Evaluation of Real Estate Bubble Measurement based on Improved BP Neural Network

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Abstract

In order to solve the present lagging problem of the real estate index and to improve the quantity and quality of indicators involved in the index. To enhance the pre-control ability of real estate index, reduce the false alarm probability of real estate index, and to reduce the deviation of prediction technique errors. In this paper, the evaluation method of real estate bubble measurement based on improved BP neural network is proposed in this paper. The structure of the system was designed which includes appraisal model, trade case, data mining and query analysis module. With the help of the L-M algorithm in MATLAB software, BP neural network was improved and the trade cases were trained, then the BP neural network which has already been trained was tested. The experiment results of this paper have a reference value for the application of BP neural network in the evaluation process of real estate bubble measurement which can also promote the overall performance substantially.

Keywords: Evaluation, real estate, bubble measurement, L-M algorithm, improved BP neural network

1. INTRODUCTION

China’s economy has developed rapidly in recent years, with the urbanization rate increasing at an average annual rate of one percentage point. And the trend of population mobility and uneven economic development occur simultaneously in the process of urbanization. Meanwhile, China’s real estate market has been a great development. Under the progress of urbanization and with the changes in China’s real estate market, real estate prices of each region had a significant difference, which has aroused the concern of the whole society. That is what a question the healthy development of the real estate industry has to face today. Both understanding and solving the problem correctly and exploring the regularity have played an important role to promote the healthy operation of the real estate market, as well as for the healthy development of China’s economy. Real estate prices differentiation is the differences and regularity of real estate market prices in different areas due to the real estate itself and economic changes in the process of urbanization. In recent years, more and more problems about real estate prices become the focus of the society and the government. The healthy development of the real estate industry, not only influences the development of relevant industries and even affects the stable operation of the national economy, the important event is also affecting the lives of people. More and more high prices, has exceeded the ordinary property buyers purchase ability. One side is the people who don’t own house cannot afford housing, the other side is the “imperial estate” and the high vacancy rate of the frequent and the housing bubble is increasingly large. The government issued a series of policies in the control of the real estate market, often in the short-term they can affect but also experienced a rebound later (Wang et al., 2015).

Real estate is a kind of special commodity with the dual attributes of consumption and investment, related many industries and downstream products, and its development is directly related to economic growth and social harmony. The Chinese government began to carry out macro-control of the real estate market since 1994, and the introduction of more intensive control measures are used from 2005 to now. But the price is more stressed the more up. In the case of the control measures are not effectively to stabilize housing prices, in April 2010 the central government issued a real estate purchase policy. However, due to various reasons, the effect is not satisfactory, and the policy quit the purchase restrictions in September 2014 in most cities. Although the
purchase of the policy has been basically quit, but extraordinary measures adopted in this extraordinary period, has become an extremely rare typical case study of government and market relations. The introduction and implementation of this policy, as well as the exit process of political economic analysis, not only can deepen the understanding of the formation and evolution of the policy, deepen the understanding of the relationship between government and market, but also can provide a theoretical basis and reference for the improvement of the government to improve the real estate. Research on the purchase of the policy, scholars focused on the legality of this policy, the effectiveness and the expected time frame for implementation of the three aspects. I have not been able retrieved the introduction of restriction policy about its implementation, quit research process and its benefits behind the relationship. Comprehensive survey of the real estate purchase of the policy and its implementation effect of political and economic factors, the emphasis on the interests of the differences and contradictions of different stakeholders analysis, using game theory to analyse the restriction policy, different strategies to select the main implementation and exit process interest, highlighting the perspective of political economics (Bell, 2014).

2. MATERIALS AND METHODS

In recent years, with the acceleration of the urbanization process, and the improvement of people's living standards, guided by the national policy which encourages individual housing consumption, real-estate sector, mainly residence, has maintained a growth rate much higher than that of GDP, making it one of the most important industries that start domestic demand and promote economic growth. However, whether they continue growth of real estate investment and the expansion of credit loan will induce the real estate bubble or not and whether the hot sale of commercial housing and the jack-up of real estate price mean the appearance of the real estate bubble or not, have become a focus of public concern.

