# POTENTIAL FOR PORTFOLIO DIVERSIFICATION ACROSS CHINA'S REAL ESTATE MARKETS

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**Abstract:** The starting point for this study is to reveal the potential for risk diversification in China's real estate investment. It explores the diversification opportunities across thirty-five large-scale and medium-scale cities in China; designs the basic diversification strategy by grouping the submarkets in the sampled six cities and investigates whether there is any stability in cluster membership across sub-periods. Hierarchical cluster analysis and K-means cluster analysis are employed successively to decide the suitable number of the cluster and the composition of each cluster. The results of cluster analyses provide strong evidence for the existence of homogeneous clusters in the thirty-five real estate markets, and the sampled study identified four unstable clusters in twenty-four submarkets. This research sheds light on the potential for the real estate portfolio diversification across cities, property types or revenue types and, also, suggested the investors to balance risk and cost with discreet market analysis and self-appraisement.

**Key words:** Real estate; Portfolio; Diversification; Cluster analysis

# INTRODUCTION

Traditionally, the greatest attention and the most resources have been devoted to specific transactions while less is directed to portfolio strategy. However, the deal-by-deal approach is not consistent with the notion of portfolio strategy even if it may deliver higher risk-adjusted returns sometimes. After first adopted in 1970's, the techniques of Modern Portfolio Theory (MPT) have been thought to be more efficient in solving the key points in real estate investment, such as to decide the investment location and time, investment object and scale, the correlative resources and information. Nowadays, reducing the risk by diversification has become a basic idea and instructs more and more investors to make the suitable decision. But the physical specialty and information asymmetry enhance the difficulties of adopting portfolio theory in real estate market. On one hand, the abilities and experience of many small institutional investors and developers are too limited to realize portfolio strategy; on the other hand, the indexes of the real estate market are not enough to fulfill "buying the market" as what the security market does. So the application of MPT to the real estate portfolio confronts unwillingness and inconformity. But that also creates a new area for further study in this promising field.

As the dominating real estate investors in China, developers still lack enough initiative, knowledge and experience to accept and apply MPT or other portfolio theory. Firstly, they don't have the motive to diversify in different regions or property types because some developers are favored by the local policy, relationship network and some special key resources. Secondly, some growing developers lack enough resources to build up their portfolio and have to limit their plan of diversification on paper. Institutional investors who are the primary users of MPT in developed market economy countries are naïve in our market. China's institutional investors have a long way to be the one of the main players in the real estate market, letting alone to substitute the developers. But for any investor who wants to be longer and stronger in the competitive market, it is necessary to study the opportunities of real estate portfolio diversification and scheme out a detailed investment plan in China right now. The improving market environment also gives a new light on this research. With more comprehensive legal system, more steady policy, more transferable resources and more financing channels, the real estate investors have the opportunities to break the existing limits of investment region and investment domain. All of these subjective and objective factors prompt us to start up this research.

The purposes of this study are to (1) develop a geographic grouping scheme of the real estate markets across China's main cities; (2) design a real estate portfolio including

different cities, property types and revenue types across sampled cities; and (3) test the stability of the cluster membership across sub-periods.

The paper is structured as follows. The next section briefly reviews the literature of diversification strategies before focusing upon methodologies and dataset in section three. Section four introduces the steps of the research: (1) find the suitable number of the city groups by hierarchy clustering analysis and confirm the composition of each group by K-means cluster analysis; (2) design the possible diversification strategy across twenty-four sampled submarkets with the same techniques; and (3) test the stability of the cluster membership. The fifth section presents the results. Finally, the portfolio implications of the findings and relevant explanations are considered.

## LITERATURE REVIEW

In the past 20 years, scholars and experts have studied almost all kinds of real estate portfolio strategies. These research results are not only useful and constructive to many investors, but also impel the development of the portfolio theory and skills. Today, the researches on grouping and optimal diversification across real estate markets are comprehensive and become one of the most important parts of the mixed-asset portfolio strategy. Economic diversification of real estate portfolios involving different region, property types or revenue types is a frequently concerned topic in the large volume of literatures.

Diversification across regions or cities is a primary strategy in constructing the real estate portfolio. Many researchers in UK and USA use a variety of econometric methods to identify fundamental groupings of regions (Hartzell, Heckman and Miles, 1986; Hartzell, Schulman and Wurtzebach, 1987; Malizia and Simons, 1991; Mueller and Ziering, 1992). All these researches focused on selecting the irrelevant or low-relevant regions into the portfolio to reduce the risk exposure and uncertainty. There are two criteria of grouping: geographical diversification and economic diversification.

The real estate market in UK is divided into 11 or 12 regions by geographical characteristics. Some American research firms such as the Frank Russell Company have long divided commercial property returns into four groups: East, South, Midwest and West. (Miles and McCue, 1982, 1984a, b;Hartzell, Hekman and Miles, 1986). This kind of geographical diversification is based on the administration region which has many smaller heterogeneous regions inside.

