_{22} & \lambda_{23} & \lambda_{24} \\ \lambda_{31} & \lambda_{32} & \lambda_{33} & \lambda_{34} \\ \lambda_{41} & \lambda_{42} & \lambda_{43} & \lambda_{44} \end{bmatrix} \begin{bmatrix} HP_1 \\ HP_2 \\ HP_3 \\ HP_4 \end{bmatrix}_{t-2} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \end{bmatrix} \quad (2)$$

3.4 Stability test of the model

After establishing the VAR model of internal city house price in Yangtze River Delta Economic Zone, the stability test of the model shall be carried out through calculation of reciprocal characteristic root of AR characteristic polynomial. If the entire reciprocal characteristic root is less than 1, the VAR model constructed is stable.

Characteristic root	Model
0.719454 - 0.326432i	0.790045
0.719454 + 0.326432i	0.790045
0.723270	0.723270
0.624309 - 0.357248i	0.719297
0.624309 + 0.357248i	0.719297
0.248087 - 0.325760i	0.409471
0.248087 + 0.325760i	0.409471
-0.247789	0.247789

Inverse Roots of AR Characteristic Polynomial

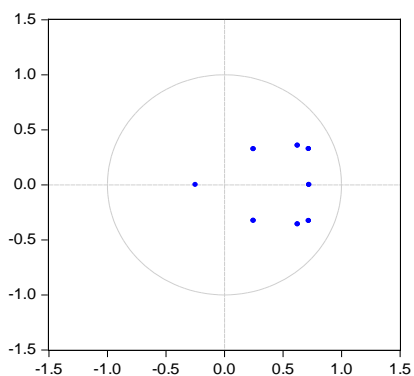


Figure 2. The unit circle and characteristic root

The table 2 and Figure 2 shows that the average model of the internal house price VAR model reciprocal of all roots is less than 1. The VAR model constructed within the unit circle is stable.

4. Empirical results

4.1 Granger causality test

We first carry out Granger causality test for the house prices of the four cities in the Yangtze River Delta so as to judge the interaction relation of house price changes of the four cities. The result of the Granger causality test is shown in Table 3 and Figure 3. There are obvious and reliable two-way causality relations of the house price in Hangzhou and Hefei. There are one-way causality relation of the house price in Shanghai and Nanjiang, Nanjing and Hangzhou, Hefei and Nanjing. No city house prices is Granger causes of changes of house price in Shanghai.

Table 3. Inner city house price Granger causality test in Yangtze River Delta

Dependent	Shanghai	Hangzhou	Nanjing	Hefei
Shanghai	—	0.66	7.50**	0.05
Hangzhou	1.14	—	1.04	7.65*
Nanjing	1.12	7.31***	—	0.40
Hefei	2.35	11.73***	5.25*	—

Note: the row city price represent dependent variable;***, **, * represent the rejection of null hypothesis based on the Significance level of 1%、5%、10%.

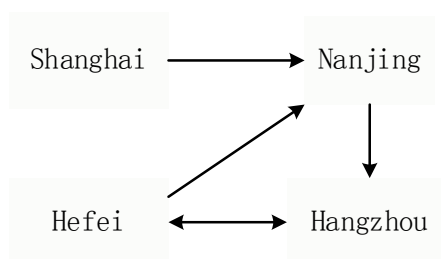


Figure 3. City house price causality relation

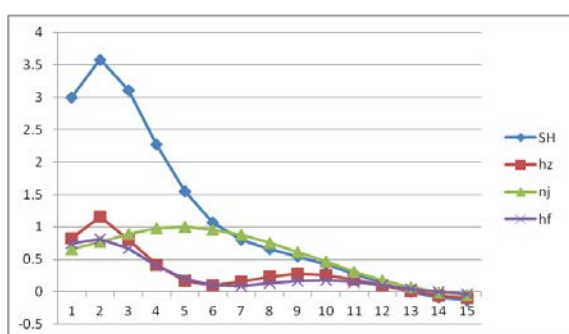
On one hand, it shows that as a city with the strongest economic strength, the house price in Shanghai is relatively independent, which is not affected by the house price in other cities.

