

# Coordination Degree Analysis of Real Estate Investment and the National Economy in China -Based on Principal Component Analysis Method

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**Abstract.** Starting from six indicators like the ratio of the real estate investment growth and GDP growth etc., this article analyses the coordination degree of real estate investment and national economy with principal component analysis, and obtains the coordination index. Using  $3\sigma$  method, the authors calculate the mean and standard deviation of the principal component indicator data, and then establish an early warning interval for real estate market. The results show that the real estate investment is a little excessive in recent years but the coordination degree between the real estate industry and the national economy is generally stable in China. Further investigations indicate that the change of the coordination index of the commercial housing sub-market is consistent with the whole commercial building market, but the one of the non-residential building is opposite to the total CB's.

## Introduction

In recent years, the Chinese government continued to take various method to ensure the healthy development of the real estate market. On February 20, 2013, the executive meeting of the State Council promulgated "Five New Policies", from multiple perspectives like stabilizing house price, refraining speculations, increasing supply, and strengthening supervision etc., to strengthen the regulation of the national real estate market [1]. As one of the most important industries in China, the real estate sector can significantly influence and be influenced by the whole national economy. Therefore, their development should keep a balanced pace, avoiding too fast or too slow in either part. As a result, the national macroeconomic indicators and the real estate market development indicators should also keep a balanced relationship in the long run. By analyzing the coordination degree of real estate investment and national economy, this paper seeks to provide some reference for the government to regulate the real estate market and formulate the related policies.

## Related Research Summary

A number of researchers have conducted studies on the coordination degree of the real estate investment and national economy. Most of the previous research qualitatively studied the importance of a coordinated development between the real estate market and the national economy [2-3]. In recent years, some researchers conducted quantitative analyses. Through the Granger causality test model based on Panel data, Pi and Wu (2004) found the bidirectional causality between the regional real estate market development and economic growth in China [4]. Qi and Chen (2009) analyzed the interaction between the real estate and national economy based on the 29 years' data after the world war II in Japan. The result showed that the real estate market fluctuation was the immanent cause for the fluctuation of national macroeconomy, but the latter's fluctuation did not necessarily influence the former [5]. Through the principal component analysis and  $3\sigma$  method, Liu, Wu and Wang (2011) analyzed the coordination degree of real estate industry and national economy in Shenyang City, and established an early warning interval [6]. The Existing literatures were mainly

focused the entire real estate industry, but there are large discrepancies across various sub-markets in current Chinese real estate market, especially between residential market and other markets, which can be proved by the fact that the national macro-control policies were majorly aimed at the residential market in recent years. This is the reason why this research is important and necessary. Based on the overall research on the coordination degree of commercial building market and national economy, this research further divided the commercial building market into two sub-markets: residential and non-residential sub-markets, and investigated the coordination situations of the two between the national economy, respectively.

## Research Method

### Principal Component Analysis Method.

**The Principle of the Method.** Both real estate industry and national economy are extremely complicated systems. Each of them can be evaluated by various indicators from various perspectives. Thus to evaluate whether the two systems are developing co-ordinately, these indicators should be integrated into one indicator. Principal Component Analysis Method is exactly one of the basic methods to solve this problem. Principal component analysis (PCA) was invented in 1904 by an American psychologist named Charles Spearman. PCA is a mathematical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables[7]. PCA is very useful for analyzing real estate industry and national economy in which multivariate indicators are available.

**The Major steps of the Method.** This method has five major steps[8].

(1). Initializing the indicators.