Cole, Guilkey, Miles and Webb (1989) propose an ingenious grouping scheme based upon economic characteristics of the region. They suggest that economic sector-based clusters may provide a useful means to diversify within real estate markets. Wurtzebach (1988) broke the contiguous geographic constraint and grouped metropolitan areas based on employment growth patterns in their dominant industries. This noncontiguous grouping scheme was compared with contiguous geographic grouping schemes in Mueller and Ziering (1992), and was found to be a superior diversification strategy. Black, Marks and Mueller (1993) tested the economic-based diversification strategy by comparing the economic performances of MSAs with the regions in which they belong. Their results suggested that MSAs may be more proper diversification categories than the geographic regions. The current trend is toward various economic-based diversification strategies by recognizing that geographic segmentation is merely a proxy for economic diversity.

Another focus in this field is to find a valid proxy for economic diversification. Goetzmann and Wachter(1995) grouped cities on the basis of percent changes in commercial office rents. They also substituted it with the vacancy rate to test whether the clustering result is reliable. More researches took more variables, including demand-side or supply-side factors, NOI (Net Operating Income) and price index, as the cluster base. (Martin Hoesli, Colin Lizieri, Bryan MacGregor, 1997; Ping Cheng, Roy T Black,1998; Ping Cheng and Youguo Liang, 2000;Timothy W Viezer,1998,2000; Kwame Addae-Dapaah, Ser Gek Wee and M Shahid Ebrahim, 2002; Theron R Nelson and Susan L Nelson, 2003).

Researching on how to diversify across submarkets is the extended area on the research of real estate portfolio diversification. This scheme divides the markets into smaller regions or different property types. With the data in Houston and Austin from 1975 to 1983, Grissom, Kuhle and Walther (1987) found the efficiency of comprehensive diversification was better than the single latitude diversification just by region or property type. Firstenberg, Ross and Zisler (1988) confirmed this viewpoint. Martin Hoesli, Colin Lizieri and Bryan MacGregor (1997) designed the comprehensive diversification strategy by combining the cluster analyses and pointed out those economic variables were the critical factors in cluster procedures.

Adding different revenue types, rent revenue and sale revenue, into the diversification strategy across regions and property types can reduce the influence of the cash flow to the whole portfolio. Previous researches have not clarified this method of diversification. But there are some useful attempts. Williams (1995) is one of these forthgoers, who indicated

that just like other strategies (diversified by location, property type or international diversification), diversification by cash flow patterns can also improve the performances of real estate portfolios. Using empirical testing, he concluded that a significant 13.8% of variation of risk-adjusted return of real estate portfolios could be explained by the level of cash flow concentration. In other words, the less dependent a real estate portfolio is on a particular component of cash flow (operating or reversion), the more efficient will be the portfolio. But still there is no further research considering the diversification strategy across regions, property types and revenue types simultaneously.

## RESEARCH DESIGN

The study is conducted in the following two steps.

### Step One: A Grouping Scheme For Geographical Diversification Including All Thirty-five Cities

In this paper, the real estate sale price index and rent price index for each of the thirty-five cities are used as the measurement of asset performances in real estate markets. The result of this step is a cluster grouping scheme that classifies the cities into homogeneous groups based upon their asset performances.

Cluster analysis is an appropriate technique for seeking homogeneous grouping of real estate markets. Instead of using subjective criteria to group the sampled cities into different subsets for diversification, cluster analysis is regarded as an objective way to search the "natural" cluster structure among the observations on a multivariate profile (Hair, Anderson, Tatham, and Black, 1992). The cluster result tends to be more efficient for diversification because the technique uses an optimization algorithm which statistically minimizes the within-group and maximizes the between-group heterogeneity.

The analysis takes the following steps:

(1) Explore the standardized dataset with hierarchical cluster analysis to decide the possible number of clusters;

(2) Perform K-mean cluster analysis for the samples and save the membership of each cluster.

### Step two: A Grouping Scheme For Comprehensive Diversification Across Submarkets In Six Sampled Cities

There are three principles to select the sampled cities:

(1) ***Representative***--with the basic characteristics of the whole cluster;

(2) ***Proportional***--the number of the typical cities in each cluster is in proportion to the scale of the cluster;

(3) ***Available***--the data, the price index in this study, is available.

In the sampled six cities, we select two property types and two revenue types to form a twenty-four scale submarkets. Then, cluster analyses are still employed to design the grouping scheme across different cities, property types and revenue types.

For a further test of the stability of the cluster structures, the dataset was split into two time-periods: 1996-99 and 2000-2001. The clustering procedures were performed on the two sub-samples using. The contrast results were intended to explore whether or not there was any stability in cluster membership across periods.

Instead of the statistic test by bootstrapping method or economic test by discriminate analysis, this paper care more about the authentic distribution of the markets or submarkets no matter whether they are statistically significant or supported by economic foundation.

## DATA

Like most academic researchers, we are limited by the availability of reliable data on real estate rents, as well as supply and demand side variables. Ideally, we would like return data for commercial properties for each of the statistical areas we might consider for inclusion in our portfolio. In fact, this is the type of data most stock and bond portfolio managers can access for use in their asset allocation decision. To date, nothing is available for real estate. Fortunately cluster analysis can be applied to alternative types of data. To the extent that real estate returns can be explained by fundamental factors such as rents and sale price, clustering on any or both of these factors provides a guide for series aggregation, and consequently for reduction of mean-variance input uncertainty.

