

Heterogeneous Responses of Chinese Cities' Housing Prices to Monetary Policies*

YAN Yan (闫妍),¹ WANG Yan-Ting (王延颀),² and ZHU Xiao-Wu (朱晓武)^{3,†}

¹School of Management, Graduate University, Chinese Academy of Sciences, Beijing 100080, China

²Key Laboratory of Frontiers in Theoretical Physics, Institute of Theoretical Physics, Chinese Academy of Sciences, Beijing 100190, China

³School of Business, China University of Political Science and Law, Beijing 100088, China

(Received May 4, 2011; revised manuscript received June 2, 2011)

Abstract This work examines the responses of housing prices to the monetary policies in various Chinese cities. Thirty-five large and medium sized Chinese cities are classified into six clusters applying the minimum variance clustering method according to the calculated correlation coefficients between the housing price indices of every two cities. Time difference correlation analysis is then employed to quantify the relations between the housing price indices of the six clusters and the monetary policies. It is suggested that the housing prices of various cities evolved at different paces and their responses to the monetary policies are heterogeneous, and local economic features are more important than geographic distances in determining the housing price trends.

PACS numbers: 89.65.Gh

Key words: monetary policy, housing price, heterogeneous responses, cluster

1 Introduction

Influenced by different economic forces, the housing values vary greatly among regions. In China, the average housing sales price of the whole country increased 5.7 percent in 2009, but great imbalance existed among 70 large and medium sized cities, with the highest housing sales price growth rate of 16.6 percent in Shenzhen, and the lowest of −2 percent in Tangshan (source: the State Information Center). However, all the cities were required to implement the same macroeconomic policies despite of the differences among regions, usually too late for some relatively developed cities and too early for underdeveloped cities.

In recent ten years, the housing market imbalance among different regions within one country has become common phenomena all over the world. Smith, Hess, and Liang (2005)^[1] classified US metros into eight clusters according to the synthetic socio-economic indices using principal component analysis. Miller and Peng (2006)^[2] examined the home price indices of 277 metropolitan areas with ARIMA models, and analyzed the relations between volatility and other variables, such as GDP. Miles (2008)^[3] developed individual GARCH models for the housing markets of fifty states, and indicated that there were GARCH effects in over half of the states, whose signs and magnitudes varied widely. Since 2006, some scholars have proposed that Chinese real estate market should also be

classified into different categories. Xiong, Deng, and Ma (2007)^[4] divided Chinese provinces into six clusters according to supply-demand equilibrium and configuration equilibrium of real estate market. Liang and Gao (2007)^[5] classified 28 provinces into three regions (eastern, middle, and western), and analyzed the factors determining housing price fluctuations based on error correction model and panel data model. Both studies classified mainly by the geographic locations with the province data. In this paper, the cities are categorized by the similarity of the housing price trends rather than geographic distances.

Real estate is a capital intensive industry, and the housing price fluctuations are very sensitive to monetary policies. An expansionary monetary policy is expected to raise the housing investment and housing price via the interest rate effect, the wealth effect, the credit channel including the bank lending channel, and the balance-sheet channel.^[6–7] Lastrapes (2002)^[8] analyzed monthly data and found that both housing prices and housing sales (new starts and existing homes) rise in a short-run in response to the positive shocks of money supply. Zhang, Gong, and Bu (2006)^[9] indicated that the correlation coefficient between Chinese property price and mortgage lending is positive, while an increase in mortgage interest rate can effectively suppress the rise of property price. Ding and Tu (2007)^[10] indicated that the efficiency of monetary policy transmission through the channel of housing price is

*Supported by the Hundred Talent Program of the Chinese Academy of Sciences, the National Natural Science Foundation of China under Grant Nos. 71103179 and 71102129, Program for Young Innovative Research Team in China University of Political Science and Law, 2010 Fund Project under the Ministry of Education of China for Youth Who are Devoted to Humanities and Social Sciences Research 10YJC630425

†Corresponding author, E-mail: zhuxiaowu@cupl.edu.cn

high, with the monetary policy represented by the monetary supply and the inter-bank market interest rate. Most studies of analyzing the relations between housing prices and monetary policies only focused on macroeconomic variables. However, a simple fact that most dramatic price booms have taken place in certain geographic areas with little price rise in other parts of the country suggests that macro variables only provide a partial explanation.

