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Research on Early Warning of Real Estate Bubble in Xiamen City Based on AHP–ECM

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Abstract—**This article takes Xiamen City as the object, selects relevant data of the real estate market from 2008 to 2018, constructs an indicator system of early warning of the real estate bubble, and uses the analytic hierarchy process and efficacy coefficient method to conduct an empirical analysis of the degree of real estate bubbles. The research results show that the state of real estate market in Xiamen City is not good, and the probability of the comprehensive warning coefficient being in the alert range is 55% from 2008 to 2018, and further precautions are needed.**

Keywords—real estate bubble; analytic hierarchy process; efficacy coefficient method; early warning

I. INTRODUCTION

Since the reform of China's housing system monetization, the real estate industry has experienced rapid growth in sales and investment, and the problem of high fever in the real estate market has become increasingly prominent. Due to the overall tightness of land supply in China, the growth rate of land prices far exceeded the rise in the average price of commercial housing sales in the same period under the circumstance that the local government monopolized the land supply market, which made the cost of real estate development year by year. For developers, the pursuit of maximizing profits is more inclined to invest in the construction of high-end housing, but the high-end housing exceeds the economic affordability of low- and middle-income earners, resulting in an imbalance in the real-estate development structure of idle high-end housing and the supply of middle- and low-end housing exceeding demand. With the optimistic expectations of speculators' return on housing purchases, housing investment and housing prices continued to rise until the real estate bubble burst, forming a vicious circle. In addition, in the past ten years, the government has adopted a loose monetary policy and repeatedly carried out currency releases. From 2014 to 2015, the economy fell due to price deflation, and public policies

once again stimulated real estate to stabilize growth. From the "930 New Deal" in 2014 to the "330 New Deal" in 2015, the restrictions on purchases and loans were reduced and taxes were reduced. The housing prices of fist-tier and second-tier cities skyrocketed [2]. In this context, the real estate bubble has been intensifying.

The excessively high housing prices make it more and more difficult for some residents to purchase housing and improve housing conditions, which will affect the healthy development of the real estate market. Therefore, it is of great significance to sort out and analyze the degree of real estate bubbles and establish a set of scientific indicators [3]. It can accurately predict the existence of the real estate bubble, judge the severity of the bubble, and warn the bursting of the bubble, which can help the real estate industry to effectively locate, alleviate the contradiction between market supply and demand, reduce the space for real estate speculation, and promote the benign development of market functions. In addition, predicting the real estate bubble in advance is conducive to controlling the size of the real estate bubble, thereby controlling the flow of corporate funds to a certain extent. Based on the existing literature, this article constructs a set of scientific indicators to measure the degree of real estate bubbles. It has real-time detection characteristics, and has a certain early warning effect on the burst of the bubble. At the research method level, the main methods of measuring real estate in China can be summarized into two categories: index method and model method. However, both methods have a certain one-sidedness, and it is difficult to effectively detect the existence of real estate bubbles and give objective observations of their size [3]. This article adopts the index measurement method, selects representative indicators, and combines the efficacy coefficient method to measure the real estate bubble by comparing the difference between the actual index value and the index critical value, which can solve the deficiencies of the existing research methods to a certain extent [4]. Taking Xiamen City as an example, comparing the difference between the actual index value and the critical value, it can

determine whether there is a bubble in the real estate market. It is of great significance for the correct estimation of future development trends. At the same time, it is of significance for the study of real estate bubbles in other areas of China.

II. SELECTION OF REAL ESTATE BUBBLE INDICATORS

Early warning of real estate bubbles is of great significance for the real estate industry and financial markets. A timely and scientific early warning of the real estate bubble can provide correct guidance and guide the healthy development of the real estate and financial markets. Therefore, the selection of indicators for measuring the real estate bubble is of great significance. This project is mainly selected from the aspects of price, investment, and financing, so that it is measured in many aspects to achieve the accuracy of the conclusion.

A. Real Estate Price Indicators

The index early warning method that uses the real estate price index as the most direct early warning indicator is different from the indirect test method and direct test method proposed by related scholars. It does not need to consider the land price time series that is missing for many years, and the unpredictable reduction rate and future cash flow. The results of selecting early-warning indicators for real estate prices are more scientific and reliable.

