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**Information Systems-based Real Estate Macro-control Systems****Yan Li**

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With the continuous increase of marketization and normalization in the Chinese real estate market, the market mechanism now plays an important role in market regulation. The existing macro-control system for the real estate market, however, appears to lack the ability to regulate it. Thus, an effective and efficient information-oriented tool is needed to guide the development of China's real estate market. The research reported herein constructs a new macro-control system for this market that is based on information systems, specifically, a real estate warning system, a confidence

index system, and a simulation system. This paper first presents the framework of the new information systems-based macro-control system, and its functions are analyzed. The methods of constructing the system are then discussed. Based on these methods, the index systems of the respective information systems are established, and the main models are presented. Finally, a case study that is based on survey data from the Shenzhen real estate market is described to demonstrate the applicability of the new macro-control system.

## Keywords

Real estate; Macro-control system; Warning system; Confidence index; System simulation

## 1. Introduction

The real estate industry is the pillar of the national economy in China, and its healthy development plays an important role in economic growth, the adjustment of the industrial structure, and the improvement of people's standard of living. Governments and leaders at all levels always attach great importance to the development of the real estate industry. Many measures have been taken, on the one hand, to enliven the real estate market (REM), and, on the other, to avoid its overheating. With the continuous increase of the marketization and normalization of China's REM, the market mechanism now plays an important role in market regulation. The existing REM macro-control system, however, appears to lack the ability to regulate the market. Hence, an effective and efficient information-oriented tool is needed to guide the healthy development of the REM. In addition, with the implementation of the *Administrative Licensing Law of the People's Republic of China*, it is difficult for the government to regulate and control the real estate industry through administrative licensing. As a result, the administrative macro control of the real estate market must be based on information-oriented regulation and tracked management. Therefore, it appears to be very important to reconstruct a real estate macro-control system that is based on information systems.

However, research in this area is limited in China, although that conducted overseas is more mature. Many developed countries have established real estate warning systems (REWS) that now run well. At the same time, the real estate confidence index (RECI) has been an important indicator of the development status of REM and its trends in Western and other developed countries, thus serving as a weathervane. The RECI operates similarly to the NASDAQ index, which reflects the condition of the stock market or the overall economy in the U.S. These tools are used to better guide the development of REM.

A real estate macro-control system that involves both an REWS and RECI and is based on information-oriented and warning systems is constructed here by considering the status of China's REM. The remainder of this paper is organized as follows. The framework of the system is first established, and its functions are analyzed in Section 2. The methods of constructing the information systems involved are then discussed in Section 3. Section 4 constructs the related index systems and the models for the information systems. Finally, Section 5 presents a case study using survey data from the Shenzhen REM to demonstrate an application of the new macro-control system, and conclusions are drawn in Section 6.

## **2. Reconstruction of the Macro-control System and its Functions**

### **2.1 Architecture of the Information Systems-based Macro-control System**

A perfect macro-control system can be described as a system that is used by governments to intervene in and control the overall economic supply and demand of an entire society via economic, legal, administrative, and information-oriented measures. It is an organic and interactive system that consists of control organs, control objects, control measures, and control policies (Xu and Zheng, 2000; Qi, 2002; Li and Ma, 2002). A real estate macro-control system that is based on information systems is a type of macro-control system in which warning systems, confidence indexes, and simulation systems are regarded as the leading control measures, and, at the same time, economic, legal, and administrative measures are synthetically applied to the macro control of the REM, as shown in Table 1.

From Table 1, it can be seen that the information-oriented measures are the leading means of control for guiding the development of the REM in the macro-control system constructed in this research. Therefore, we place emphasis on these information-oriented measures, that is, the warning system, the confidence index system, system simulation, and policy experiments.

### **2.2 Functions of the Information Systems-based Macro-control System**

An REM macro-control system based on information-oriented and warning systems may reflect the developmental status and future trends of REM from different points of view and provide effective information for different types of users.

First, by analyzing the leading monomial indicators and the composite indicator, the REWS ascertains the current status of the REM, namely by determining whether it is overheating, overcooling, or normalizing, thereby providing effective information to help governments establish policies or investors make decisions.

**Table 1 The Architecture of a Real Estate Macro-Control System Based on Information Systems**

The macro-control system of real estate		
Control measures	Control means	Functions
Information-oriented measures	Warning system Confidence index system System simulation and policy experiments	Leading role
Economic measures	Fiscal means Monetary means Investment means Price means	Basic role
Legal measures	Specialty regulation Pertinence regulation	
Administrative measures	Planned means Planning means Administrative means	Assistant role

Second, the RECI synthesizes efficient supply and demand (S&D), latent demand, and latent supply and constructs a complete index system that reflects the confidence and expectations of the public and experts about the REM for the near future. Such a system not only effectively provides investors and consumers with important decision-making information to use in the investment and consumption of real estate, but it also supplies reference information to governments to help them formulate macro-control policies.

Third, real estate System Simulation and Policy Experiments (SS&PE) dynamically simulate the operation of the REM. On the one hand, they simulate the ongoing trends of the REM under the conditions of a certain policy, forecast the future situation for the REM, and supply dynamic data to warning systems, and, on the other hand, they serve as simulation experiments for different policies. These systems not only allow dynamic warning systems to be issued, but are also a good means of measuring the rationality of policies or of selecting appropriate policies.