The emphasis of this study is on examining the housing price difference among Chinese cities and the heterogeneous responses of housing prices to monetary policies. Minimum variance clustering method is employed to classify 35 large and medium sized cities into 6 clusters, and the composite indices are calculated to obtain the average price trend of each cluster. Time difference correlation analysis is performed to quantify the relations between each composite indices and monetary policies, which are represented by M2 growth rates and the weighted average of 7-days inter-bank market interest rates. It is indicated that neither all the Chinese cities' housing markets develop at the same pace, nor their responses to monetary policies follow the typical path homogeneously.

2 Clustering Method and Results

2.1 Method

The similarities of the housing price indices are quantified by calculating the correlation coefficients of their time series. The degree of the correlation between the housing price indices of two cities is quantified by calculating the correlation coefficient $C(X, Y)$,

$$c(X, Y) = \frac{E((X - E(X))(Y - E(Y)))}{[E(X^2) - E^2(X)]^{1/2}[E(Y^2) - E^2(Y)]^{1/2}}, \quad (1)$$

where X and Y are the housing price indices of two cities, which are regarded as two random data sequences, and $E(\dots)$ denotes the average of random variables. The cities can be classified into clusters according to the correlation coefficients by employing the minimum variance clustering method.^[11] Every two cities are treated as two nodes connected by an edge with the correlation coefficient of the two cities as the weight of this edge. Starting from a number of clusters with only one node (city) in one cluster and the edge between two nodes also the edge between the corresponding two clusters $w_{X,Y} \equiv c(X, Y)$, the clusters are merged into larger ones recursively. In each step, the two clusters connected by the edge with the largest weight are combined into a new one. The weight between two clusters is defined as the average of all correlation coefficients between these two clusters,

$$w_{\alpha,\beta} = \frac{1}{m} \sum_{i=1}^m c_i(X_\alpha, Y_\beta), \quad (2)$$

where m is the total number of edges between the two clusters, c_i is the weight of the i -th edge connecting the node X in cluster α and the node Y in cluster β . The merge of clusters is performed recursively until only a designated

number of clusters n is left. A schematic of this clustering method is illustrated in Fig. 1.

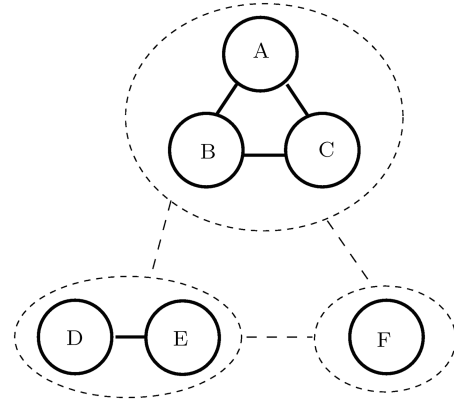


Fig. 1 Schematic of the minimum variance clustering method. The six nodes are classified into three clusters, with the dashed lines representing the edges between two clusters and the solid lines representing the edges between the nodes in the same cluster.

2.2 Data and Results

We intercept quarterly housing price index (the same quarter of previous year = 100) of 35 large and medium sized cities, including all the capital cities and sub-provincial cities, between the first quarter of 1998 and the third quarter of 2009, for the Urban Housing Reform started in 1998. The original data are from the State Information Center of China. The correlation coefficients between time series of housing price indices are calculated, and the minimum variance clustering method is employed to divide 35 cities into several clusters with the number of clusters ranging from 3 to 9. The results are listed in Table 1.