1) Real estate price growth rate / real GDP growth rate: The growth rate of real estate prices / real GDP growth rate is mainly used to measure the expansion rate of the real estate industry relative to the national economy. It is an important dynamic indicator reflecting the real estate bubble. The ratio of real estate growth rate to GDP growth rate is within a reasonable range of 1, 1-2 bubble warning, more than 2 housing price bubbles.

2) Price-to-income ratio: The so-called house-to-income ratio, that is, the ratio of the median house price to the median household income, is a comprehensive indicator that reflects the relationship between a city's household income and house prices. Through the ratio of housing price to income in different years, it can see whether the housing affordability of residents has increased or decreased. The World Bank points out that the normal ratio of housing prices to income in developed countries is between 1.8 and 5.5, while the reasonable ratio of housing prices to income in developing countries is between 3 and 6. The calculation method uses the World Bank's algorithm. The average housing price-to-income ratio of a country is usually calculated by the ratio of the household income to the total household income. Among them, the calculation formulas of total housing price per family and total annual income per family are as follows: total housing price per family = housing area per capita × average population per family × average selling price per unit area; total annual income per household = average population per household × total annual income per capita.

3) Housing price index growth rate / cpi growth rate: It is generally believed that real estate can be used to resist currency depreciation caused by inflation. When real estate prices rise rapidly and greatly exceed the CPI increase, it means that real estate prices deviate from the basic value and a bubble has appeared. The higher the ratio is, the larger the bubble is. It is generally believed that this index should not exceed 2; there is a slight bubble when the index is 2-4; there is serious bubble when the index exceeds 4.

B. Real Estate Investment Indicators

Real estate investment indicators can reflect the current real estate investment situation, whether the real estate bubble caused by overheated investment. It plays a early warning role. Therefore, it is believed that real estate investment indicators can reflect the situation of real estate bubble to a certain extent.

1) Real estate investment / total fixed asset investment of the society: This indicator can reflect whether the proportion of real estate in the structure of fixed assets investment in the whole society is reasonable, and whether there is a problem of excessive investment. It is an important indicator to measure the stability and durability of the development of the real estate market. [5] The larger the index is, the larger the proportion of real estate investment will be. The insufficient funds for other social infrastructure and renovation will affect long-term economic development. According to relevant scholars, the ratio should be 20-25%. The ratio over 25% indicates the existence of severe bubble.

2) Real estate investment growth rate / GDP growth rate: This ratio reflects the growth rate of real estate investment in the overall social investment market. The growth rate of real estate investment should match the overall growth rate of the economic market, not too fast or too slow, which can effectively reflect whether the growth rate of China's real estate investment is too fast and whether the bubble is accelerated. China is in the process of industrialization. Coupled with the new requirements of urbanization for urban housing, the ratio can be set at 1.3.

C. Financial Assets Indicators of Real Estate

As a gold-intensive industry, financing is the key to its development. The development of the real estate industry can't be separated from the support of bank credit. The prosperity of the real estate industry is closely related to bank credit. Therefore, related indicators such as the source of funds in the real estate industry and the credit status of financial institutions are very important for early warning of real estate bubbles, and such indicators should be selected.

1) Total real estate loans / total financial institution loans: Real estate loans include real estate development loans and personal housing mortgage loans. The larger the proportion, the greater the credit tendency, the higher the degree of support for real estate, the better the basic conditions for real estate financial risks. According to the domestic environment and the actual situation of Xiamen's

economic development, the ideal standard for this indicator should be 0.08, while 0.2 is the critical value, and exceeding 0.2 indicates a serious bubble.

III. METHOD AND PROCESS OF EARLY WARNING OF REAL ESTATE BUBBLE

Combined with the selected index system, the specific steps for calculating the comprehensive early warning coefficient of real estate bubbles in a certain area using the efficacy coefficient method are:

Scientific selection of indicators can accurately reflect the situation of real estate bubble. It is necessary to select data from the past ten years to ensure accuracy and long-term performance.

It is possible to determine the impermissible value X_i^s and satisfaction value X_i^r of each early warning indicator.