Therefore, a real estate macro-control system efficiently performs the functions of information leading and warning and reflects the development status and trends of REM. This offers effective and timely information to governments to help them establish policies, to investors to help them make investment decisions, and to consumers to help them make purchasing decisions, and also ensures the healthy development of the REM.

### **3. Methods of Constructing Information Systems**

#### **3.1 Method of Constructing the REWS**

Based on research into the characteristics of China's real estate industry and the methods of establishing economic warning systems, the Yellow warning method was selected for the REWS in this research. The selection of warning factors is the basis of constructing a warning system. The indicators of the warning signs that reflect the warning factors are then selected by adopting a time-difference correlation analysis method. An index system for the warning signs is then established, and the limit of each indicator of the warning signs is determined. Finally, based on the data of our investigation of China's REM, all of the indicators of the warning signs are calculated, and the composite warning indicator is formed.

### 3.2 Method of Constructing the RECI

An index system that effectively reflects S&D, latent demand, and latent supply is first established by employing the questionnaire and factor analysis methods. Then, index simulation methods, such as the TRECI & BRE index methods, are applied to construct the model of each indicator. Finally, the composite index is synthesized, and predictive analysis is carried out using the weighted average method.

### 3.3 Method of Constructing the SS&PE

The SS&PE are founded on System Dynamics (SD). The SD simulation model of a real estate system is established on the basis of analyzing the structure and sub-modules of that system and the relationships among the main variables. The relevant data are then adopted to perform a simulation analysis and evaluate the aforementioned models. Based on the SD system simulation model, the experiments on the relevant policies can be carried out by setting the parameters of those policies.

## 4. Index Systems and Main Models of the Information Systems Concerned

### 4.1 Index System of the REWS

The real estate price is selected as a warning factor, according to the methods of constructing the warning system. Then, the index system of warning signs is established, as shown in Figure 1, by adopting the time-difference correlation analysis method. Warning analysis can then be performed on the nine monomial indicators shown in the figure. The warning values of all of these indicators are then synthesized to form the warning value of the composite indicator by using the weighted average method. The model is as follows.

$$P = \sum_{i=1}^9 w_i P_i \quad i = 1, 2, \dots, 9, \quad (1)$$

where  $P$  is the composite warning value;  $P_i$  is the warning value of each monomial indicator; and  $w_i$  is the weighting coefficient concerned.

Note that the warning value is derived from the actual value of each monomial indicator through the normalizing process, interpolation and extrapolation, and the adjustment of accumulation. The warning situation may be determined by a comparison between the warning value and the warning limit.

#### 4.2 Index System of the RECI

The index system of the RECI, which is shown in Figure 2, is also established via the aforementioned methods. The system is divided into four levels. The first level is the composite index level. The second is the monomial index level, which involves an efficient S&D index, latent demand index, and latent supply index. The third is the sub-index level, and the fourth is the basic index level. All of the superior indexes are derived from the weighted averages of the inferior indexes concerned. The relevant models are not discussed here in detail.

The following are the main models of the indexes.

(1) The model of the housing price index. Because the housing price is influenced by a great number of non-market factors, for example, the view, the location, the number of stories, etc., the market price should be adjusted before constructing the price index to make it comparable. Both the weighted average method and the ratio method are then employed to establish the models of the price indexes for the secondary and third-class residential housing markets. The detailed modeling process is as follows.

1) Based on the Hedonic model (Clapp, 1990; Peng and Wheaton, 1992; Rowan and Workman, 1992; Ye and Feng, 2002; Li and Sun, 2003; Haurin and Hendershott, 1991), the prices for the secondary and third-class residential housing markets are adjusted according to the flat model and characteristics, as follows.

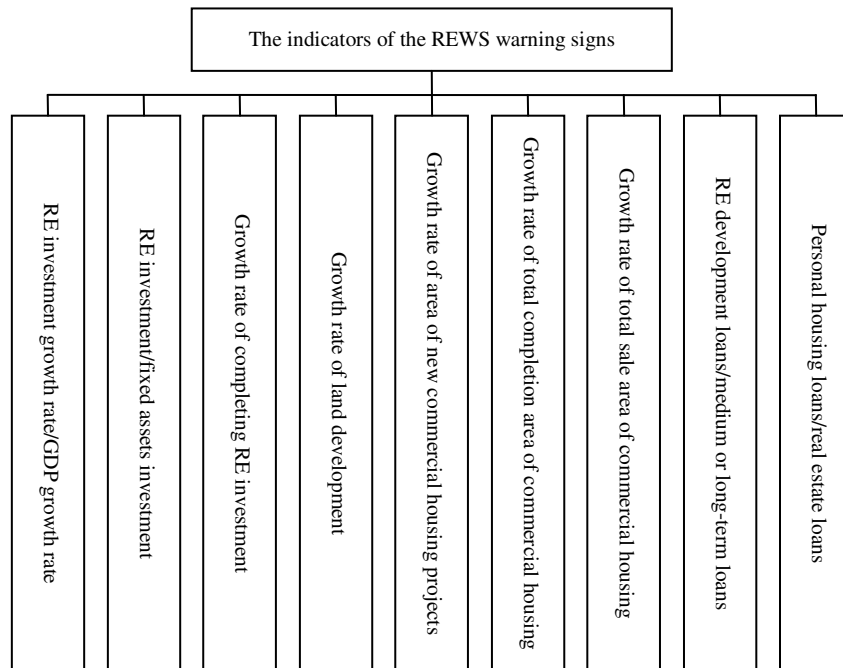
$$P = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_m X_m + \gamma_1 D_1 + \gamma_2 D_2 + \dots + \gamma_n D_n + u, \quad (2)$$

where  $P$  is the post-adjusted price;  $\alpha$  is the asking price;  $X_1, X_2, \dots, X_m$  are the attributes of a sample point, such as stories, area, decoration, etc.;  $\beta_1, \beta_2, \dots, \beta_m$  are, respectively, the correction coefficients of each of the attributes;  $D_1, D_2, \dots, D_n$  are dummy variables;  $\gamma_1, \gamma_2, \dots, \gamma_n$  are, respectively, the coefficients of each of the dummy variables; and  $u$  is a chance error variable.