In the first step, the real estate sale price index and rent price index for each of the thirty-five sampled cities are collected for the time period 1Q2000 through 4Q2004. All the data are from *China Monthly Economic Indicators* published by National Bureau of Statistics of China. The problems of the data and the reasons to adopt them are as follows:

(1) There is no existing return data available and price index is a fairish substitute which generally goes with the change of the return. Theoretically, portfolio optimization should deal with total returns. However, such data at the

submarket level is not publicly available. Meanwhile, the price index including rent price index and sale price index can reflect the overall return of the market and be a better means for measuring the market performance.

(2) The time series is only four years while we know there must be at least five years of history data for the investors, especially institutional investors, to build up an effective portfolio. But in China, many investors agree that since 2000, the real estate market has been more mature with many relevant data systems first built. So it is meaningful to predict the future situation and design the diversification strategy with more reliable dataset.

In the second step, the rent price index and the sale price index are collected from the residential and office markets of Beijing, Shanghai, Tianjin, Dalian, Guangzhou and Shenzhen for the time period 1Q1996 through 4Q2003. All the data are from DTZ DEBENHAM TIE LEUNG Limited by the data, other types of property are omitted from this study; meanwhile, the residential and office properties referred are both in the top grade.

The third step inherits the data from step two. For the contrast purpose, the data series are split into two periods: from 1Q1996 to 4Q1999 and from 1Q2000 to 4Q2003.

## RESULT

Exhibit 1 is the dendrogram of the hierarchy cluster analysis on the thirty-five real estate markets. Using the full dataset, the real estate markets are clustered using both a Euclidean metric and the square of the correlation coefficient as a measure of similarity. As noted above, hierarchical procedures start by treating each case individually and end with all individuals fused into a single cluster. It is obvious that all the cities complete the clustering in early steps except Beijing. Exhibit 2 shows the increasing degree of irrelevant coefficient in every stage. Because the change is too large in the last stage, we omit it to see what happens in the first thirty-one stages. There are four places of significantly increasing dissimilarity along the curve, so it is reasonable to divide the cities in the first thirty-one stages into four clusters. When we take account of the last stage, the number of clusters becomes five.

Based on the results of the hierarchical cluster analysis, the K-means cluster procedures use an iterative relocation algorithm to minimize the within-group squared Euclidean distance and output the cluster membership for each observation. Exhibit 3 lists the five

clusters of the thirty-five cities. An obvious feature of Exhibit 3 is that the scale of each cluster is very different. For example, only Beijing is in the first cluster, while twenty-three cities belong to the third cluster. Another feature is that some members in the same cluster are located the same city or in the similar level of economic development, most members of the forth cluster are in inland region and their counterparts in the fifth cluster are in coastal region. Meanwhile, the economy status of the cities in the second and the forth cluster are generally in the middle level countrywide with a less developed real estate market, while most members in the first and fifth cluster have more developed economic environments with mature real estate markets.

**EXHIBIT 1：Dendrogram of Hierarchical Cluster Analysis on Thirty-five Cities' Real Estate Markets (From 1Q2000 to 4Q2003)**

