Comprehensive evaluation on housing market supply & demand based on principal component analysis: the case of Xi'an, China

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Abstract

At present, China's housing prices and structures have been severe distorted, which have been done serious harm on the development of national economy and people's lives, the government has implemented the most strictest macro-control. This paper applies the correlation and principal component analysis on the supply & demand of housing market. Aims to points out clear direction for the implementation of macro-control policies in the future.

Keywords: Macro-control; Correlation (Statistics); Principal Component Analysis; Comprehensive Evaluation; Supply & Demand Coordination Degree; Tourism Real Estate

1 Introduction

In recent years, China's housing market has entered a white-hot stage, the prices and structures of housing are irrational, and the housing market distortions do serious harm to the social and economic development. After 2010, the government has taken the most severe macro-control policies to promote the healthy and orderly development of the housing market. The supply & demand relationship development is the culprit of many problems and most intuitive response to market conditions, studying the current housing market supply & demand is imminent. The purpose of research is to study the supply & demand analysis indicators to provide accurate information on the country's macro-control of intensity and direction in the future.

2 Some Related References Background

Until now, there have been many references studying supply & demand of housing, and correlation and principal component analysis (PCA) have been applied widely in various domain including science, commerce, agriculture, medicine, and industry. In [1], housing supply is affected by construction costs, demand is determined by the renting/buying considerations of the public, adopting three price indices of the Taiwan housing market, the CCI, the RPI and the HPI, and examines long-term and short-term correlations among the three indices [1]. The reference [2] focuses on the housing demand increase in Belgium. An overview of the housing market is presented wherein several are identified such as rental, private, new-build and secondhand. Forty-three percent of households looking for housing in 2009 bought an existing house, 43 percent rented, 11 percent opted for new self-build, and three percent bought a new house [2]. The reference [3] hypothesizes that the increase in money supply accosted by rapid economic growth leads to strong investment demand in the Taiwanese housing market. When the growth rate of money supply is below the model's estimated threshold value, household number, income, and user cost of housing capital are significant variables. Results suggest that non-linear movement of housing prices is primarily driven by investment demand [3]. The reference [4] discusses briefly the methodology used, the housing situation, the dynamics of the housing sector, and etc. the main parts of the research is to analyze the policies and practices, supply factors and demand factors. Showing the housing policy adopted by the government aims to diversify housing types according to household incomes. And analyzing two supply factors which are land development regulations and ownership, and housing production and ownership, and two demand factors which are housing finance and housing subsidies [4]. The reference [5] aims to solve the current high price's dilemma, according to the effective housing demands, and combining the local real income levels then build up three high, middle and low real estate markets with independent operation, and mutual connection and conversion [5], and etc [6-8].

In [9], principal component analysis (PCA) was employed to optimize an LUR model for PM2.5. An optimized surrogate of vehicle emissions was produced by PCA and employed as the predictor variable in the model, resulted that the method used can contribute to LUR techniques in two major ways: 1) by improving the predictive power of

the input variable, by substituting a principal component for a single variable and 2) by creating an orthogonal set of predictor variables, and thus fulfilling the no colinearity assumption of the linear regression methods. The proposed PCA method should be universally applicable to LUR methods and will expand their economical attractiveness [9]. The reference [10] applies the principal component analysis and parallel analysis to smoothed tetrachoric correlation matrices were investigated in a simulation study. To evaluate the effect of several smoothing algorithms, 360 different types of data sets were simulated [10], and etc [11-12].

3 China's Housing Market Performances under the Macro-control Background

3.1 A slump in China's housing market

At the beginning of 2011, the country has implemented series of forceful measures, such as purchase limit, credit limit, price limit, and etc. the government used widely of the land, finance, taxation and other means to return to the reasonable prices and structures of housing. According to the concerned statistic data of 2011 shown, real estate enterprises invested 4430.8 billion in the construction of housing, it grown 30.2% than 2010, increasing ratio decreased 2.6%. The sales of commercial housing area and the transactions of second-hand housing area also declined sharply. The commodity housing sales area is 970.3 million square meters, increasing ratio declined 4.4%; second-hand housing transaction area is 93.38million square meters, declined 33.0% than 2010. The boom index of real estate has dropped fall since in June 2011, it has fallen to 99.87 and 98.89 in November and December respectively, which dropped below the boom line 100 for the first time since 2009.