2) We construct the housing price index model of a district as

$$I = \frac{P^t}{P^0} \times 1000, \quad (3)$$

where  $I$  is the housing price index of the district;  $P^0$  is the average housing price of the district on a comparison date; and  $P^t$  is the average housing price of the district on the report date.

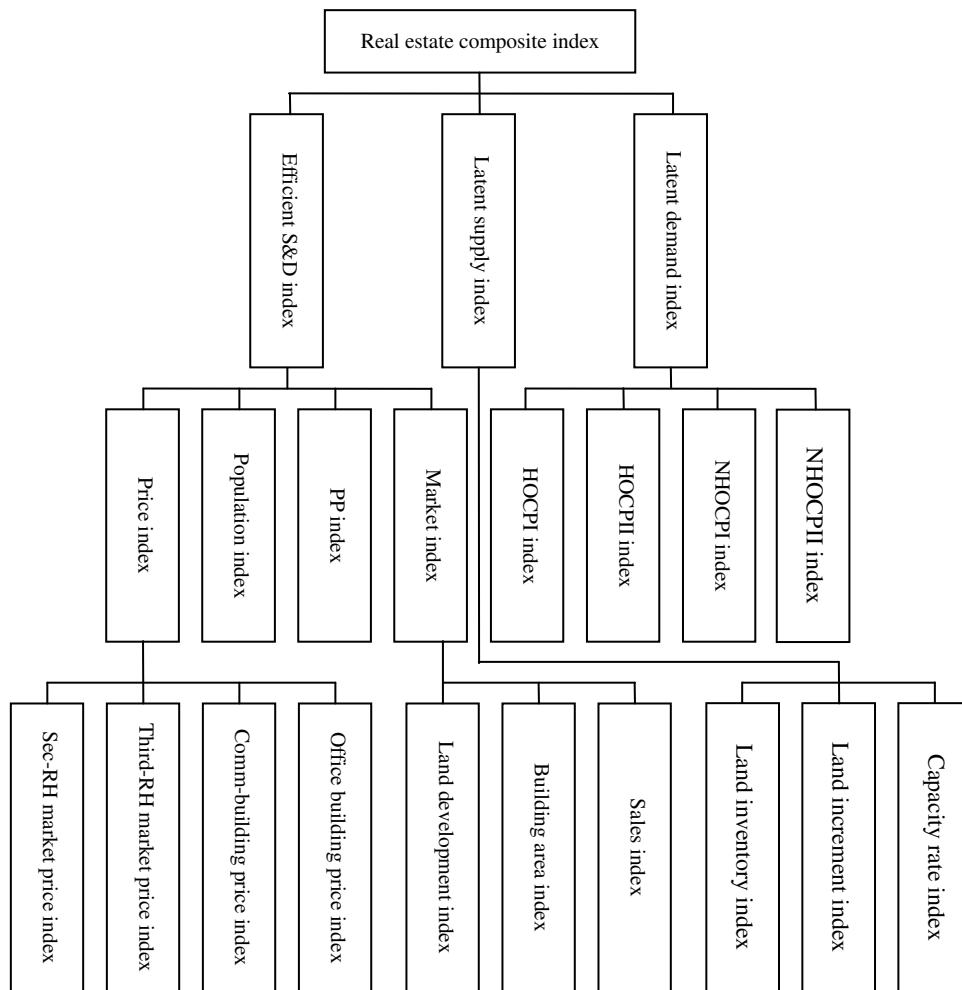
**Figure 1** The warning sign index system of the real estate warning system

(2) The models of the price indexes of commercial and office buildings. The main difference between the price index model of commercial buildings and that of office buildings lies in the calculation of the average price. After determining the average price of each, the same method may be used to construct the index models concerned.

(3) The models of the sub-indexes of latent demand. The questionnaire method and the comprehensive graded approach are adopted to construct these indexes, and the model is constructed as follows.

$$I = \frac{1}{k_1} \sum_{i=1}^{k_1} \sum_{j=1}^{k_2} T_{ij} \times 1000, \quad (4)$$

where  $I$  is all of the latent demand sub-indexes;  $T_{ij}$  is the value of question  $j$  gained from responder  $i$ ;  $T$  is the total optimal value of the questionnaire;  $k_1$  is the number of responders; and  $k_2$  is the number of questions in the questionnaire.

**Figure 2 The index system of the real estate confidence index system**

PP is purchasing power, HOCPI is a homeowner considering a purchase, HOCPII is a homeowner and a conditional purchaser; NHOCPI is a non-homeowner considering a purchase, NHOCPII is a non-homeowner and a conditional purchaser, Sec-RH market is the secondary residential housing market, Third-RH market is the third-class residential housing market, and Comm-building is a commercial building.