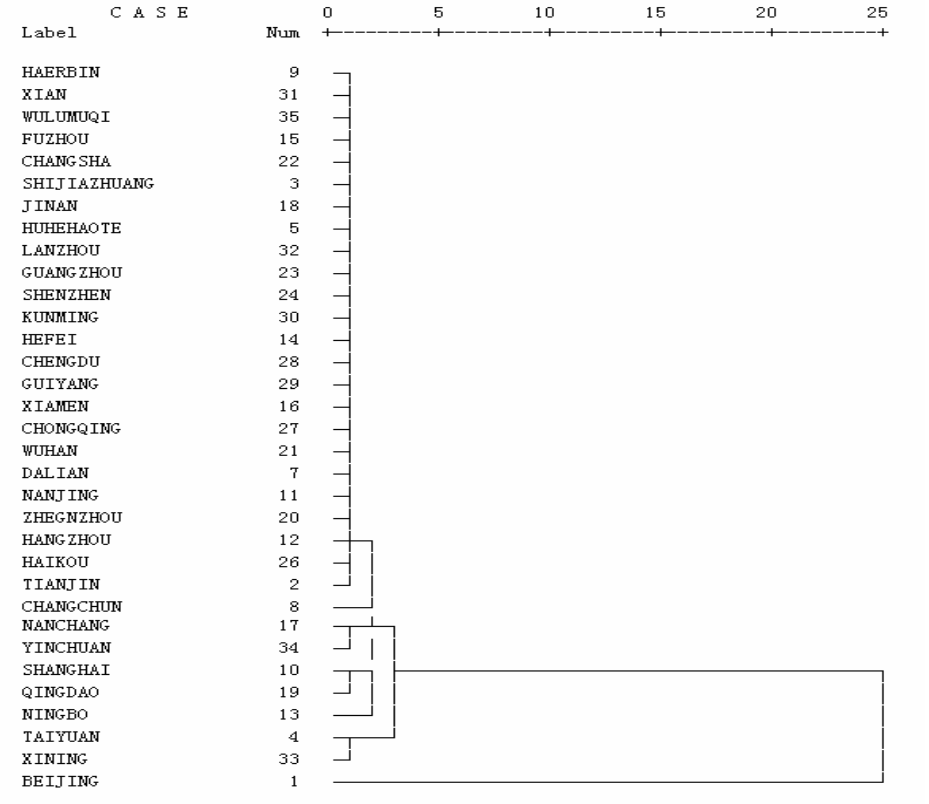



**EXHIBIT 2: Hierarchical Clustering: Increasing Dissimilarity**

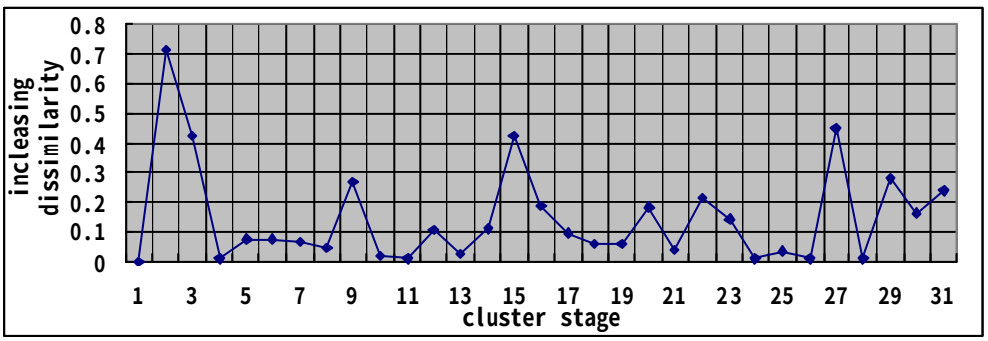


**EXHIBIT 3：Result of K-means Cluster Analysis on Thirty-five Cities' Real Estate Markets (From 1Q2000 to 4Q2003)**

<table>
<tr><th>CLUSTER 1</th><th>CLUSTER2</th><th colspan="2">CLUSTER3</th></tr>
<tr><td>BEIJING</td><td>YINCHUAN<br>NANCHANG</td><td rowspan="3">TIANJIN<br>SHIJAIZHUANG<br>HUHEHAOTE<br>SHENYANG<br>DALIAN<br>HAERBIN<br>HEFEI<br>FUZHOU<br>XIAMEN<br>JINAN<br>WUHAN<br>WULUMUQI</td><td rowspan="3">CHANGSHA<br>GUANGZHOU<br>SHENZHEN<br>NANNING<br>HAIKOU<br>CHONGQING<br>CHENGDU<br>GUIYANG<br>KUNMING<br>XI'AN<br>LANZHOU</td></tr>
<tr><th>CLUSTER4</th><th>CLUSTER5</th></tr>
<tr><td>TAIYUAN<br>CHUANGCHUN<br>ZHENGZHOU<br>XINING</td><td>SHANGHAI<br>NANJING<br>HANGZHOU<br>NINGBO<br>QINGDAO</td></tr>
</table>

Now we have to select suitable cities to represent every cluster. Proportional to the scale of each cluster, we select one of every five cities. But as the limited statistic data, we finally focus on Beijing, Tianjin, Dalian, Guangzhou, Shenzhen and Shanghai for further study. Fortunately, diversification strategies across these markets are more suitable for investors who focus on better developed regions, while not suitable to those whose emphasis is on less developed regions. In the near future, there must be many investors who care more about the mature real estate market, especially residential and office property. So the fruit of this study is also meaningful.

Exhibit 6 shows the composition of each of the four clusters by property type, revenue type and city. We can see from Exhibit 6-1 that the residential and office properties account for 50% in every group. That means the performance of different property types don't differ significantly, but the same property types may include different price features. In Exhibit 6-2, the properties for sale or for rent spread in different clusters. In detail, properties for sale assemble in cluster one, cluster four and also possess 60% of group three; while cluster two contains eight of the nine submarkets (almost 89%). Exhibit 6-3 illustrates the city composition in each group. To be noticeable, the price characteristics in Beijing and Shanghai never belong to the same group indicating significantly different trajectories. While other cities combine in cluster two and three. This phenomenon is just like what we got in Exhibit 3 where Beijing and Shanghai separate in different cluster while other four cities belong to the same group. That confirms the rationality of the previous sampling procedure.