3.2 Real estate industry structure confronted adjustment

At present, under the background of the draconian control policies and the inflation, the real estate industry is confronted with the adjustment of industrial structure. The real estate industry structure ratio will be transformed from the domination of the housing real estate in the world into the commercial real estate as its core with a collection of the industry chain. Along with the policy changes in recent years, the financing costs, transaction costs and holding costs of the real estate have increased gradually, and the housing real estate investment function has been disappeared step by step, thus housing estate will be gradually transformed into a product against inflation. Along with the Chinese enterprises in the industrial restructuring, consumer consumptive habits transformation,

the reform of financial system and the adjustment of industrial structure, China's commercial real estate development model will be changed from simple property rental into commercial estate as the core with the integration of the industry chain and capital chain.

National implementation of stringent regulation policy aims to adjust market supply & demand, and from the performance of the housing market and the real estate industry we can see that, the implementation of the policy also played a certain role, thus analysis of housing market supply & demand coordination degree seems much more necessary.

4 Housing Market Supply & Demand Analysis: The Case of Xian

4.1 The selection of Indexes and analysis tools

1) In this paper, the analysis of data processing, correlation, principal component and parameter interval estimation, and the calculation of comprehensive evaluation value, all use the software of Excel 2007 and SPSS Statistics 20.

2) According to the related references, there have selected five indexes which can synthetically reflect the housing market supply & demand: housing capital fund / the sales of housing X_1, housing pre-sale area / housing area sales X_2, the completed housing area / housing vacancy X_3, housing average price growth rate / urban per capita disposable income growth X_4, housing sales price index / housing sales price index X_5, show as Table 1.

Table 1 2004-2011 the data of different indexes

	X_1	X_2	X_3	X_4	X_5
2004	1.362	0.568	0.236	3.165	1.035
2005	0.924	0.603	0.313	2.387	1.046
2006	1.26	0.699	0.251	-0.556	1.023
2007	1.219	0.584	0.091	0.288	1.024
2008	1.566	0.756	0.086	0.838	1.027
2009	1.261	0.911	0.063	-0.008	1.002
2010	1.014	0.953	0.064	0.913	1.091
2011	0.856	0.667	0.426	1.9614	1.012

Notes: the above data derived from 2003-2012 the statistical year books of Shaanxi Province

4.2 The analysis of index correlation

The data in table 1 is processed by the correlation analysis, and then obtained correlation coefficients and significance test of the indexes, show as Table 2.

Table 2 Pearson correlation coefficients and significance test of the indexes

Indexes		X_1	X_2	X_3	X_4	X_5
correlation coefficients	X_1	1.000				
	X_2	0.014	1.000			
	X_3	-0.566	-0.568	1.000		
	X_4	-0.264	-0.480	0.517	1.000	
	X_5	-0.254	0.291	-0.228	0.216	1.000
Sig.(2-tailed)	X_1					
	X_2	0.974				
	X_3	0.143	0.142			
	X_4	0.527	0.229	0.189		
	X_5	0.544	0.484	0.588	0.607	

* *Correlation is significant at the 0.05 level (2-tailed).

According to table 2, it can be known that 1) the significance of the t-test between the correlation coefficient among the five index is significantly greater than 0.05, thus the null hypothesis is accepted, and there is no significant linear correlation among the five index.2) There is a correlation between different index. Results X_1 is negatively correlated with X_3, X_4 and X_5, X_2 is negatively correlated with X_3 and X_4, negative correlation is existed between X_3 and X_5,other are positively correlated, so that they provide information about the overlap. Therefore, the direct usage of these indexes is difficult to accurately evaluate the housing market supply & demand, require the application of principal component analysis method.