This paper comments on the recent study of the real estate bubble, from research theories, measuring methods to empirical studies, in order to explain how to judge the existence of the real estate bubble, how to measure the extent of the real estate bubble, and how to early warning the real estate bubble, on the pursers of guiding the healthy development of the real estate market in our country better. Efficient market hypothesis (EMH) showed that, stock prices have reflected all related information, and people couldn’t gain earnings by certain established analysis models or operations. According to the scale of stock price information set, market efficiency can be divided into weak type of effective market, half strong type of effective market and strong type of effective market. In light of previous research, Chinese stock market haven’t attained to half strong efficiency. Combining with Chinese stock market’s reality, the research proposed hypothesis 1: Chinese stock market is non-half-strong effective, namely that there is excessive response before M&A event or lag response after M&A event. Network industrial products’ marginal costs reduce along with the productivity increasing. Because the representative sectors in network industry, such as communication, internet, computer hardware and software and so on, have to pay tremendous cost in infrastructure construction. The enterprises’ M&A in network industry could increase its’ scale and reduce unit cost, further realize scale economy. Therefore, the research proposed hypothesis 1: network industrial M&A possesses of scale economy effect.

Event research method which was widespread used in short-run M&A performance areas was utilized in the research. Abnormal Return (AR) was derived from the balance of sample listed companies’ actual return rate and predictive return rate. Then, evaluate M&A events’ effect namely short-run M&A performance by analysing M&A events’ average AR (AAR) and cumulative AR (CAR). One sample T test was utilized to test the significance of AAR and CAR to 0. The data were from China Stock Market & Accounting Research database and China Listed Companies M&A database, which were provided from GTA Research Service Centre. 157 samples were chosen from 2001 to 2015 in information technology sector. The rules to choose samples were as follows (Qin et al., 2015):

(1) The M&A time was from 2001 to 2016 and the samples were not special treated (ST) companies.

(2) If the same companies took place M&A in adjacent 2 years, remove the last sample away.

(3) If several M&A events occurred in one year, choose the sample of biggest total M&A price. And if the information was not announced, choose the sample of biggest transaction scale. If the information referred to above was also not announced, choose the first M&A event as the sample. If parts of M&A events information were announced, choose the samples announced first.
4. If the evaluation window or event window were not enough, remove the sample away.

5. If there was no open quotation on M&A transaction day or market transactions were stopped, choose the next transaction day as 0 T (event day).

Figure 1 shows the UBS real estate bubble index in 2015. By 2010 a new round of housing prices rose rapidly, not only seriously affected the financial entities and economic security, but also caused the majority of low-income earners discontent. In this context, for the central government to ensure national economic security and access to public support considerations, even local government is expected to respond to the policy conditions, the central government chose different strategies to weigh costs and benefits, and carry out the introduction of restriction policy decisions. Although the purchase of the policy will affect the revenue of local governments, but the central government determines the promotion and appointment of local officials, local governments can only choose to support. At the stage of restriction policy implementation, in terms of interest in the study, there are two level games: the central government and local government; local governments and real estate developers and investment buyers. Under serious asymmetry in information, multiple tasks required and the rational allocation of resources practical constraints, taking into account the high dependence on local government finance land, the central government chose not to strictly supervise the implementation of the purchase of local government policy; under the conditions of this selection, local governments maximize the benefits policy response is certainly not strictly enforced. Local governments do not strictly enforce the restriction policy, which means no strict supervision of developers and investment buyers to comply with the purchase, this way, the latter two stakeholders in the interest of maximizing principles, would choose "not strictly observed". Game strategy equilibrium of the two levels formed by the three stakeholders, determines the local government, developers and investment buyers as much as possible to avoid the implementation of or compliance with the purchase policy, through the "conspiracy", illegal ways to reduce its loss of profits. Game Equilibrium of the purchase policy implementation phase determines the purchase of the policy implementation effect (Or, 2015).