(4) Other basic models or sub-index models. Other models, including those for the land development index, the building area index, the sales index, the population index, the PP index, the land inventory index, the land increment index, and the capacity rate index can be calculated using the ratio method. Note that when



analyzing the capacity rate index, its model does not directly apply the capacity rate, but rather adopts the average capacity rate. When the PP index is determined, Purchasing-Power Parity (PPP) (Castle, 1999; IWEPCASS, 1989; Wang, 1994) is adopted as the original value.

Finally, the model of the index forecast is established by employing Moving Average (MA), Moving Average Convergence and Divergence (MACD), and BIAS (Hellstrom and Holmstrom, 1998; Venkataramani, 2003).

### 4.3 SS&PE of Real Estate

According to the system decomposition principle, an urban commercial housing system may be divided into four sub-systems: land for housing, housing demand, housing supply, and housing price. The model of land for housing involves the following variables: land supply (GYLAND), the amount of land that annually enters the market (RSLAND), the delay in the amount of land entering the market (RSNOKF), and the parameter of land policy. For the housing demand model, such variables as theoretical demand (XUQIU), the ratio of rents to sales (ZUSOUB), the purchasing power of residents (GML), and the amount of exports (WAIXIO) and such parameters as population policy, customs policy, and mortgage loan policy are needed. The housing supply model is related to the housing inventory (EMP), the building area approved for pre-sale (PZYUSO), and the building area not sold (JUNNYU) and to the parameters of a policy approving pre-sales, the average capacity rate of housing, the ratio of domestic loans, and the deposit and advance receipts policy. In the housing price system model, there are two variables, cost (COST) and the ratio of input to output, and three policy parameters, namely, the interest rate of development loans, the land price, and the tax rate. For each of the sub-models, the DYNAMO equation concerned needs to be established. The following is an example of a DYNAMO equation for land available for housing.

The DYNAMO equation for land supply:

$$A \quad \text{GYLAND.K} = \text{PDPLAN.K} + \text{RESERV.K}, \quad (5)$$

where PDPLAN is the land remised, and RESERV is the land inventory.

The DYNAMO equation for the amount of land annually entering the market is a multiple linear regression equation (after 2002), as follows.

$$\text{RSLAN1.K} = -.28 + 0.12 * \text{GYLAND.K} + 0.9 * ((\text{DEMAND.K} / \text{CRPOLI.K}) + \text{CJIJ}) - 0.25 * \text{RSNOKF.K}, \quad (6)$$

where GYLAND is the land supply; DEMAND is the housing demand; and RSNOKF is the delay in the amount of land entering the market.

The DYNAMO equation of the delay in the amount of land entering the market is

$$L \quad \text{RSNOKF.K} = \text{RSNOKF.J} + \text{DT} * \text{DRNOKF.JK}, \quad (7)$$

where DRNOKF is the rate of delay.

From the above analysis, we can see that the final result of the simulation represents the 12 indicators that are shown in Figure 3.

For the policy experiments, there are five types of policy parameters: land policy, population policy, financial policy, policy approving pre-sales, and other policies, which involve about 13 parameters to be tested. Note that during the system simulation, the parameters of the policies have been given, whereas in the policy experiments, the parameters in concern need to be adjusted.

## 5. Case Study

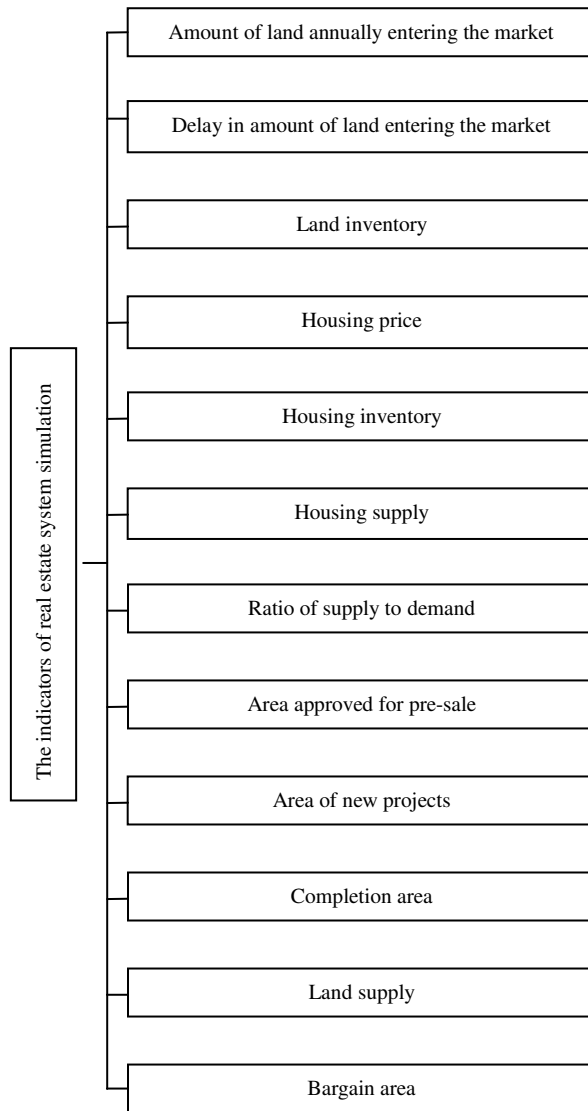
Research was carried out to test the new control system constructed here using data from an investigation of the Shenzhen real estate market and to ensure its practicability and effectiveness.