It is convenient to calculate the efficacy coefficient ξ_i of each indicator. The calculation formula is as follows: $\xi_i = [(X_i-X_i^s) (/ X_i^r-X_i^s)] \times 40 + 60$

According to the formula, combined with the observed actual data values of the early warning indicators, it is necessary to make the weighted average of the efficacy coefficients of all indicators, so as to obtain the comprehensive early warning coefficient K of the real estate bubble in the area.

The calculation formula is as follows: $K = \sum \xi_i w_i$. Among them, i is the number of early warning indicators selected, and w_i is the weight of the early warning indicators.

It is possible to judge the degree of real estate bubble by comprehensive warning coefficient K. The weighted average of the efficacy coefficients of each indicator is used to obtain the comprehensive warning coefficient K, and determine whether there is a bubble and the extent of the bubble [4]. This paper draws on the research results of "Research on the Early Warning System and Method of Real Estate Bubble" of Li Weizhe and Qu Bo in 2002, and divides the early warning into 4 levels, with K values corresponding to each stage being <-100 (high danger), -100-0 (danger), 0-60 (alert), > 60 (safety).

IV. CALCULATION AND ANALYSIS OF COMPREHENSIVE COEFFICIENT OF EARLY WARNING OF REAL ESTATE BUBBLE IN XIAMEN CITY

A. Analytic Hierarchy Process (AHP) Empowerment

Analytic Hierarchy Process (AHP), refers to a system of complex multi-objective decision problems, decomposes goals into multiple goals or criteria, and then into multiple levels of multi-indicator (or criteria, constraints). Hierarchical single ordering (weight) and total ordering are calculated by the fuzzy quantification method of qualitative index as a systematic method of objective (multi-indicator) and multi-program optimization decision-making. This paper uses the analytic hierarchy process to incorporate real estate price, real estate investment, and real estate financing into the criterion layer, and includes each type of specific indicators into the indicator layer. Delphi method is used to score the judgement matrix of indicators at various levels by experts. (See "Table I").

TABLE I.   THE WEIGHT OF EACH INDEX ON THE TARGET LAYER AND THE SATISFACTION VALUE AND IMPERMISSIBLE VALUE OF THE INDEX

Serial Number	Criterion layer	Indicator layer	AHP weight	Satisfaction value	Bubble Reference Standard	
					Mild	Severe (impermissible value)
1	Real estate price indicators	Real estate price growth rate / real GDP growth rate X11	0.1492	1	1-2	>2
2		The price-to-income ratio X12	0.1376	3	3-6	>6
3		Housing price index growth rate /CPI growth rate X13	0.1566	2	2-4	>4
4	Real estate investment indicators	Real estate investment / total fixed asset investment X21	0.1315	0.2	0.2-0.25	>0.25
5		Real estate investment growth rate / GDP growth rate X22	0.1167	1.1	1.1-2	>2
6	Real estate financing indicators	Total real estate loans / total financial institution loans X31	0.3084	0.08	0.08-0.2	>0.8

B. Efficiency Coefficient Method (ECM)

The efficacy coefficient method can use the efficacy function to transform various indexes of different dimensions into dimensionless efficacy coefficients, and then integrate the efficacy coefficients through linear or nonlinear methods to finally get a comprehensive value, which can be used for evaluation and judgment [6]. Specifically, the efficacy coefficient method sets a satisfaction value and an impermissible value for each evaluation index, with the satisfaction value as the upper limit and the impermissible value as the lower limit. The degree of satisfaction of each index was calculated to determine the score of each index, and then the weighted average was used for synthesis to evaluate the comprehensive status of the studied object. "Table II" shows the actual observed values of the above six indicators of Xiamen City from 2008 to 2018. According to the calculation formula of efficacy coefficient, the efficiency coefficient of each single index is specifically solved, as shown in "Table III".