5 Comprehensive Evaluation of Housing Market Supply & Demand Coordination Degree Based on Principal Component Analysis

5.1 The principal component analysis basic model

The principal component analysis method is a multivariate statistical method aims to use the idea of dimension reduction, by researching the inner structure relation of the index system, to transform a lot of indices into a few independent indices which are comprehensive indices contain most information of the original index (80% ~ 85%).

If there are m indicators, the observed value of each indicator is n, so the principal component analysis model is established as follows:

$$\begin{cases} Z_1 = a_{11}X_1 + a_{21}X_2 + \cdots + a_{n1}X_n \\ Z_2 = a_{12}X_1 + a_{22}X_2 + \cdots + a_{n2}X_n \\ \vdots \\ Z_m = a_{1m}X_1 + a_{2m}X_2 + \cdots + a_{nm}X_n \end{cases} \quad (1)$$

In (1), $a_{1i}, a_{2i}, \ldots a_{ni}(i = 1,2,\ldots m)$ is the characteristic vector of the characteristic value of the covariance matrix of X, and X_1, $X_2, \cdots X_n$ is the standardized variable of X, $a = (a_{ij})_{m \times n} = (a_1, \ a_2, \cdots a_m)$, $R_{ai} = \lambda_i a_i$, R is the correlation coefficient matrix, λ_i is the corresponding characteristic value, a_i is the unit orthogonal vector, and $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_n \geq 0$.

5.2 The process of the principal component analysis

The data in table 1 is analyzed by the principal component analysis method, and then obtained total variance explained, show as Table 3.

Table 3 Total Variance Explained

Component	Eigen-vector of different indexes				
	X_1	X_2	X_3	X_4	X_5
1	-0.248	-0.323	0.404	0.335	-0.040
2	-0.422	0.339	-0.050	0.150	0.631
3	0.625	-0.345	-0.332	0.583	0.438

Component	Extraction sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	2.255	45.098	45.098
2	1.396	27.915	73.013
3	0.869	17.376	90.389

The data in table 3 shows that: in the first three indices of cumulative contribution rate of 90.389%, indicating that the first three index reflects the original index mostly, can be substituted for the original five index of the Xi'an housing market supply & demand for comprehensive evaluation, according to the standardization eigenvector, there can get the expressions of the three new comprehensive index:

$$CI(1) = -0.248X_1 - 0.323X_2 + 0.404X_3 + 0.335X_4 - 0.040X_5 \quad (2)$$

$$CI(2) = -0.422X_1 + 0.339X_2 - 0.050X_3 + 0.150X_4 - 0.631X_5 \quad (3)$$

$$CI(3) = -0.625X_1 + 0.345X_2 - 0.332X_3 + 0.583X_4 - 0.438X_5 \quad (4)$$

From the above expression can be clearly seen that 1) by the reducing dimension, can make the 5 original interrelated supply & demand indexes into three new independent comprehensive indexes, and retain the information of the original index 2) most of the information of different indexes on CI(x) effect is also different. In the CI(1), X_2 and X_4 have the greatest impact on the evaluation value; In CI(2), the impact of X_5 and X_1 is the biggest, but the former has positive effect, the latter produces negative effect; in the CI(3), X_1 and X_4 is the maximum impacts 3) the three new comprehensive index contribution different rates will exercised different influence on CI(x), so there should goes further in the comprehensive evaluation.

5.3 Comprehensive evaluation on the housing market supply & demand coordination degree

1) The comprehensive evaluation expression
According to the principal component expressions, there can calculate 2004-2011 Xi'an housing market supply & demand comprehensive evaluation value of CI(x); according to the contribution rate and the contribution rate of (Table 3), there can calculate the comprehensive indicator weight K_1=0.4989, K_2=0.219 3088, K_3=0.1922, respectively, and then establish Xi'an housing market supply & demand coordination degree comprehensive evaluation expression CE:

$$CE=CI(1)*K_1+CI(2)*K_2+CI(3)*K_3 \qquad (5)$$

2) The comprehensive evaluation grade
According to the parameter interval estimation principle, CE is analyzed by the method of confidence intervals, therefore, Xi'an housing market supply & demand comprehensive evaluation grade can be calculated, show as Table 4.