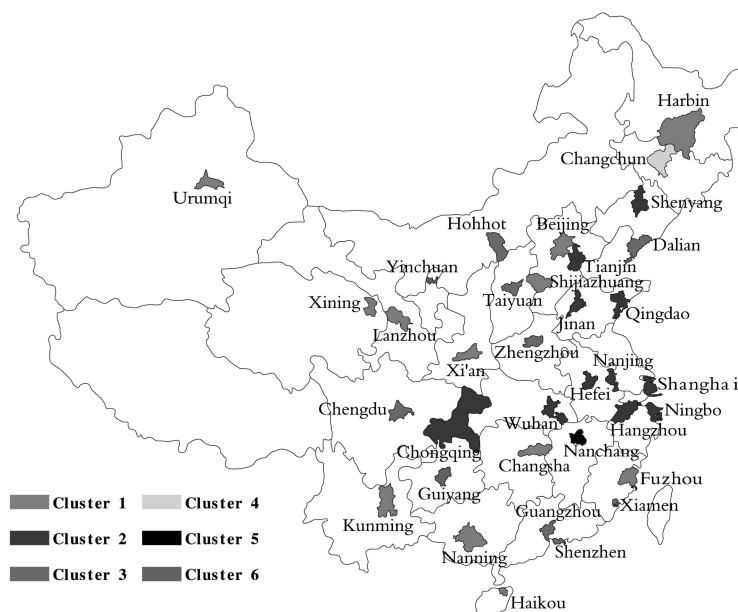
In Table 1, Changchun (8), Nanchang (17), Guiyang (29), and Yinchuan (34) are separated into independent groups when the number of clusters is larger than 4, for their housing price index plots are quite different from the others'. According to our empirical knowledge of the local economic features of those Chinese cities, dividing those cities into six clusters seems to best reflect their economic nature. In Fig. 2, 35 cities are colored in a Chinese map according to the six clusters they belong to.

Clusters 1–3 comprised of 31 cities (88.6 percent of the 35 cities) represent the mainstream of housing price trends in China. Generally, the cities geographically close to each other are in the same cluster. Most cities in Cluster 1 are inland cities located in the middle part of China. Cluster 2 is comprised of all the large cities located in the Yangtze River Delta and some other relatively developed cities. The southeast inshore cities are mainly involved in Cluster 3. According to the correlation coefficient matrices, Xi'an and Beijing in Cluster 1, Nanjing and Shanghai in Cluster 2, Guangzhou and Xiamen in Cluster 3 are typical cities highly related with the others in the same cluster. The four cities in Clusters 4–6 are very dissimilar to the mainstream cities.

Table 1 Clustering results of 35 cities' housing price indices.

<u>Three clusters</u>			
Cluster 1:	1 2 3 4 5 6 7 9 10 11 12 13 14	Cluster 2:	8
	15 16 17 18 19 20 21 22 23 24	Cluster 3:	29 34
	25 26 27 28 30 31 32 33 35		
<u>Four clusters</u>			
Cluster 1:	1 3 4 5 7 9 15 16 20 22 23 24	Cluster 3:	8
Cluster 2:	25 26 28 30 31 32 33 35	Cluster 4:	29 34
	2 6 10 11 12 13 14 17 18 19 21 27		
<u>Five clusters</u>			
Cluster 1:	1 3 4 5 7 9 15 16 20 22 23 24	Cluster 3:	8
Cluster 2:	25 26 28 30 31 32 33 35	Cluster 4:	17
	2 6 10 11 12 13 14 18 19 21 27	Cluster 5:	29 34
<u>Six clusters</u>			
Cluster 1:	1 3 9 15 22 25 26 30 31 32 33 35	Cluster 4:	8
Cluster 2:	2 6 10 11 12 13 14 18 19 21 27	Cluster 4:	17
Cluster 2:	4 5 7 16 20 23 24 28	Cluster 6:	29 34
<u>Seven clusters</u>			
Cluster 1:	1 3 9 15 22 25 26 30 31 32 33 35	Cluster 4:	4 20
Cluster 2:	2 6 10 11 12 13 14 18 19 21 27	Cluster 5:	8
Cluster 3:	5 7 16 23 24 28	Cluster 6:	17
		Cluster 7:	29 34
<u>Eight clusters</u>			
Cluster 1:	1 3 9 15 22 25 26 30 31 32 33 35	Cluster 5:	8
Cluster 2:	2 6 10 11 12 13 14 18 19 21 27	Cluster 6:	17
Cluster 3:	4 20	Cluster 7:	29
Cluster 4:	5 7 16 23 24 28	Cluster 8:	34
<u>Nine clusters</u>			
Cluster 1:	1 3 9 15 22 25 26 31 32 33 35	Cluster 5:	8
Cluster 2:	2 6 10 11 12 13 14 18 19 21 27	Cluster 6:	17
Cluster 3:	4 20	Cluster 7:	29
Cluster 4:	5 7 16 23 24 28	Cluster 8:	30
		Cluster 9:	34