If there are  $m$  indicators and every indicator has  $n$  original data, the mode of the principal component analysis method is equation (1).

$$Y_1 = a_{11}X_1 + a_{21}X_2 + \dots + a_{n1}X_n$$

.....

$$Y_m = a_{1m}X_1 + a_{2m}X_2 + \dots + a_{nm}X_n \quad (1)$$

Where the  $Y_1$  is the first component and the  $Y_2$  is the second one and so on. Then we can get the standardized data by the equation (2).

$$x_{ij} = \frac{X_{ij} - X_i}{S_i}, \text{ where } S_i = \sqrt{\frac{1}{n-1} \sum_{j=1}^n (X_{ij} - X_i)^2} \quad (2)$$

(2). Calculating the correlation coefficient matrix  $R(r_{ij})_{m \times m}$  by the equation (3).

$$r_{ij} = \frac{1}{n} \sum_{s=1}^n [(x_{is} - \bar{x}_i)(x_{js} - \bar{x}_j)] \quad (3)$$

(3). Calculating the eigenvalue  $\lambda$  of the  $R$  by the equation (4).

$$|R - \lambda I| = 0 \quad (4)$$

(4). Calculating the contribution rate and cumulative contribution rate by the equation (5).

$$a_k = \frac{\lambda_k}{\sum_{k=1}^n \lambda_k} \quad \text{where the } a_k \text{ stands for the contribution rate of the first } k \text{ data.} \quad (5)$$

(5). Selecting the principle and building the equation.

**3 $\sigma$ Method.** The  $3\sigma$  method is obtained by the normal distribution density function. Its meaning is that the probability that a random event falls in the scope of its mean plus or minus one standard deviation ( $\sigma$ ) is 68.3%, while it will be 95.4% and 99.73% when the scope is its mean plus or minus two and three standard deviation ( $\sigma$ ). The smaller the probability is, the harder the event happens. If the event doesn't fall in the  $3\sigma$  scope in first trying, this shows the system isn't stable.

## Empirical Research

**Selecting the Indicators and the Source of the Data.** Based on the existing research, this paper selects six indicators including the ratio of the real estate investment growth and GDP growth to calculate coordination degree of the real estate investment and national economy in China, (Table 1). This paper studies the coordination degree of the commercialized buildings market and national economy in China and the real commercialized buildings market in China begins from 1998; so we collect the data from 1998[9]. We get the data from Statistical Yearbook.

Table 1 Indicators of coordination degree of the real estate investment and national economy

Indicators	
A	Commercialized buildings investment growth rate /GDP growth rate
B	Commercialized buildings investment / Urban fixed asset investment
C	Self-raising funds for real estate development /Total funds
D	Total sale of commercialized buildings sold/ Commercialized buildings investment
E	Floor space of commercialized buildings sold/Floor space started of commercialized buildings
F	Floor space started of commercialized buildings growth rate /GDP growth rate

**Calculation of the Coordination Degree Index of Chinese Real Estate Investment and National Economy.** After establishing the coordination degree indicators of real estate investment and national economy in China and collecting the raw data, the authors calculated the index value in the table 1 and then conducted the principal component analysis by SPSS19.0.

**Step One.** Calculating Eigen value, contribution rate and cumulative contribution rate of the coefficient matrix.

Table 2 Total Variance Explained

Component	Initial Eigenvalues								
	Total			% of Variance			Cumulative %		
	CB	RB	NB	CB	RB	NB	CB	RB	NB
1	3.09	3.47	2.24	51.57	57.78	37.36	51.57	57.78	37.36
2	1.25	1.37	2.03	20.90	22.89	33.88	72.47	80.67	71.25
3	0.85	0.59	0.99	14.25	9.75	16.48	86.72	90.42	87.73
4	0.62	0.46	0.52	10.37	7.73	8.68	97.09	98.15	96.40
5	0.14	0.07	0.13	2.33	1.20	2.10	99.42	99.36	98.50
6	0.03	0.04	0.09	0.58	0.64	1.50	100.00	100.00	100.00

According to the principle that the cumulative contribution rate should be larger than 85%, the authors selected the first three components.