Table 4 Comprehensive evaluation grade of the housing market supply & demand coordination grade

Grade	Perfect coordinated	Well coordinated	Coordinated
Range	$\geq$ 1.293	(0.848,1.293)	(-0.041,0.848)

Grade	Not well coordinated	Not coordinated
Range	(-0.485,-0.041)	$\leq$ -0.485

3) The comprehensive evaluation results
According to the comprehensive evaluation expression and grade, Xi'an housing market supply & demand

comprehensive evaluation results can be obtained, show as Table 5.

Table 5 the comprehensive index value CI(x) and comprehensive evaluation value CE of the housing market supply & demand

	CI(1)	CI(2)	CI(3)	CE	Grade
2004	0.593	0.734	2.875	1.075	Well coordinated
2005	0.461	0.817	2.115	0.889	Well coordinated
2006	-0.664	0.254	0.588	-0.140	Not well coordinated
2007	-0.398	0.369	1.146	0.135	Coordinated
2008	-0.358	0.365	1.628	0.247	Coordinated
2009	-0.624	0.405	0.887	-0.016	Not well coordinated
2010	-0.272	0.717	1.293	0.335	Coordinated
2011	0.361	0.776	1.750	0.756	Coordinated

From table5 and Figure 1, it can be known: 1) In 2004 and 2005 Xi'an housing market supply & demand coordination grades both are the Well coordinated, 2004 Xi'an housing market supply & demand coordination degree reached 1.075, it decline from 0.889 of 2005 to minimum value -0.140 of 2006 in the 8 years, the grade of coordination degree is down to coordinated from not well coordinated. 2006-2008 supply & demand improved slightly, rising the grade of coordinated. because of the 2008 financial crisis, 2008-2009 the comprehensive evaluation value decline to -0.016, nearly the minimum value of 2006, return to the grade of not well coordinated; In 2009-2011, because the country introduced a series of incentives, Xi'an housing supply & demand coordination degree high speed increased by 0.772 points; In 2011, owing to the implementation of the most stringent regulatory policies by far, Xi'an housing market supply & demand coordination degree increased by 0.071 comparing 2011 to 2010, and up to the grade of coordinated.2) At present, Xi'an housing market supply & demand is at the grade of coordinated. The implementation of the macro-control policies played a significant effect on curbing the speculative demand, reducing price and adjusting housing structure. Therefore, the government of housing market ironhanded macro-control can't relax, and must guide effective demand at the same time.

6 Recommendations

Under the strict macro-control background, curbing the speculative demand and guiding the effective demand at the same time is the only key, and there some recommendations on the housing market and real estate industry development.

6.1 Focus on the housing market regulation, meanwhile deepen comprehensive housing policies

Under the market economic system, the housing real estate, like other commodity markets, run under the interaction of the supply & demand mechanism, price mechanism and competition mechanism, but because of the particularity and complexity of the supply & demand, the supply & demand balance of the housing market is a long and difficult task under normal circumstances. So there should give priority to the market adjustment, meanwhile continue to use the visible hand to make up for market failure, to correct market irregularities, by the comprehensive use of economic, legal and requisite administrative means to achieve the equilibrium of supply & demand. There should strengthen the macro-control policies, the banking and credit system, and actively and effectively play the regulatory role of the property tax, to deepen the policy of regulation, in order to curb the speculative demand and guide the effective demand, prompting prices return to reasonable.