**EXHIBIT 4：Dendrogram of Hierarchical Cluster Analysis on Twenty-four Submarkets (From 1Q1996 to 4Q2003)**

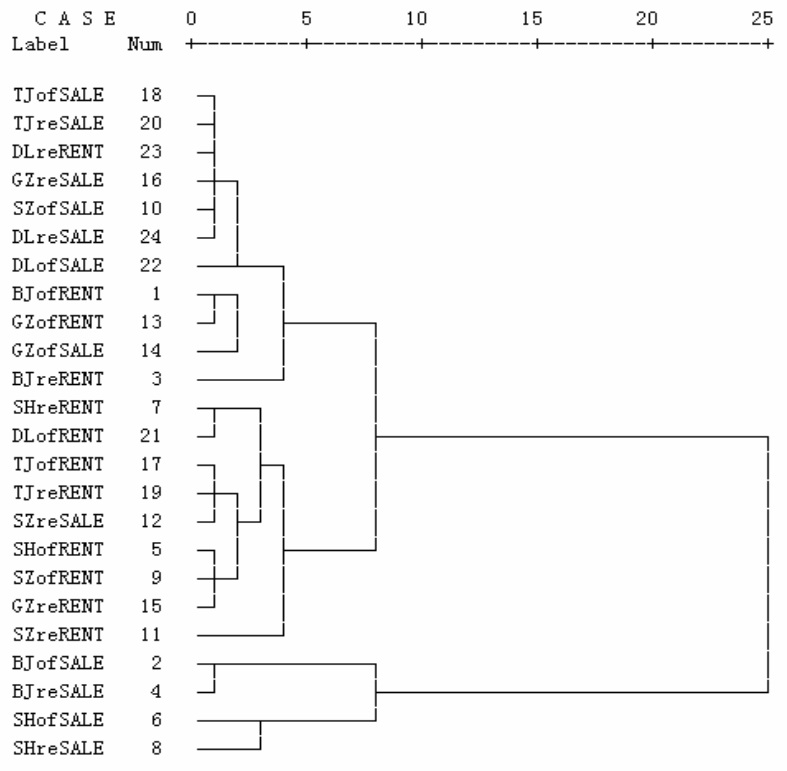
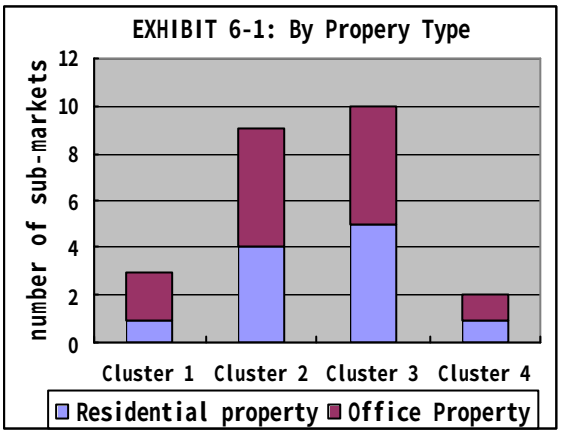


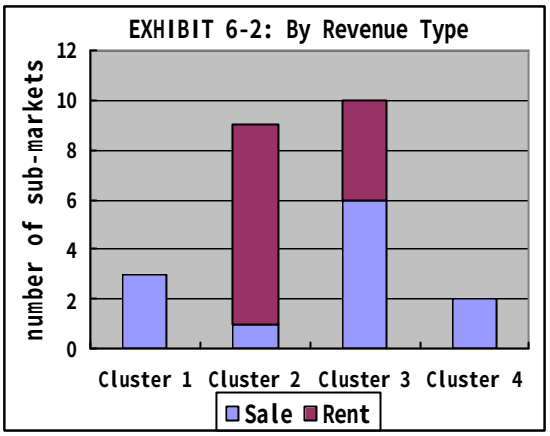

**EXHIBIT 5：Result of K-means Cluster Analysis on Twenty-four Submarkets (From 1Q1996 to 4Q2003)**

| CLUSTER 1 | CLUSTER 2 | CLUSTER 3 | CLUSTER 4 |
|---|---|---|---|
| SH-Office-Sale | SH-Office-Rent | BJ-Office-Rent | BJ-Office-Sale |
| SH-Residential -Sale | SH-Residential-Rent | BJ-Residential-Rent | BJ-Residential -Sale |
| GZ-Office-Sale | SZ-Office-Rent | SZ-Office-Sale | |
| | SZ-Residential-Rent | GZ-Office-Rent | |
| | SZ-Residential-Sale | GZ-Residential-Sale | |
| | GZ-Residential-Rent | TJ-Office-Sale | |
| | TJ-Office-Rent | TJ-Residential-Sale | |
| | TJ-Residential-Rent | DL-Office-Sale | |
| | DL-Office-Rent | DL-Residential-Rent | |
| | | DL-Residential-Sale | |

Next, we split the dataset into two time-periods to further test the stability of the cluster structures. Exhibit 7-1 and Exhibit 7-2 show the results of the hierarchy cluster analysis on the dataset from 1Q1996 to 4Q1999 and from 1Q2000 to 4Q2003. There appears to exist three-, or four –cluster structures. However, in order to contrast with previous analysis on the whole dataset, the four-cluster structure is selected for further analysis. Exhibit 8 and Exhibit 9 are the results of corresponding K-means cluster analysis.

**EXHIBIT 6：The Composition of the Clustering (From 1Q1996 to 4Q2003)**



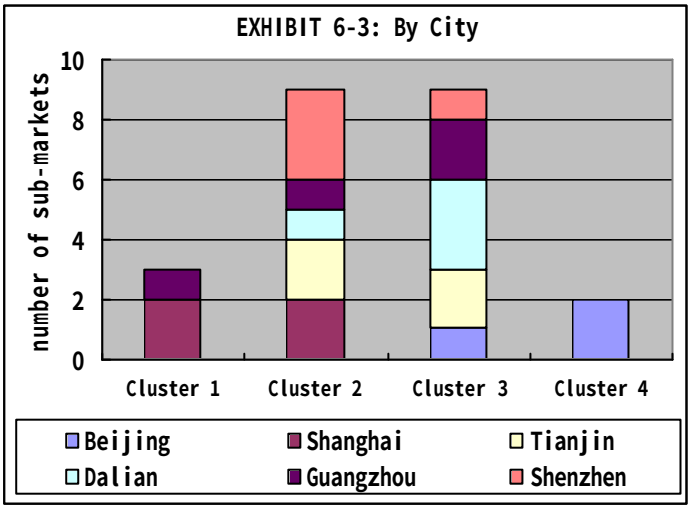




Exhibit 10, 11 and 12 shows the composition of each cluster by property type, revenue type and city in different period. As shown in Exhibit 10-1 and 10-2, for the earlier 1996 -99 period, there are some special cities with obviously different performance, such as the lease market in Shenzhen, the office and residential market in Beijing; but there is no clear borderline between most lease market and sale market, since they each possess half of cluster one, three and four. But when comes to the period from 2000 to 2003, the situation changed to have almost no particular cities with outstanding performance. Every group, especially the first three groups, has similar scale and mixes of at least two types of properties. The performances of different property markets go similar, but the submarkets with the same property type show different performances.