3. RESULTS AND DISCUSSION

Here the use of the BP neural network model with multi-input and single-output as a building management evaluation, the topology is shown in Figure 2.
Non-linear relationship between the output and input between each node is described as Sigmoid function, that is (Fan and Wu, 2015):

\[ p(x, y) = \frac{1}{N} \cdot \text{the number of occurrences of } (x, y) \] (1)

Firstly, the characteristic function is introduced. For example, the probability of the word make being translated into meaning of write is small. If the word make is followed with treaty, the probability of the word make being translated into meaning of write is big. In order to express this event, following characteristic function can be used.

\[ f(x, y) = \begin{cases} 1, & \text{if } y = \text{"write"and } \text{"tready" follows} \\ 0, & \text{otherwise} \end{cases} \] (2)

It is a binary function, event is the \( Y \times X \) space is mapped into (0,1) space. For any characteristic function \( f_i \), experience expectation on training sample is

\[ E_{p^{f_i}} = \sum_{x,y} \bar{p}(x, y) f_i(x, y) \] (3)

The expectation of characteristic function \( f_i \) is

\[ E_{p^{f_i}} = \sum_{x,y} \bar{p}(x) p(y / x) f_i(x, y) \] (4)

\( \bar{p}(x) \) represents experience marginal distribution of \( x \) in the training sample. The expectation value calculated by model should be consistent with experience expectation value.

\[ C = \{ p / E_{p^{f_i}} = E_{\bar{p}^{f_i}}, i \in \{1,2,...,K\} \} \] (5)

\( C \) represents a series of probability distribution. The core idea of maximum entropy is to choose the model with largest entropy in these models. In all probability distribution, \( p^* \) is selected, which meets the following equation.

\[ H(p) = -\sum_{x,y} \bar{p}(x) p(y / x) \log p(y / x) \] (6)

\[ p^* = \arg \max_{p \in C} H(p) \] (7)

\( p^*(y / x) \) represents condition entropy used to represent evenness of condition probability \( p(y/x) \). This is an optimization problem, the introduction of Lagrange operator makes us get the form of solution.

\[ p^*(y / x) = \frac{1}{Z(x)} \exp \left( \sum_{i=1}^{K} \lambda_i f_i(x, y) \right) \] (8)

\[ Z(x) = \sum_{y} \exp \left( \sum_{i=1}^{K} \lambda_i f_i(x, y) \right) \] (9)
This task is converted to solve optimal solution of $\lambda_i, i=1, 2, ..., K$. It can be solved by generalized iterative scaling algorithm. For any $(x, y) \in X \times Y$, the sum of characteristic function is

$$\sum_{i=1}^{K} f_i(x, y) = C, \quad \lambda_i^{(0)} = 1$$ (10)

$$\lambda_i^{(n+1)} = \lambda_i^{(n)} \left[ \frac{E_{\mu^i} f_i}{E_{\mu^{(n)} f_i}} \right]$$ (11)

$$E_{\mu^{(n)}} f_i = \sum_{x, y} \overline{p}(x) p^{(n)}(x / y) f_i(x, y)$$ (12)

$$p^{(n)}(x / y) = \frac{1}{Z(x)} \exp \left( \sum_{i=1}^{K} \lambda_i^{(n)} f_i(x, y) \right)$$ (13)

Log-likelihood value of $\tilde{P}$ is

$$L(p) = \sum_{x, y} \overline{p}(x, y) \log p(y / x)$$ (14)

$$L(p^{(n+1)}) \geq L(p^{(n)})$$

$$\lim_{n \to \infty} p^{(n)} = p^*$$ (15)

To obtain the inverse local fractional Hilbert transform, write again Eq. (16) as

$$\hat{f}_H^\alpha(x) = \frac{1}{\Gamma(1+\alpha)} \int_{-\infty}^{\infty} \frac{f(t)}{(t-x)^\alpha} (dt)^\alpha$$

$$= \frac{1}{\Gamma(1+\alpha)} \int_{-\infty}^{\infty} f(t) g(x-t) (dt)^\alpha$$

$$= f(x) * g(x),$$ (16)

Variable $x^{(0)}$ has the original data series $x^{(0)}=[x^{(0)}(1), x^{(0)}(2), ..., x^{(0)}(n)]$, with a 1-AGO order to generate an accumulated generating sequence $x^{(1)}=[x^{(1)}(1), x^{(1)}(2), ..., x^{(1)}(n)]$ Among them:

$$X^{(1)}(k) = \sum_{i=1}^{K} x^{(0)}(i)$$ (17)

Since the sequence $x^{(1)}(k)$ has an exponential growth law, and the solution is just a first-order differential equations exponential growth in the form of solution. So it can be considered the sequence $X^{(1)}$ satisfies the following first-order linear differential equation model.