**Step Two.** The unit eigenvectors of every component is the relation between the components and the indicators.

Table 3 The relation between the components and the indicators

	Component1			Component2			Component3		
	CB	RB	NB	CB	RB	NB	CB	RB	NB
A	-.906	-.933	-.055	.067	.118	.886	.259	.246	.337
B	.374	.778	-.841	-.442	-.368	.107	.812	-.486	-.024
C	.652	.673	.899	-.521	-.473	.098	-.279	.431	-.251
D	.780	.701	.810	.476	.660	-.061	.094	.106	.514
E	.707	.694	-.250	.659	.689	-.649	.173	.025	.700
F	-.774	-.750	-.070	.351	.301	.895	.108	-.302	.240

**Step Three.** Calculating coordination degree index (K).

The accumulation of the product of the three principal components and the contribution rate can be calculated through the following equations.

$$K_{CB} = -0.417A + 0.216B + 0.188C + 0.515D + 0.527E - 0.310F$$

$$K_{RB} = -0.488A + 0.318B + 0.327C + 0.566D + 0.561E - 0.394F$$

$$K_{NB} = 0.335A - 0.282B + 0.328C + 0.366D - 0.198E + 0.317F$$

Here:

$K_{CB}$  stands for the coordination degree index of the commercialized buildings investment and the national economy;

$K_{RB}$  stands for the coordination degree index of the residential buildings investment and the national economy;

and  $K_{NB}$  stands for the coordination degree index of the non-residential buildings investment and the national economy.

According to these equations, the authors calculated the coordination degree index (K), as shown in figure 1.

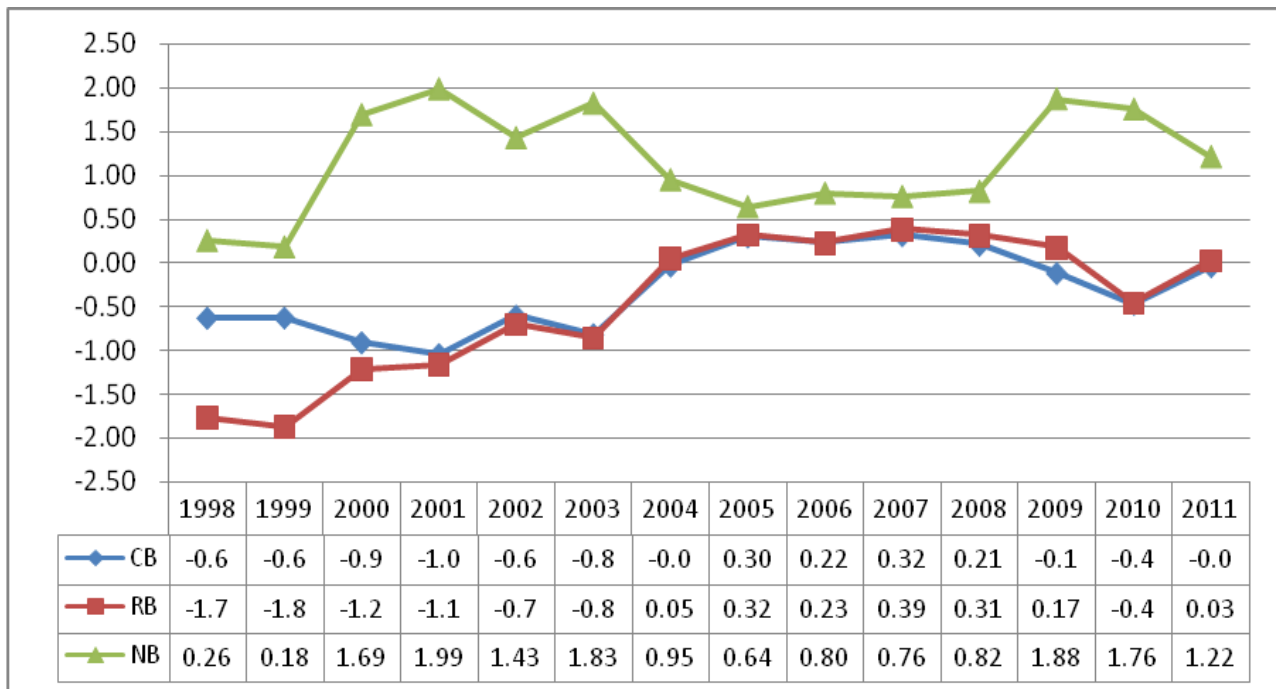


Figure 1 Coordination degree index of the real estate investment and the national economy in China