On the other hand, the causality relation of house price and similarity of industrial structure are closely associated. According to the research in Chinese Academy of Social Sciences, the industrial structure similarity level between Shanghai and Jiangsu and which between Jiangsu

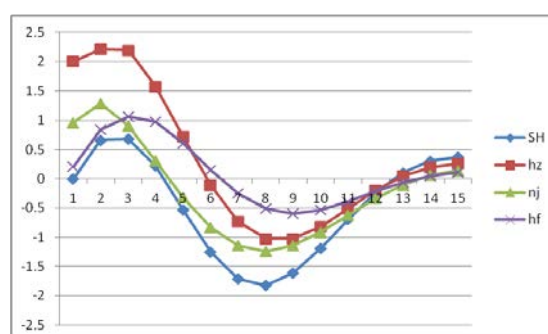
and Zhejiang is relatively high, respectively 0.9 and 0.85 while the industrial structure coefficient in Shanghai and Zhejiang keeps around 0.7, which shows that the industrial structure in Jiangsu is between that in Shanghai and Zhejiang and the industrial structure similarity in Anhui and Jiangsu and Zhejiang reach 0.8 or above, which explains that there is no direct Granger causality relation of the house price between Shanghai and Hangzhou to a certain extent while the house price in Hefei can lead the house price in Nanjing and Hangzhou. The higher the city industrial structure similarity is, the closer connection of the city house price will be.

4.2 Impulse response results

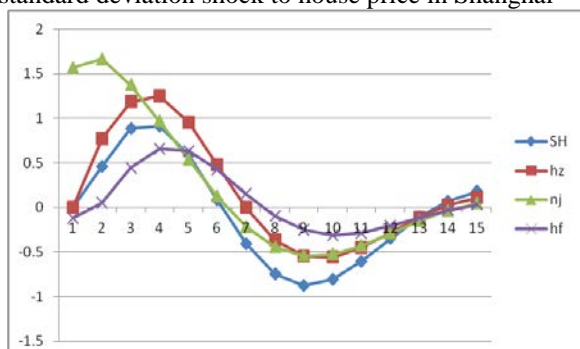
Granger causality test can only explain the short term relation between variables but cannot show the intensity of this relation and analyze the dynamic relation of the variables, also called the dynamic spillover effect of the city house prices. This paper adopts the Generalized Impulse Response Function (GIRF) put forward by Pesaran and Shin so as to analyze the correlation of the city house price and dynamic spillover effect of the city house prices in the four cities in Yangtze River Delta Economic Zone. This method will produce exogenous shock which needs no orthogonality hypothesis. The result we get has no relation with variable order but solve the difficulty of city house price series. The result will be more reliable.



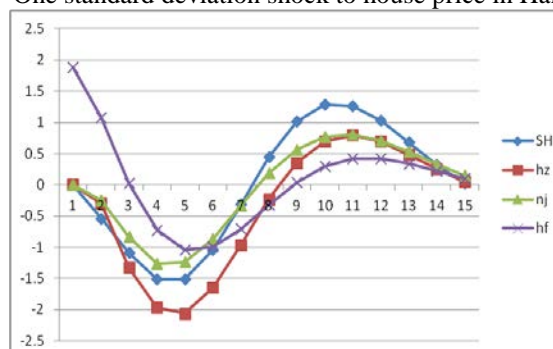
One standard deviation shock to house price in Shanghai



One standard deviation shock to house price in Hangzhou



One standard deviation shock to house price in Nanjing



One standard deviation shock to house price in Hefei

Figure 4. Dynamic spillover effect of house price across Yangtze River Delta

One standard deviation positive shock is given to the house price in Shanghai, Hangzhou, Nanjing and Hefei. The response of house price in other cities will be stable after the 15th quarter. So the impulse response graphs of the 15th quarter are listed in Figure 4.