1: Beijing 2: Tianjin 3: Shijiazhuang 4: Taiyuan 5: Hohhot 6: Shenyang 7: Dalian 8: Changchun
 9: Harbin 10: Shanghai 11: Nanjing 12: Hangzhou 13: Ningbo 14: Hefei 15: Fuzhou 16: Xiamen
 17: Nanchang 18: Jinan 19: Qingdao 20: Zhengzhou 21: Wuhan 22: Changsha 23: Guangzhou
 24: Shenzhen 25: Nanning 26: Haikou 27: Chongqing 28: Chengdu 29: Guiyang 30: Kunming
 31: Xi'an 32: Lanzhou 33: Xining 34: Yinchuan 35: Urumqi

**Fig. 2** Map illustration of the 35 cities grouped into six clusters.

2.3 Composite Housing Price Index

The composite housing price index is calculated to quantify the general trend of housing price changes of each cluster. Composite housing price index is the weighted average value of several housing price indexes, where the weight is usually the percentage of the housing sales quantity, e.g., the national housing price index published by the National Bureau of Statistics of China. But in this paper, we differentiate the housing price indexes and classify the similar ones into same clusters first. So the composite housing price index of each cluster is similar to the average of the housing price indexes. If there are n_i cities in cluster i , $\text{CHPI } i(t)$ is the composite housing price index of the i -th cluster at period t , $\text{HPI } i_c(t)$ is city c 's housing

price index in the i -th cluster at period t , then

$$\text{CHPI } i(t) = \frac{1}{n_i} \sum_{c=1}^{n_i} \text{HPI } i_c(t), \quad i = 1, 2, \dots, 6. \quad (3)$$

The composite housing price indices of the six clusters are calculated and plotted in Fig. 3. Cluster 1 had mild housing price rise of less than 5 percent per year before the first quarter of 2007, and reached the peak growth rate of 12 percent in the end of 2007, later than other clusters. The housing price of Beijing, a typical city in Cluster 1, increased at a speed of more than 10 percent in each quarter between the third quarter of 2007 and the second quarter of 2008.

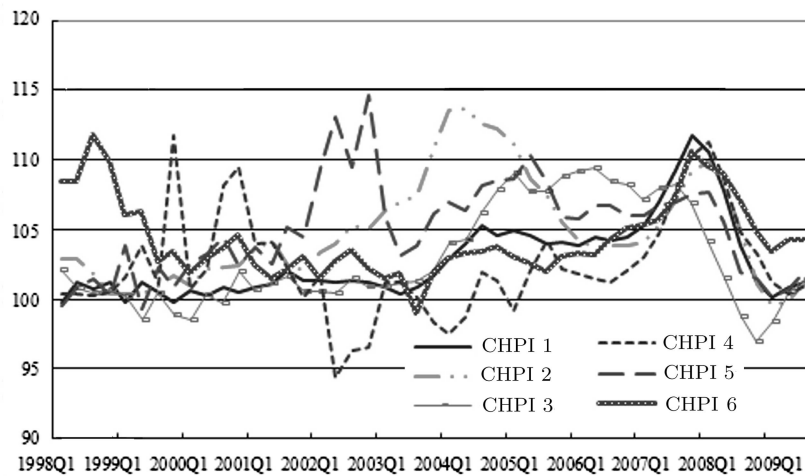


Fig. 3 Composite housing price indices of 6 clusters.

Since the third quarter of 2002, the housing price of Cluster 2 began to increase rapidly and reached the highest growth rate of 13.7 percent in the first quarter of 2004, indicating that the housing markets of the Yangtze River Delta developed earlier than most other parts of China. Since 2005, the central government has paid more attention to the exorbitant housing prices and excessive real estate investment. The State Council published the Notice on Stabilizing the Housing Price in 2005 and the Notice on Modifying the Housing Supply System in 2006 to suppress the overheated real estate market. The tight policies suppressed the housing prices of Cluster 2 to reach the minimum value in the second quarter of 2006.

The housing prices of Cluster 3 kept increasing at a high speed of more than 6 percent between the third quarter of 2004 and the fourth quarter of 2007, with little evidence that the tight policies took any effect on the housing markets. The housing price of Shenzhen in Cluster 3 increased more than 10 percent from 2006 to 2007, and reached 20.2 percent in the second quarter of 2007, the highest in the whole country.