The original basic quality attributes may be because of changes in time and no difference in the environment and become quality. From the customer psychology research conclusion and verification of view findings that the quality of charm, quality and basic quality expectations have changes over time in order to sink
characteristics. It means that charm quality attributes over time will gradually become the desired quality, and finally becoming a basic quality.

\[ \frac{dx^{(1)}}{dt} + \alpha x^{(1)} = \mu \]  

(18)

In the formula, \( \alpha \) and \( \mu \) are parameters, \( \mu \) is the control. Solution of the differential equation as follows:

\[ x^{(0)}(k+1) = \left[ x^{(0)}(1) - \frac{\mu}{\alpha} \right] e^{-\frac{k}{\alpha}} + \frac{\mu}{\alpha} \]  

(19)

Among them, \( \alpha \) and \( \mu \) are the approximate solution of formula (2), according to the least squares method to obtain:

\[ \begin{bmatrix} \hat{\alpha} \\ \hat{\mu} \end{bmatrix} = (B^T B)^{-1} B^T Y \]  

(20)

\[ Y_n = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n-1) \end{bmatrix} \]  

(21)

Formula (5) called GM (1,1) model of response time function model, it is a specific formula for calculating GM (1,1) model of gray prediction, this type do regressive reduction, gray had predicted the number of columns in the original model:

\[ \bar{x}^{(0)}(k+1) = \bar{x}^{(1)}(k+1) - \bar{x}^{(1)}(k) \]  

(22)

4. CONCLUSION

The real estate bubble is an asset bubble. It is a shallow false prosperity created by a continual growth of the real estate price deviating from the basic market value due to speculation. Its performance can be described like that: the land price skyrocket in the economic prosperity, whereas when the price shoots to the peak, the demand toboggans, the price crashes, and consequently the bubble bursts. Western scholars have made a systematically research of asset bubble, and the domestic scholars introduced the theories of asset bubble in an early time. Though the research on the real estate bubble is based on that of asset bubble, up to now, the research on the real estate bubble is not mature enough at home and abroad. Generally speaking, the main research areas consist: the reason of the real estate bubble, the measuring and demonstration of the real estate bubble, and the early-warning of the real estate bubble. The reasons why the real estate bubble is formed can be summarized as: agent problem, excessive financial support, expectation and speculation, government regulation and control errors, etc.

This point of view thinks that it is the information asymmetry between financial institutions and borrowers that causes the financial asset bubble based on the information asymmetry theory (Uzun et al., 2015). Allen built an asset bubble model to simulate the interaction between financial institutions and real sectors, and he found that the agent problems of financial agencies lead to the formation of the asset bubble in the end (Amonhaemanon, 2014).

Scholars supporting this kind of view think that it is the financial risk accumulation of financial deregulation, relaxation of monetary regulation, diversity and complexity of credit instruments innovation, and credit of financial institutions against regulation (Zang, 2014), which speed up the fluctuations of the real estate cycle, and prompt the formation and the breakdown of the real estate bubble, through researching the formation
principle of Japanese economic bubble, and global real estate cycle. Furthermore, the over expansion of bank credit in the real estate market is not only the main formation reason of the real estate bubble, but also has the same function in causing the bubble breakdown and the economic crisis (Janet, 2015).