6.2 Strengthen the construction of the indemnificatory housing, establish multifunctional housing supply system

There should strengthen the government oversight and enforcement, meanwhile improve the laws and regulations for indemnificatory housing. There should accelerate the implementation of the "Twelfth Five-Year Plan" of the indemnificatory housing industry, further enhance the construction of the affordable housing, capped-price housing, public rental housing, low-rent housing as well as the shed housing vigorously. To steadily solve the housing problem of all income groups, such as city employees (mainly college graduates newly participate in the work) as well as the migrant workers' quickly. All of this is in order to establish indemnificatory housing supply system step by step, which is based on protection of basic needs and guidance of rational consumption, is the government provide basic protection mainly and the market meet the multi-level needs mainly.

6.3 Coordinate at all levels of real estate markets, balance supply & demand

There should establish the monitoring and evaluation system of the land market and perfect the land market information communication mechanism, improve the differentiation of the land supply policy to ensure the land transaction is fair and reasonable moderate, further stabilize market expectations. There should coordinate the development of secondary real estate market, guide he real estate developer to invest reasonably and the buyers consume rationally, and improve the real estate market

information system to make the information transparent, in order to avoid blind investment and consumption. There should promote the reform of state-owned real estate enterprises, improve enterprise and personal credit file and evaluation system, guide the healthy development of the real estate market. We know that China's large population, poor little rich, so less indemnificatory housing in solving the housing problems of lower-middle class is just a drop in the bucket, it's necessary to promote reasonable housing concept vigorously, encourage low-income and middle-income groups to purchase second-hand and rental housing, and guide the second-hand rental housing market actively, that play the linkage effects of the real estate markets at all levels to promote the equilibrium of supply & demand.

6.4 Conformed and combined with the tourism, accelerate the sustainable development of tourism real estate

Tourism real estate is a new convergence industry which is combined tourist industry with real estate industry. A successful tourism real estate projects always have itself cultures, which are not just rely merely on the tourism resources. Therefore, the real estate the real estate developers should find their strength and make the best use of opportunities instead of using housing development ideas on the development of tourism real estate, they need to make innovations and open up different development concept. 1) housing real estate should be transformed from low-end to high-end, from a single housing real estate to the diversification of the tourism real estate, from one-time development to sustainable development, and increase the diversification of the tourist hotels, vigorously develop the service industry, and then strengthen the real estate industry 2) whereby the quality of tourism industry to promote the development of the real estate market, which will be the long-term way of Xi'an development. So there should establish the orderly development of high-end tourism real estate goals, adhere to high standard, high-quality and high-end development principles, to construct a diversified tourism real estate supply system which includes high-star hotel, the hotel property, high-end leisure houses, and so on.

6.5 Accelerate the adjustment of the real estate industry structure, promote the housing industrialization gradually

There should deepen the policy control, promote the structural adjustment of the real estate industry, and establish a diversified real estate product supply system which take commodity housing as a basic, affordable housing as a protection, travel health real estate as a characteristic. Gradually form the housing supply system which has the protection in the low-end, has the support in

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the medium-end, has the market in the high-end, and has the reputation in the characteristics. There should gradually promote the housing industrialization. First, there should develop a variety of housing standards, and narrow the gap between the standard; Second, there should focus on building energy efficiency, and reduce the construction cost; Third, there should adapt to the needs of the residents, and strengthen the demonstration and driving effect of the government; Fourth, there should take the concept of green and sustainable development, healthy and comfortable living environment as the prerequisite to accelerate the process of housing industrialization.

7 Conclusions

In this paper, the application of correlation analysis and principal component analysis method on the comprehensive evaluation of Xi'an housing market supply & demand under the macro control, the results show that under the sustaining implementation of the housing policies in the last two years Xi'an housing market has obtained satisfaction effect, so the study verifies the effect of the government regulation and the efficiency of the principal component analysis method in the application of the housing market supply & demand comprehensive evaluation. The results provide the meaningful guidance for the intensity and direction of the macro-control in the future, and what great important is the meaningful reference and valuable theoretical basis for the future research.

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