The housing price trends of Clusters 4-6 are quite different from Clusters 1-3, whose peak and valley values occurred in different time. However, the housing price growth rates of all the clusters began to decline sharply since the fourth quarter of 2007, and dropped to the valley values in the fourth quarter of 2008 or the first quarter of 2009. Influenced by global financial crisis in September 2008, Chinese economy and housing markets were exposed to a systematic risk. China reduced interest rates 5 times in the last four months of 2008, and allowed 30 percent discount of mortgage interest rates for the first-house buyers. The central government exempted the operation taxes for houses bought for more than 2 years, and reduced the deed taxes for first-house buyers from 1.5 percent to 1 percent, to stimulate the housing market development. Driven by proactive fiscal policies and moderately loose monetary policies, housing markets were greatly stimulated and rebounded since the second quarter of 2009. The house sales volumes and housing prices in some large cities (e.g., Beijing, Shanghai, and Shenzhen) increased more and reached their new records in 2009.

3 Correlations of Monetary Policies and Housing Price Indices

A common practice around the world is that the goal of monetary policies is to keep the inflation rate at a low positive level for long runs.^[12] The objective of the People's Bank of China has been set to maintain the stability of the currency values and to promote the economic growth. To fulfill this objective, the central bank focus on the in-

termediate targets, including monetary aggregates (M0, M1, M2) and interest rates, which have direct impacts on final goals of monetary policies.^[13] Time difference correlation analysis is used to analyze the relations between the housing price indices $P(t)$ of 6 clusters and the monetary policies $M(t)$, represented by M2 growth rates and the weighted average of 7-days inter-bank market interest rates

$$c(P, M, t) = \frac{E((P(t_0) - E(P(t_0)))(M(t_0 + t) - E(M(t_0 + t))))}{[E(P^2(t_0)) - E^2(P(t_0))]^{1/2}[E(M^2(t_0 + t)) - E^2(M(t_0 + t))]^{1/2}}, \quad (4)$$

where t_0 is the starting point of a time sequence, and t is the time difference between the sequences $P(t)$ and $M(t)$. When doing this calculation, the time series of quarterly housing price indices are linearly interpolated into monthly data to be consistent with the monthly data of 7-days national inter-bank market interest rates and M2 growth rates. Consequently, the calculated correlation coefficients have an uncertainty of 3 months caused by the interpolation.

A higher M2 growth rate corresponds to a loose monetary policy with more money supply in the system, and the ample fluidity encourages housing demands and drives the housing price higher, since real estate is a capital intensive industry in both demand and supply. As in Fig. 4, the housing price indices of most cities are positively correlated with M2 growth rates, except Clusters 5, which is nearly irrelative to the money supply alterations, as indicated by the correlation coefficients of less than 0.01 in the whole range. The housing prices of Cluster 2 have the most rapid response to M2 growth rates, with the maximal influence appeared at a time lag of 8 months, much earlier than other clusters. This can be explained by the fact that Cluster 2 is mainly comprised of the cities in the Yangzi River Delta and some other developed cities, which are highly market-oriented and more sensitive to monetary policies. The housing prices of Clusters 1 and 3 are positively correlated with M2 growth rates with a time lag of 16 months.

When monetary policies tighten and interest rates raise, housing prices soften as housing demand declines through the user-cost transmission mechanism. Therefore, a meaningful correlation coefficient between interest rates and housing prices should be negative. As in Fig. 5, except Cluster 4 and Cluster 6, the housing prices of most cities are negatively correlated with the interest rate changes. After the 1997 Asian Financial Crisis, the People's Bank of China implemented an expansionary monetary policy of reducing the deposit reserve ratio and deposit based rate which stimulates the housing demand and drives the housing prices higher. Driven by the wealth effect, CPI increased very fast in 2006–2008. In order to avert inflation, the People's Bank of China raised the deposit reserve ratio 17 times, and raised the basic interest rates 8

times between 2006 and 2008. The tight monetary policy suppressed the super hot housing markets, leading to the housing sales quantity reduction and housing price decrease in 2008.

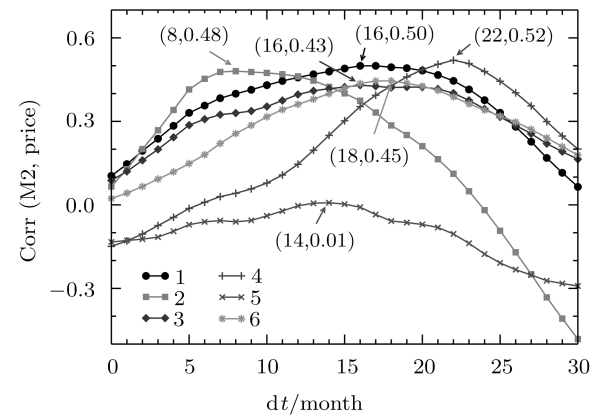


Fig. 4 Responses of 6 clusters' housing price indices to M2 growth rates.