### (1) Analysis of the REWS

We first conduct a warning analysis of a single indicator, the indicator of *area of new commercial housing projects*, as shown in Table 2 and in Figures 4 and 5.

The warning of the composite indicator is then analyzed. Considering the significance of the indicator of the growth rate of real estate, *investment/GDP growth rate*, its weighting coefficient was determined as 0.3 by experts. The other indicators remain the same. Thus, the composite warning value is derived from the weighted average of the value of all of the monomial indicators. Table 3 shows the warning values of the individual indicators and the composite indicator.

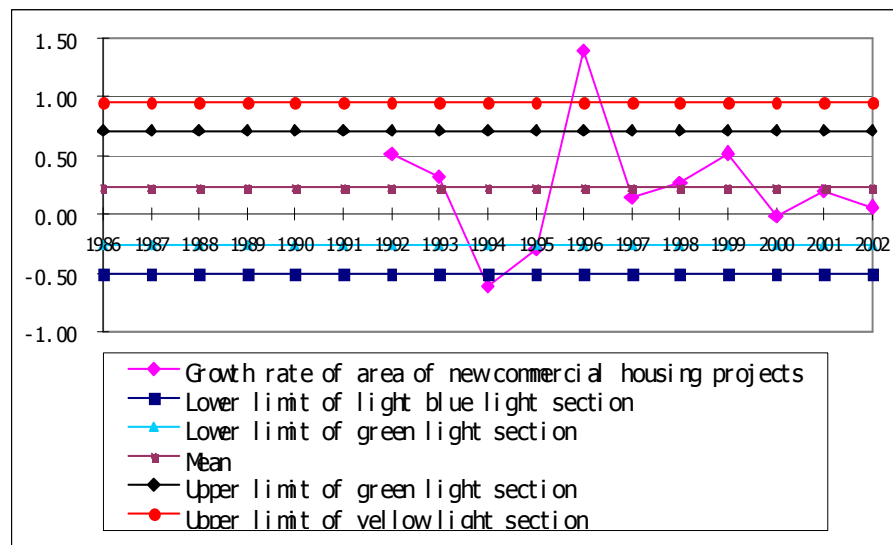
**Figure 3** The Index System of System Simulation for Real Estate



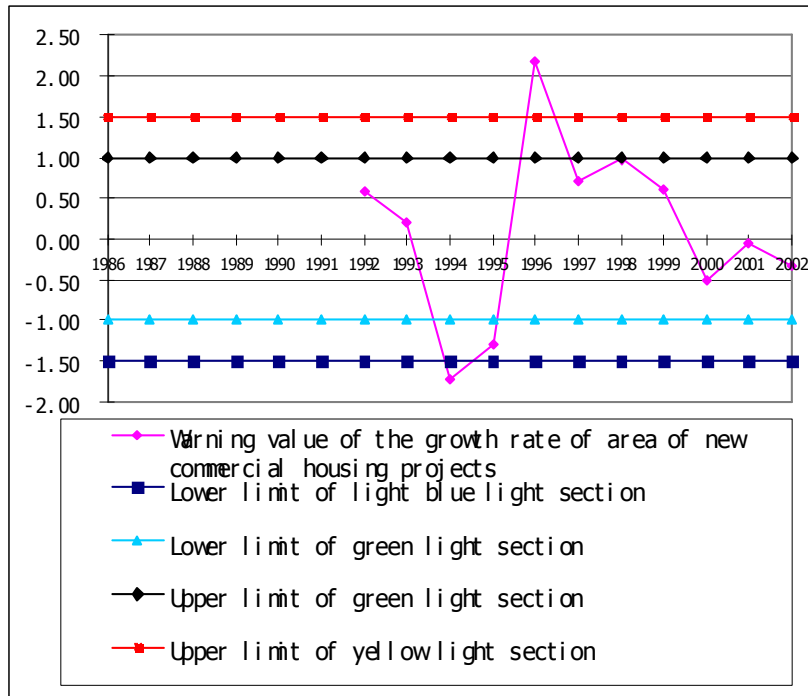
**Table 2** Warning Analysis of the Indicator of Area of New Commercial Housing Projects

Year	Area of new commercial housing projects (10 <sup>4</sup> m <sup>2</sup> )	Growth rate	Normalizing	Adjustment of accumulation
1991	251.31			
1992	380.67	0.51	0.59	0.59
1993	504.49	0.33	0.20	0.20
1994	200.06	-0.60	-1.72	-1.72
1995	141.30	-0.29	-1.08	-1.30
1996	337.43	1.39	2.39	2.17
1997	386.35	0.14	-0.17	0.72
1998	490.17	0.27	0.08	0.97
1999	745.15	0.52	0.60	0.60
2000	737.56	-0.01	-0.49	-0.49
2001	884.86	0.20	-0.06	-0.06
2002	944.54	0.07	-0.33	-0.33