Exhibit 11-1 and Exhibit 11-2 show the revenue types of each cluster in different periods. Similar to the previous analysis, in the earlier period, a lease market dominates cluster two and two sale markets are predominantly in cluster four, while two-third of the remaining markets fall in the first cluster. In the later period, cluster four is dominated by

three sale markets, while others are all mixed groups composed of both types of property. It seems no obviously difference between these two types of property.

**EXHIBIT 7：Dendrogram of Hierarchical Cluster Analysis on Twenty-four Submarkets**

**EXHIBIT 7-1 1O1996 - 4O1999**

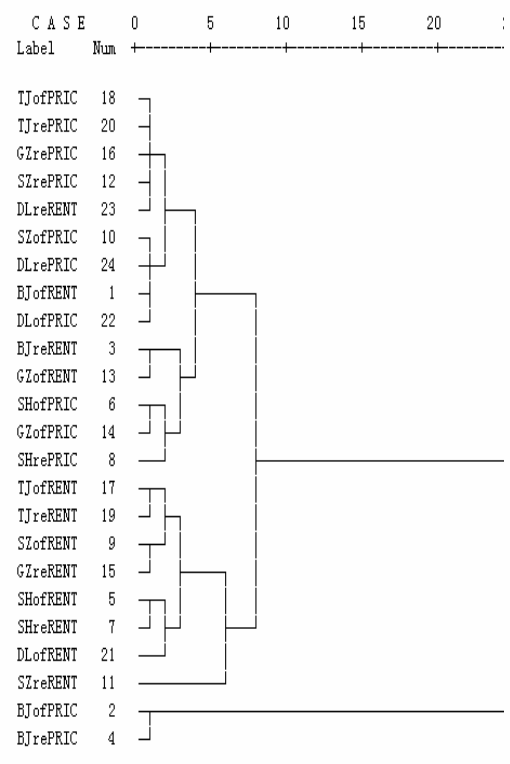



**EXHIBIT 7-2: 1O2000 - 4O2003**

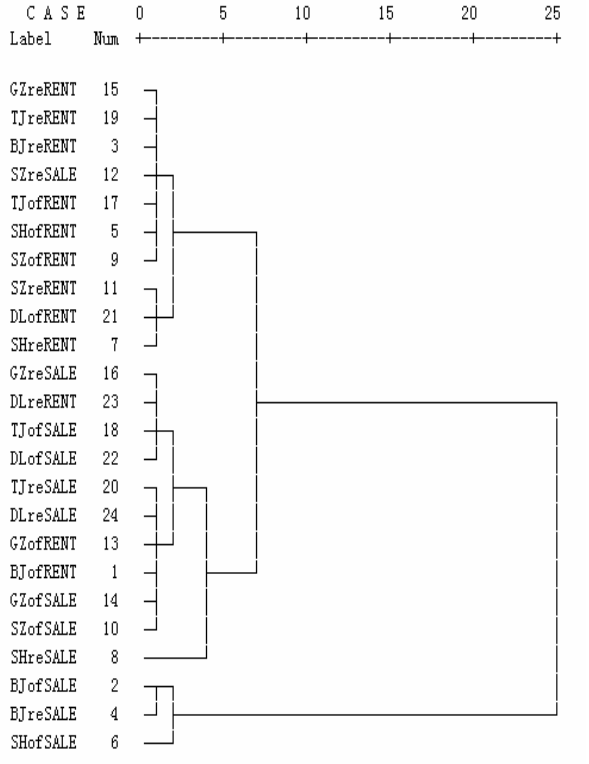



**EXHIBIT 8：Result of K-means Cluster Analysis on Twenty-four Submarkets (From 1Q1996 to 4Q1999)**

| CLUSTER 1 | | CLUSTER 2 |
|---|---|---|
| | | SZ-Residential-Rent |
| | | CLUSTER 3 |
| BJ-Office-Rent | TJ-Office-Rent | BJ-Residential-Rent |
| SH-Office-Rent | TJ-Office-Sale | SH-Office-Sale |
| SH-Residential-Rent | TJ-Residential-Rent | SH-Residential-Sale |
| SZ-Office-Rent | TJ-Residential-Sale | GZ-Office-Rent |
| SZ-Office-Sale | DL-Office-Rent | GZ-Office-Sale |
| SZ-Residential-Sale | DL-Office-Sale | |
| GZ-Residential-Rent | DL-Residential-Rent | CLUSTER 4 |
| GZ-Residential-Sale | DL-Residential-Sale | BJ-Office-Sale |
| | | BJ-Residential-Sale |