Firstly, house price in Shanghai, Hangzhou and Nanjing will bring positive spillover effect to the house price in other cities and the spillover effect will be fundamentally the same with the maximum response value between 1.2 and 0.6. The house price impact in Hefei brings negative response to the house price in other cities because of different cycle of Hefei real

estate market, resulting in the rising of house price in Hefei and the decrease of house price in other cities. It is closely related with the population movement in the Yangtze River Delta. As the underdeveloped area in the Yangtze River Delta, the house price in Hefei is relatively low. With the establishment of high-speed rail in modern society, people who work in Shanghai, Hangzhou and Nanjing choose to buy houses in Hefei. Therefore, this phenomenon produces.

Secondly, it will response to the shock from house price in other cities differently, especially as for response speed. The house price in different cities response to shock from the

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house price in Shanghai fastest and it reaches the maximum response value in the second quarter. Response to the shock of house price in Hangzhou, Nanjing and Hefei reach the maximum in the third, fourth and fifth quarter respectively. The response of the house price in other cities to the shock of house price in Nanjing and Hefei is 1 quarter behind and the response of house price in Shanghai to the shock of house price in all other cities of is always 1 quarter behind.

Generally speaking, the house price trend in Shanghai, Hangzhou and Nanjing in the Yangtze River Delta are basically the same and they will bring positive spillover effect to other cities. The spillover effect is almost the same. But the spillover speed of house price in Shanghai is the fastest, and then Hangzhou, the spillover effect in Nanjing lags 1 quarter. The spillover direction in Hefei is opposite to the direction of other three cities and brings negative spillover effect to other cities with relative slower spillover speed, which is closely related with the real estate market development level and integration degree of industrial structure.

4.3 variance decomposition results

Variance decomposition describes the relative importance of the shock from house price in cities to city house price fluctuation. The result is shown in Figure 5 based on the city house price

variance decomposition of VAR model. The conclusion is as follows.

The house price fluctuation in Shanghai and Hefei mainly comes from the impact of their own house price. The impact of house price in Shanghai explains 56% of the fluctuation and the house price in Hefei, Hangzhou and Nanjing explains 19%, 18% and 7% of the house price in Shanghai. The impact of house price in Hefei explains 50% of the fluctuation. The house price in Hangzhou, Shanghai and Nanjing explains 27%, 12% and 9% of the house price in Shanghai. The fluctuation of house price in Shanghai and Nanjing is easily to be affected by fluctuation of house price in other cities. The impact of house price in Hangzhou and Nanjing contribute to 45% and 28% of their own house price fluctuation. The house price fluctuation contribution by house price impact in other cities have exceeded their own house price impact effect, especially in Nanjing, the contribution to the house price impact has exceeded the house price of the tenth phrase in Hangzhou.

It can be seen that the spillover effect of house price in Shanghai and Hefei is small. The house price in Hangzhou and Nanjing is easily to be spilt by other cities. The real estate markets in Hangzhou and Nanjing have realized integration. The real estate markets in these two places have strong substitutability.