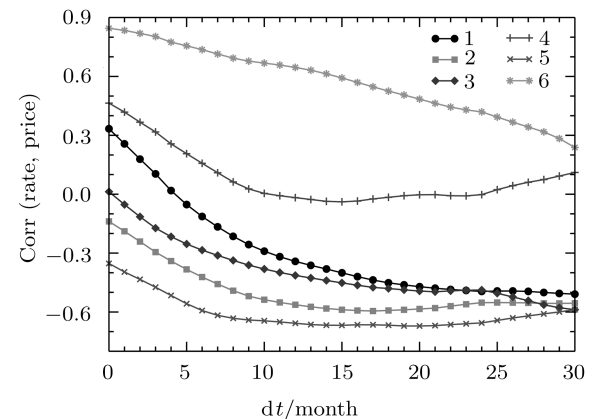


Fig. 5 Responses of 6 clusters' housing price indices to the weighted average of 7-days inter-bank market interest rates.

In contrast the housing price indices of Clusters 4 and 6 have positive correlation coefficients with the interest rates, indicating that monetary policies did not take obvious effects on regulating the housing prices of the cities

in Clusters 4 and 6. The housing price index of Cluster 5 (Nanchang) is sensitive to the interest rates, but insensitive to the monetary supply growth. This implies that, when Nanchang residents consider the possibility of buying houses, the main concern is the interest rate which is related to the monthly mortgage payments, not other people's investment decisions, which are positively related with the increased housing credit and monetary supply.

4 Conclusions

The analysis in this article indicates that housing prices of 35 Chinese large and medium sized cities have evolved at significantly different paces. The 35 cities are classified into 6 clusters by applying minimum variance clustering method, with 31 cities in Clusters 1-3 accounting for 88.6 percent of all the cities. Not all the cities in one cluster are geographically close to each other, which indicate that the similarities of housing markets are determined by local economic features, rather than geographic

distances. The cities located in the Yangtze River Delta (e.g., Shanghai, Nanjing) form the core of Cluster 2, reaching their first peak values of the housing price growth are much earlier than other cities, and are the most sensitive to the monetary supply and interest rates, due to their matured market economy. Cluster 1 is comprised of inland cities, while southeast inshore cities are mainly in Cluster 3. The housing price trends of the four cities in Clusters 4-6 are quite different from the main trends of China. Also, great heterogeneity exists in the responses of the cities to monetary policies. Based on the above analysis, we suggest that Chinese central government should release the guidelines for national housing market development, but allow local governments to formulate local rules according to economic circumstances. In addition, if we try to forecast the housing price trend of the whole country, we can rely more on analysis of the housing markets of the cities in Cluster 2, for their leading status in the whole country's housing markets.

References

- [1] A. Smith, R. Hess, and Y. Liang, *Journal of Real Estate Portfolio Management* **11** (2005) 197.
- [2] N. Miller and L. Peng, *Journal of Real Estate and Financial Economics* **33** (2006) 5.
- [3] W. Miles, *Journal of Real Estate Research* **30** (2008) 73.
- [4] F. Xiong, C. Deng, and Y. Ma, *Chinese Journal of Management* **4** (2007) 829.
- [5] Y.F. Liang and T.M. Gao, *Economic Research Journal* **8** (2007) 133.
- [6] B.S. Bernanke and M. Gertler, *Journal of Economic Perspectives* **9** (1995) 27.
- [7] F.S. Mishkin, *the Economics of Money, Banking, and Financial Markets* (Seventh Edition), China Renmin University Press (2007) 619.
- [8] W.D. Lastrapes, *Journal of Housing Economics* **11** (2002) 40.
- [9] C. Ding and M.Z. Tu, *Journal of Quantitative & Technical Economics* **11** (2007) 106.
- [10] H.C. Romesburg, *Cluster Analysis for Researchers*, Lulu Press, North Carolina (2004).
- [11] G. Marvin and P. Eswar, *CESifo Economic Studies* **53** (2006) 2.
- [12] National People's Congress, *Law of the People's Republic of China on the People's Bank of China* (1995).
- [13] T. Zhang, L.T. Gong, and Y.X. Bu, *Finance Research* **2** (2006) 1.