**EXHIBIT 9：Result of K-means Cluster Analysis on Twenty-four Submarkets (From 1Q2000 to 4Q2003)**

| CLUSTER 1 | CLUSTER 2 | CLUSTER 3 | CLUSTER 4 |
|---|---|---|---|
| BJ-Residential-Rent | SH-Residential-Rent | BJ-Office-Rent | BJ-Office-Sale |
| SH-Office-Rent | SZ-Residential-Rent | SH-Residential-Sale | BJ-Residential-Sale |
| SZ-Office-Rent | SZ-Residential-Sale | SZ-Office-Sale | SH-Office-Sale |
| GZ-Residential-Sale | GZ-Residential-Rent | GZ-Office-Rent | |
| TJ-Office-Sale | TJ-Office-Rent | GZ-Office-Sale | |
| DL-Office-Sale | TJ-Residential-Rent | TJ-Residential-Sale | |
| DL-Residential-Rent | DL-Office-Rent | DL-Residential-Sale | |

Exhibit 12-1 and 12-2 show where the members of each cluster located. Generally, they have the similar characteristics with the previous four exhibits. In detail, the submarkets in Shenzhen and Beijing have outstanding performance, while most other cities have similar price feature. At the later period, there is less particular city. For example, Shenzhen has more commonness with others. No obvious borderline lies between different submarkets. So instead of being clustered by region, the submarkets are clustered by price feature of each submarket.

The stability tests of clusters across time-periods didn't broadly confirm the findings of the full sample clustering analyses from 1996 to 2003. There are significant changes across the two time-periods. This is hardly surprising given the different trajectories followed by markets.

## CONCLUSION AND SUGGESTION

The purpose of this study is to explore the real estate diversification opportunities in China. The research questions being addressed are: (1) what is the cities grouping that allows optimal geographic diversification in China real estate markets? (2) If (1) exists, is there any sample strategy that allows optimal diversification across property types, revenue types, and regions? The results provided strong evidence for the existence of homogeneous groups in the thirty-five real estate markets. Then, the following analysis designs a sample diversification strategy for the submarkets across the selected six cities. In conclusion, this study confirms the potential of the real estate portfolio diversification and suggests diversifying more extensive across property type, revenue type and city. Meanwhile, it points out the importance of further study on the investors in different environments based on the contrast study.

Based on these empirical findings, the paper gives four suggestions as follows:

**EXHIBIT 10：The Property Type Composition of the Clustering**

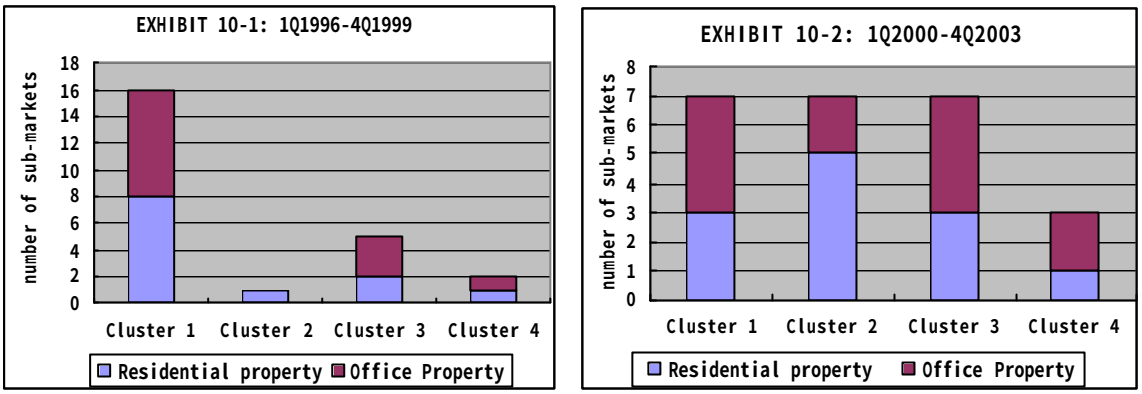



**EXHIBIT 11：The Revenue Type Composition of the Clustering**

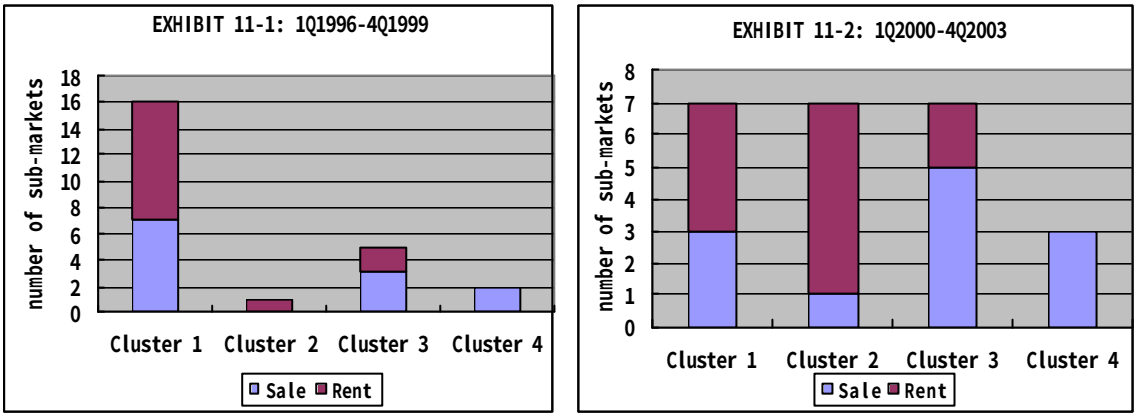
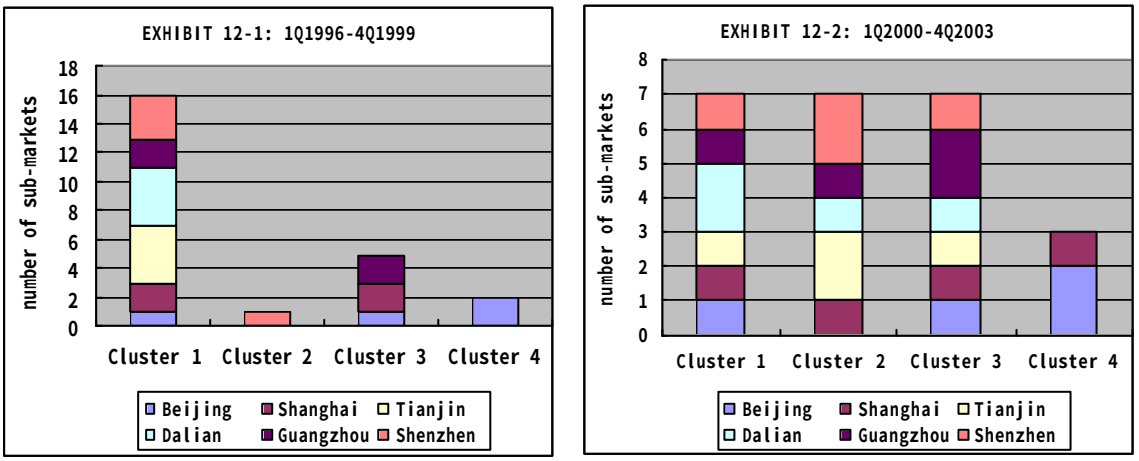



**EXHIBIT 12：The City Composition of the Clustering**




Firstly, there is economic foundation to carry out real estate diversification across China's main cities. The grouping result of all the thirty-five markets seems like a *rhombus* with a few cities at both ends while more cities in the middle. On one hand, a few cities with developed investment environment and more financing conduits, like Shenzhen, Beijing and Shanghai, often dominate a cluster at the end of the rhombus. For example, Beijing is the most outstanding one without any analog. Together with surrounding cities, Shanghai becomes reprehensive of an economic development style in recent years. These

two cities take special economic status and investment attraction. This feature brings both investors and speculators into the markets so that their performances are different with others in a way. On the other hand, most cities in the middle of the rhombus are the economic or political centers of a province. And the grouping of the middle three clusters is generally based on the economic geography pattern. Cluster two and four include more inland cities with less developed real estate markets than the coastal cities in cluster three.

Secondly, the diversification by submarkets can be more efficient than just by city market. As shown by the contrast of Exhibit 3 and Exhibit 9, the latter breaks the borderline between the cities and demonstrates the possibility of comprehensive diversification. This is more coincident with the reality that the real estate asset performances may be heterogeneous inside a single city area and diversification benefits can be realized by properly investing in different submarkets across cities, property types or revenue types. The investors can take the advantage of this idea in two ways: focus on intracity diversification to reduce the cost of investing into different regions, or select familiar submarkets to construct more practical portfolio in different cities. Both ways are not limited by property type or revenue type, which gives the investors more opportunities to compose the portfolio with familiar submarkets. And it is remarkable that, in different time-period, the different performance between the properties of different revenue type are always more significant than of different property type or location.

Thirdly, the rationality of the real estate markets is different between cities. Generally, we test the relationship between the rent price and sale price to tell whether a real estate market is rational. If the change of sale price deviates from the change of rent price too much, we could say the market have some irrational factors inside. In Beijing and Shanghai, the sale price is separated with the rent price; while in most other cities, they often belong to the same cluster. It demonstrates that there may be some irrational factors in the sale markets of Beijing and Shanghai; and other cities seem to be more rational. The phenomenon is stable through different time-period which gives us more hints to diversify across cities.

Finally, investors should be both active and discreet to diversify their real estate portfolio. The contrast analysis shows the markets go from *triangular* to *rectangle* with less special individual and more diversified submarkets. It might be the right time to move from Beijing or Shanghai to more cities. Investors can select more property types or properties with different revenue types across more regions to diversify the investment. Meanwhile, the study gives different diversification strategy suggestions in different time-period. Before

investing, investors should check the current situation and compare it with the above two situations to find the most similar one. Then, they could modify the model and put forward a suitable strategy for further investment.

This study contributes to the literature in these aspects. First, it produces new information on China's real estate markets in the context of portfolio diversification. The geographic grouping scheme and other information documented in this study provide a useful guideline for real estate investors to select appropriate invested areas. Second, empirical findings generally support the theory. The sample diversification strategy across regions, property types and revenue types is a significant attempt in adopting portfolio theory to China's real estate market. It also put forwards the importance of further study on the investors' behavior.

With better dataset and statistical index, this paper could be improved in following aspects, such as testing the reliability of the cluster procedures and adding more sample submarkets in the same or different region, property type or revenue type.

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