**Figure 4** Chart of the Growth Rate of Area of New Commercial Housing Projects



**Figure 5** Chart of the Warning Value of the Growth Rate of Area of New Commercial Housing Projects

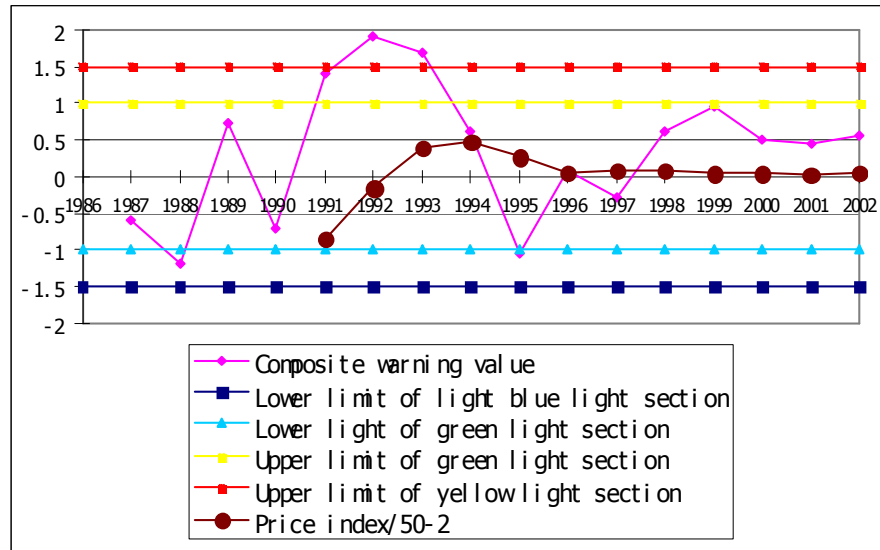


Finally, the composite warning value is compared with the “real estate price index/50-2” (see Figure 6) to analyze the relationship between the warning value and the price index. From Figure 6, it can be seen that the composite warning value leads the real estate price index by one year, and their changing trends are the same. Also, in the time-difference correlation analysis, their correlation coefficient is largest under the condition of leading by one year. Therefore, the composite warning indicator may warn and forecast the situation of the real estate market.

Table 3 The Warning Value of Each of the Monomial Indicators and the Composite Indicator

Year	Growth rate of real estate investment /GDP growth	Real estate investment fixed assets investment	Growth rate of completion of real estate investment	Growth rate of land development	Growth rate of new commercial housing projects	Growth rate of total completion of commercial housing	Growth rate of commercial housing total sale area	Growth rate of commercial housing long-term loans	Real estate development loans /medium or long-term loans	Personal housing loans /real estate development loans	Composite warning value
1987	-1.80	-0.56	-0.80	-0.35		-1.50	2.52				-0.60
1988	-2.35	-1.90	-1.13	-0.07		-1.38	-1.02				-1.19
1989	2.49	-1.57	0.85	-0.25		2.25	-1.57				0.72
1990	-0.50	-2.00	-0.82	-0.72		-1.50	-1.54				-0.73
1991	4.40	-0.61	1.82	1.25		-0.04	1.22		-0.92	-1.68	1.41
1992	5.39	0.94	3.10	0.16	0.59	0.68	0.71		-0.83	-1.87	1.92
1993	5.23	1.21	1.78	-0.66	0.20	1.06	0.00		-0.81	-1.43	1.69
1994	1.78	1.53	1.13	-0.05	-1.72	-0.12	0.82		-0.76	0.24	0.63
1995	-2.20	-0.05	-1.06	-0.55	-1.30	-0.52	-0.36		-0.59	-0.16	-1.06
1996	-0.25	0.01	-0.26	-0.65	2.17	0.48	-0.03		-0.62	0.79	0.09
1997	-1.95	-0.29	-0.48	3.36	0.72	-1.17	0.26		1.32	-0.41	-0.30
1998	1.13	-0.29	-0.23	0.96	0.98	0.81	-0.56		1.69	-0.10	0.62
1999	1.52	-0.04	-0.11	1.81	0.60	0.58	0.29		2.08	0.38	0.94
2000	1.37	0.46	-0.16	-0.46	-0.49	0.01	-0.28		0.89	1.17	0.51
2001	1.06	0.81	-0.29	0.28	-0.06	0.16	-0.63		0.03	1.19	0.45
2002	1.35	1.40	-0.14	-0.36	-0.33	0.19	0.18		-0.32	1.13	0.56