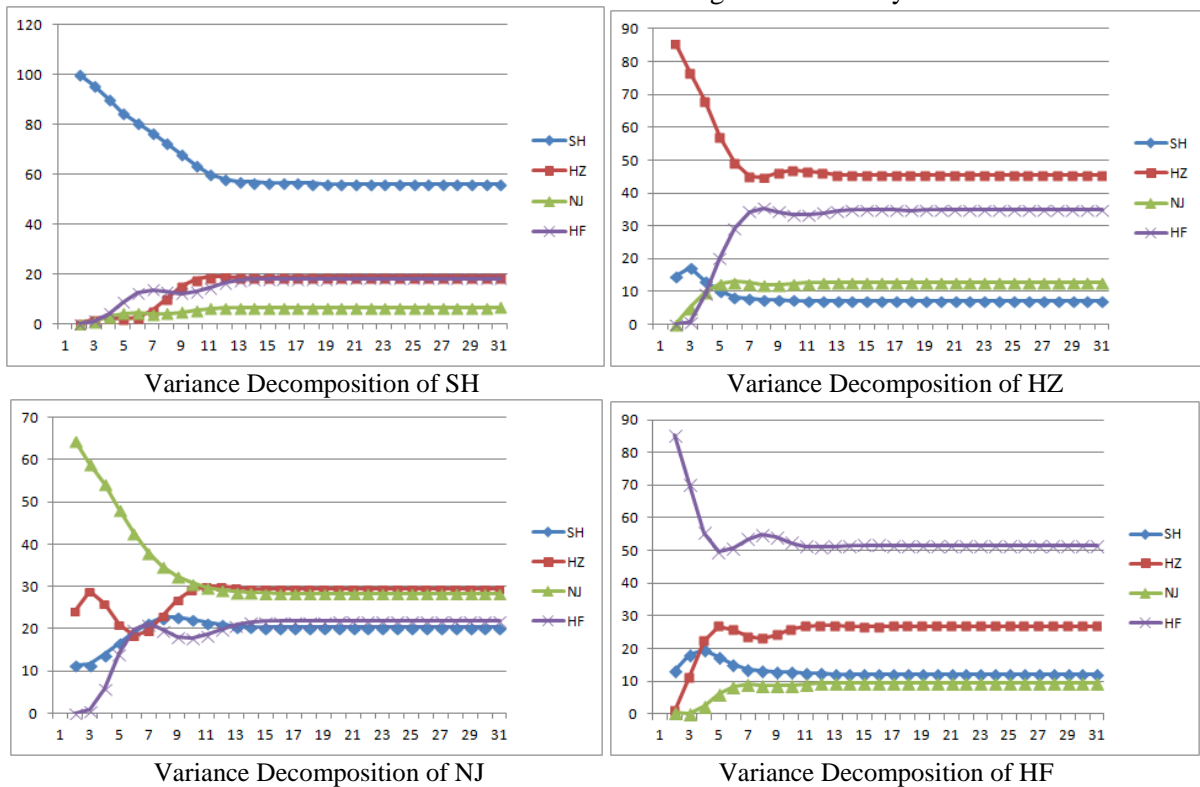


Figure 5. Variance decomposition result in the Yangtze River Delta

5. Conclusion

It is found that through the construction of city house price VAR model, housing sales price index in the first quarter in 2001 and the fourth quarter in 2014 of the municipalities and provincial capital in the Yangtze River Delta, Granger causality test, impulse response and variance decomposition. (1) The real estate market integration degree of the cities in the Yangtze River Delta is high and there exists mutual house price spillover effect. The house price in Shanghai, Hangzhou and Nanjing bring positive spillover effect. The house price cycle in Hefei is opposite to the other cities. The spillover speed of house price in Shanghai is fastest to house price in other cities. (2) There exist Granger causal relation between the real estate in Shanghai and Nanjing, Nanjing and Hangzhou, Hefei and Hangzhou, Hefei and Nanjing, which is closely related with the industrial structure similarity. The higher the industrial structure similarity is, the closer of the house price will be. (3) Shanghai and Hefei are located on the two ends of development of Yangtze River Delta Economic Zone. The real estate market is relatively independent. The smaller the spillover degree is, the higher the integration degree of the real estate market in Hangzhou and Nanjing and the higher of the spillover degree will be.

The government should grasp the interaction relation and spillover effect of house price in Yangtze River Delta and promote the integration of real estate market and coordinative development of house price through adjustment of industrial structure. Especially Hefei joins the Yangtze River Delta Economic Zone late and in a very short time. The real estate market is easily to be affected by the house price in Hangzhou and Nanjing but will not be affected by the house price in Shanghai. Anhui should have comprehensive connection with Jiangsu and Zhejiang through industrial structure adjustment and then accept the influence of Shanghai so as to eventually integrate into the industrial division system of the Yangtze River Delta.

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