This kind of view thinks that apart from market, some external elements like speculation caused by group mind, fashion and mania, are also vital elements to determine prices (Costin, 2015). Many scholars studied the origins of the financial crisis in Asia and Thailand, and they think that it was the economic overheating of Thailand and the large influx of international capital before the outbreak of the financial crisis created the false impression of good market expectations, made the Thai real estate developers over-optimistic, formed the Herding Behavior, and at last resulted in the appearance, inflation and breakdown of the real estate bubble (Devi, 2015). Some domestic scholars put up a testing model of the real estate speculation; they thought that the future uncertainty of the expectation of credit expansion and the extent of credit expansion would increase the severity of the bubble (Venkata, 2015), and the transaction behaviors between buyers and sellers in real estate market were also one of the key elements that caused the formation of the speculative price in the real estate market.

Government regulation and control errors can also be an ecboic element of the real estate bubble. Government external or internal guarantee will lead investors to spread risks and overestimate the asset prices, which accelerates the emergence of the real estate bubble. One of the main sources of economic fluctuations in China's real estate is external shocks from policy cycle. The alternation of China's economic expansion and tightening is in accordance with the fluctuations of China's real estate economy cycle. The failure of government's intervention, power rent seeking, and the unhealthy of regulations are all the elements that promote the formation of the real estate bubble (Ko, 2014). The measuring methods of the real estate bubble mainly consists model method, index method and statistical method. On the other hand, many scholars try to empirical analyze the existence of bubble through mathematical analysis.

As there are much qualitative factors in evaluation, so use expert judgment method. Highest score is 10 points; the lowest score is 1 point. Then use the expert scoring method for evaluation of real estate bubble to make a comprehensive evaluation to obtain their evaluation scores. Using the above method, the organization 18 experts in Wuhan real estate assessed the credibility of the authority to obtain a higher evaluation results (see Table 1).

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The steps of real estate bubble evaluation model algorithm based on BP artificial neural network are as follows

1. Determine the structural parameters of BP network, namely nodes number of each layer of neurons.
2. Use MATLAB to establish an artificial neural network, and select training function;
(3) Input data, start learning and training network. By constantly perform iterative process, up to meet the learning accuracy.

![Figure 3](image1.png)

**Figure 3.** The Expectations of 10 Records and 18 Records

![Figure 4](image2.png)

**Figure 4.** The Variance of 10 Records and 18 Records

As can be seen from Figures 3 and 4, with the increase of the number of iterations, the expectation and variance are gradually converge (The Iterating times is 20). And the final expectation converges to 5, the variance converges to 4. On the other hand, the performance of inputting 18 records is better than the performance of inputting 10 records, which converges faster.

In order to make up the drawbacks, such as strong subjectivity and big error, some scholars built early-warning indicator system of real estate through empirical research, by adopting quantitative analysis. It put forward an idea to build early-warning indicator system by using grey relational analysis and system core theory. The first step of this method is to make a serious processing of the sample data to get the correlation between indicators, using grey relational analysis, based on the original table of indicator system. The second step of this method is to figure out the relationship between indicators according to their correlation, and build the topology of indicator system. The last step of this method is to calculate the core of the topology. The components of the core are just the early-warning indicators and indicator system of real estate.

Whether the bubble of Chinese real estate exists or not, how to measure and make a forecast-alarm of it have always been the research hotspot. This article makes a summary of real-estate bubble problem from the above-mentioned three aspects. Among them, agency problem, excessive financial support, anticipation and speculation, government regulation and control error are main reasons for the appearance of the real estate bubble. Model method, index method and statistical method are the mainly methods to measure real estate bubble; meanwhile, in the respect of real estate early-warning system, scholars have made a serious research finding, including early-warning model, indicator system, and early-warning system, through combining qualitative analysis and quantitative analysis, drawing lesions from other disciplines, and combining early-warning theory and compute techniques.
In the future study, it can explore further the relationship between the real estate bubble and financial support. To build equilibrium model between the extent of financial support and the real estate bubble through quantitative inspection, so as to figure out the critical value of excessive financial support. In another word, it is to establish a dynamic optimization model of financial support to find out the optimal path of financial support. It can also explore more suitable early-warming methods and model, and to find out how to apply theories like artificial neural network and fuzzy control into the early-warming area of real estate, so as to create new early-warming methods and model.

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