**Figure 6 Chart of the Composite Warning Value of the Shenzhen Real Estate Market**



## (2) Analysis of the RECI

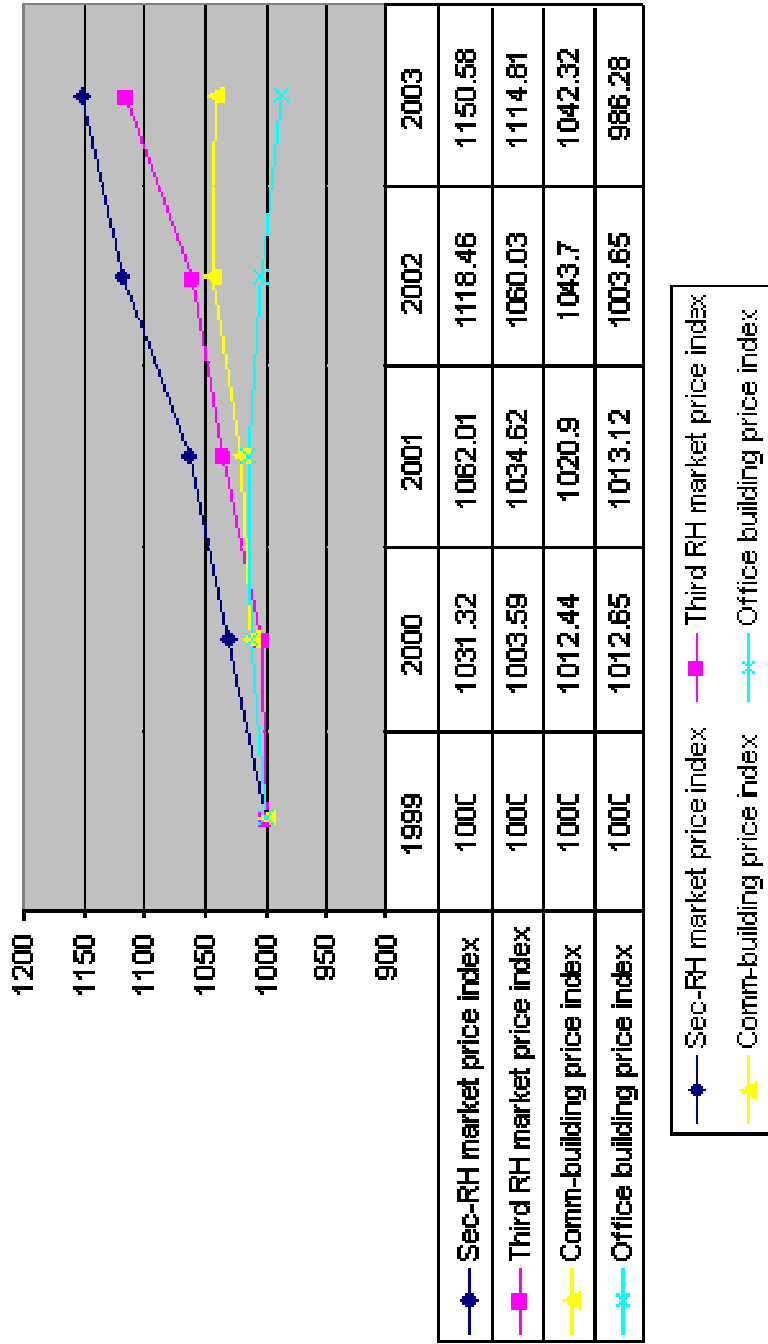
Like the REWS, the basic indexes, sub-indexes, and monomial indexes are first constructed. The price index is taken as an example to analyze its application, as shown in Figure 7.

Figure 7 shows that the housing prices of the Sec-RH market and the Third RH market have continuously increased, particularly between 2001 and 2002. The prices of commercial and office buildings have increased comparatively less. The price index of office buildings even shows a fall.

The composite confidence index is then constructed, as shown in Figure 8, which shows that Shenzhen's REM is in a healthy state and has been on an ascendant trend in recent years. Although the outbreak of SARS in 2001 and the macro-control policies of 2003 have had an impact, Shenzhen's REM has generally kept on a steady course.

Note that this paper does not provide detailed predictive analysis of the confidence indexes.

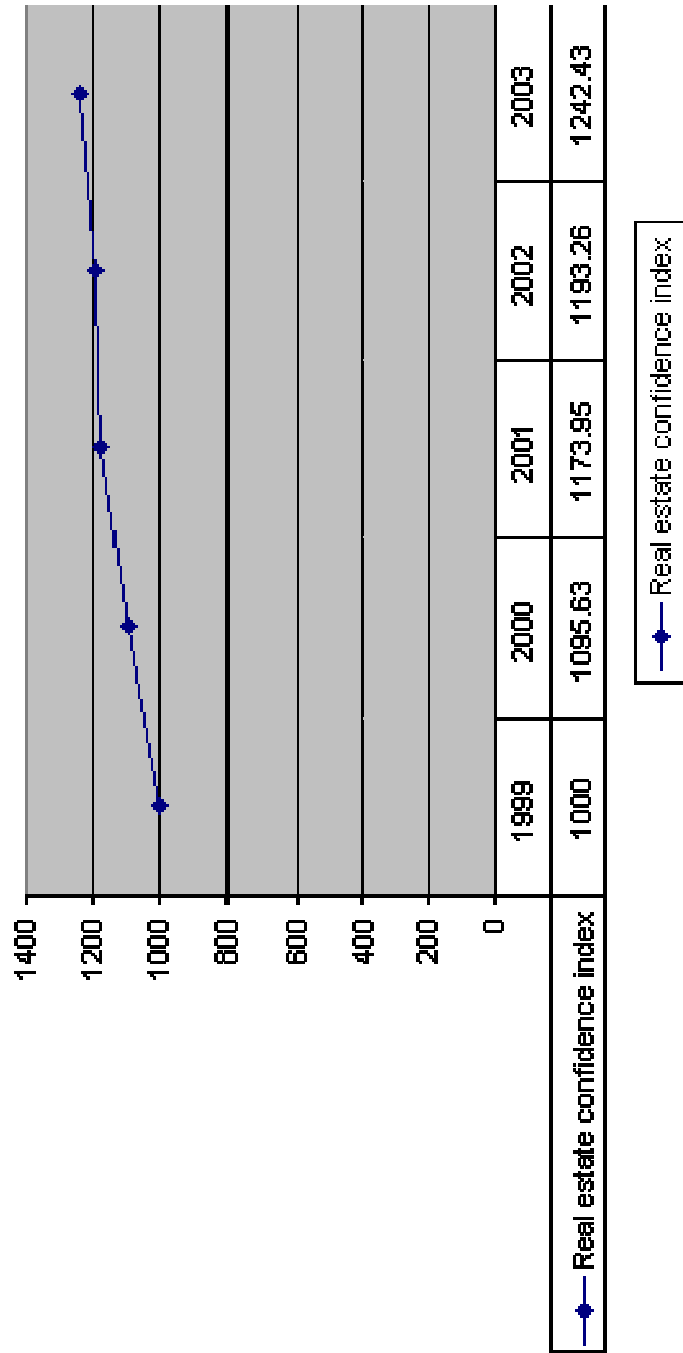
Figure 7 The Basic Indexes of the Price Index of the Shenzhen Real Estate Market