From figure 1, it can be found that the change of the coordination index of the RB is consistent with the CB, while the index of NB is opposite to the CB. Further investigations shows that the consistency between RB and CB is accounted for the proportion of the RB greatly larger than that of the NB in the CB market. The competitive relationship between non-residential building market and the other two markets may be the reason that the index of the NB is inconsistent with that of the other two markets. When the RB market has higher yields, more investment to RB results in a reduction of investment in NB, and vice versa. From the change of single index of the RB or CB market, it can be found that the index rose continuously from 1998 to 2005, kept relatively smooth from 2005 to 2009, dropped in 2010, and once again started to increase in 2011; the change of the index of NB is opposite. This trend is consistent with the actual development trend of Chinese real estate market: before 1998, due to the welfare housing distribution policy, the investment is very low; after market-oriented reform in 1998, the investment began to increase. To prevent the real estate investment from being overheated, the government started to control the real estate market through multiple methods from 2004, and this

control is increasingly stronger in next consecutive years. Affected by macro control of the real estate market, the continuous increasing of investment enthusiasm started to slow down, however, the investment (especially the investment in RB) is still very high. In 2008 and 2009, the global financial crisis made the investment enthusiasm drop; and due to the economy recovery, the value of the K started to rise again. Overall, the investment of the real estate has a little excessive.

**Establish an Early Warning Interval of Coordination Index.** Based on the  $3\sigma$  theory the previous research, we choose 1 time and 2 times of standard deviations to be the limits of the early warning interval. By calculating the mean and standard deviation of various indicator data series, the authors defined the interval which deviates from the central value within 1 time of standard deviation ( $[E-\sigma, E+\sigma]$ ) as the basically normal interval; Off-mean more than 2 times the standard deviation interval ( $[-\infty, E-2\sigma]$  and  $[E+2\sigma, +\infty]$ ) is the abnormal interval. By doing this we can get five evaluation intervals.

The means and standard deviations of CB, RB and NB are as follows:  $E_{CB} = -0.306$ ,  $E_{RB} = -0.468$ ,  $E_{NB} = 1.15$ ,  $\sigma_{CB} = 0.480$ ,  $\sigma_{RB} = 0.798$ ,  $\sigma_{NB} = 0.611$ . The early warning intervals of Chinese real estate investment and the national economy are shown in table 4.

Table 4 Warning interval of coordination index of real estate investment and national economy

	abnormal	Basically normal	Normal	Basically normal	abnormal
$K_{CB}$	<-1.266	-1.266—0.786	-0.786—0.174	0.174—0.654	>0.654
$K_{RB}$	<-2.065	-2.065—1.267	-1.267—0.330	0.330—1.128	>1.128
$K_{NB}$	<-0.064	-0.064—0.547	0.547—1.769	1.769—2.990	>2.990

According to figure 1 and table 4, it can be found that the change of coordination index of real estate investment and national economy is generally stable from 1998 to 2011. The  $K_{CB}$  fell in the normal and basically normal intervals in 6 and 8 years of the past 14 years, respectively and never fell in the abnormal intervals. Further investigations showed that residential buildings (RB) and non-residential buildings (NB) sub-markets had never fallen in the abnormal intervals. This result shows that Real estate macro-control policy has played a good role to restrain the over-investment in real estate market in the past 14 years in China.

### Conclusion and Suggestion

The empirical research showed that principal component analysis method is effective for analyzing the coordination degree of Chinese real estate investment and the national economy in China. The results showed that the real estate investment is a little faster than the national economy and their coordination degree is generally stable, which is consistent with the actual situation. In addition, the authors, established an early warning interval of coordination index based on the  $3\sigma$  method. However, one of the shortcomings of this research is that the relatively low sample size for using  $3\sigma$  method due to the short history (14 years) of Chinese real estate market. More data can be supplemented and further research will be conducted to validate the result in this paper in the future.

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