TABLE II.   ACTUAL VALUES OF VARIOUS INDICATORS OF XIAMEN CITY FROM 2008 TO 2018

Year	X_{11}	X_{12}	X_{13}	X_{21}	X_{22}	X_{31}
2018	2.55	24.29	1.67	0.34	0.05	0.02
2017	1.81	21.04	7.95	0.37	1.17	0.04
2016	3.26	18.45	6.29	0.35	-0.12	0.05
2015	1.19	14.23	0.64	0.41	1.69	0.06
2014	2.53	12.58	3.91	0.45	3.65	0.01
2013	2.43	9.8	4.96	0.39	0.36	0.08
2012	-0.07	8.71	-0.14	0.39	1.72	0.06
2011	0.64	9.54	1.1	0.39	0.43	0.05
2010	1.68	9.43	1.43	0.39	1.82	0.06
2009	-0.96	7.64	-2	0.33	-1.22	0.09
2008	-0.08	8.68	0.76	0.35	-0.37	0.07

TABLE III.   EFFICACY COEFFICIENTS OF INDICATORS

Year	X11	X12	X13	X21	X22	X31
2018	38.00	-183.87	106.60	-12.00	146.67	120.00
2017	67.60	-140.53	-19.00	-36.00	96.89	113.33
2016	9.60	-106.00	14.20	-20.00	154.22	110.00
2015	92.40	-49.73	127.20	-68.00	73.78	106.67
2014	38.80	-27.73	61.80	-100.00	-13.33	123.33
2013	42.80	9.33	40.80	-52.00	132.89	100.00
2012	142.80	23.87	142.80	-52.00	72.44	106.67
2011	114.40	12.80	118.00	-52.00	129.78	110.00
2010	72.80	14.27	111.40	-52.00	68.00	106.67
2009	178.40	38.13	180.00	-4.00	203.11	96.67
2008	143.20	24.27	124.80	-20.00	165.33	103.33

V.   CONCLUSION

Viewing from the calculated comprehensive early warning coefficient K of the real estate bubble ("Table IV"), the level of early warning of the real estate market in Xiamen City continued to change from 2008 to 2018, and the overall situation was good. It was in a safe state from 2008 to 2012, but it was on alert after 2012. In particular, the bubbles were relatively severe in 2014 and 2017. In 2017, the housing price of real estate in Xiamen City rose from 25,862 yuan / square meter in 2016 to 31,805 yuan / square meter, with a growth rate of 22.98% and a housing price-to-income ratio of 21.04, far exceeding the impermissible value. The ratio of housing price growth rate / CPI growth rate was 7.95, more than twice the impermissible value, which was a year when the real estate bubble was severe. From 2016 to 2018, the state issued a number of policies to regulate, such as the adjustment of the down payment ratio of personal housing loans by the banking industry; in the report of the 19th National Congress, the country will curb the unfavorable rise in housing prices and prevent the risk of real estate bubbles

to a strategic level; the country should actively cultivate and develop the leasing market and so on. In 2017, the real estate and construction industry were included in the scope of the pilot reform of business reform. As the upstream industry's construction industry, the cost of materials, labor, and expenses have all risen, and the increase in tax burden will be passed on to the real estate industry, leading to the rise in housing prices. The real estate market has improved in 2018. The ratio of housing price growth rate / CPI growth rate has dropped to 1.67, which is within a safe range. The investment growth rate / GDP growth rate has dropped from 1.17 in 2017 to 0.05, which is lower than the impermissible value. At the second meeting of the 15th National People's Congress of Xiamen held in 2018, the government work report proposed the government's work goals and priorities in 2018, which described the real estate regulation and control in this way. Xiamen would implement a differentiated regulation and control policy in 2018 to meet the rigid demand of first-set house and support the improvement of demand, which restrained the continued expansion of the real estate bubble to some extent.

TABLE IV.   COMPREHENSIVE WARNING COEFFICIENTS AND WARNING LEVELS OF THE REAL ESTATE BUBBLE IN XIAMEN CITY FROM 2008 TO 2018

Year	K	Level	Year	K	Level	Year	K	Level
2008	92.78	safety	2012	81.46	safety	2016	38.36	Alert
2009	113.04	safety	2013	53.57	Alert	2017	29.30	Alert
2010	64.26	safety	2014	34.98	Alert	2018	49.61	Alert
2011	79.54	safety	2015	59.43	Alert			

On the whole, Xiamen's real estate market is in a relatively unhealthy state. During the eleven years from 2008

to 2018, some periods were in the safe range, while the years on alert were also mild. The probability of normal operation

of real estate is 45%, and the whole is in a stable state. Under the government's macro-control, the situation of the real estate market has gradually improved, but further precautions are still needed.

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