◆ Sec-RH market price index    ■ Third RH market price index  
▲ Comm-building price index    ✦ Office building price index



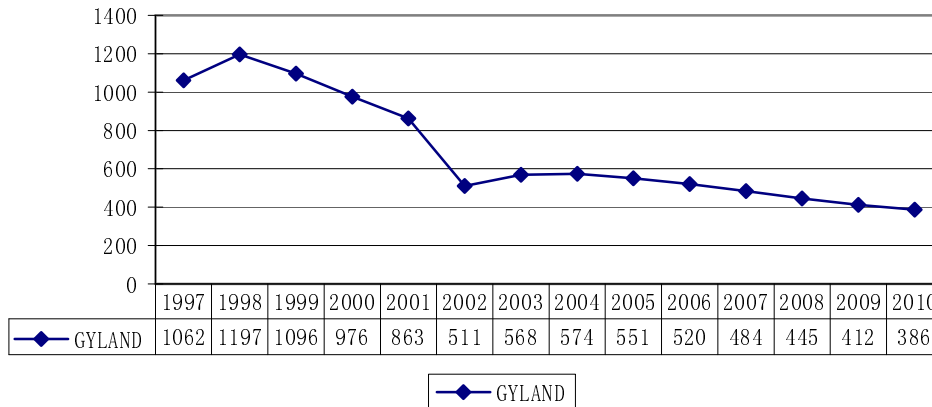
Figure 8 The Composite Confidence Index of the Shenzhen Real Estate Market



(3) Analysis of the SS&PE of real estate

Here we present an example of the indicator of *land supply* to analyze the application of the system simulation. By setting the parameters of the relevant policies, the system simulation can be carried out using the relevant DYNAMO equations and the data from 1997. The simulation result, which derives the data from 1998 to 2010, is shown in Figure 9. As can be seen, the amount of land available for housing in Shenzhen was greatest in 1998, 19,970,000m<sup>2</sup>, and from then on decreased every year. Since 2002, the amount of land available has remained steady at between 4,000,000m<sup>2</sup> and 6,000,000m<sup>2</sup>. There are two reasons for this: one is that the government has strengthened its control over the land available for housing, which has led to a decrease in the amount of land transferred for housing, and the other is that under the condition of stable demand, the land supply has held steady since the large influx of land into the market in 2000 and 2001.

**Figure 9 The Simulation of Land Supply from 1997 to 2010**



Based on the data simulated above, experiments can be carried out on certain policies by changing their parameters to obtain the effects of implementing them. This paper takes the policy on the *interest rate of real estate development loans* as an example to analyze the policy experiments. The bargain area of housing, the housing supply, and the housing price are regarded as indicators that respond to any changes in the policy parameters.

Before we adjust the relevant parameters, note that the interest rate of loans is the following table function.

A LXPOLI.K = TABLE(LX, TIME.K, 1997, 2010, 1), and  
 T LX = .1/.08/.0594/.0594/.0594/.0594/.0594/.0594/.0594/.0594/.0594/.0594/.0594/.0594/.0594.

To test the effect of the adjustment of the interest rate on the real estate market, the interest rate of housing development loans between 2003 and 2004 is increased to 0.1. After this adjustment, the table function is as follows.

$$LX = .1/.08/.0594/.0594/.0594/.0594/.1/.1/.0594/.0594/.0594/.0594/.0594/.0594.$$

The simulation result of this policy experiment is shown in Table 4.

A conclusion may be drawn from Table 4. If there is an increase in the interest rate for real estate development loans in the next two years, then real estate development costs will rapidly ascend, which will result in a fall in expected returns, a decline in development, and, therefore, a decrease in the housing supply. In addition, this high cost will lead to higher housing prices, which will further suppress housing demand. However, if this interest rate falls, then housing prices will also fall, housing demand will rise, and the housing supply will increase. Therefore, the Shenzhen real estate market is very sensitive to adjustments in the interest rate of real estate development loans.

From the above analysis of the application, it is clear that a real estate macro-control system that is based on information-oriented warning systems can better reflect the status quo and the development trends of the real estate market from different points of view and can provide different users with effective information to assist them in making decisions, which satisfies our expectations.

## 6. Conclusions

Considering the requirements of the development of China's REM, this paper has discussed the construction of a real estate macro-control system. The framework of this macro-control system, which is based on information systems, has been presented and its functions analyzed. The methods used to construct the information systems involved have also been addressed, and, based on these methods, the index systems and relevant models of the REWS, RECI, and SS&PE have been established. This paper has also tested the new macro-control system based on survey data from the Shenzhen REM, and the case study presented has demonstrated that the system can accurately and effectively reflect the status and development trends of REM. Thus, it may be adopted to assist governments in managing the REM and lead investors to make better investment decisions and consumers to make better purchasing decisions. Hence, it has good application value in addition to enriching the theory of real estate macro-control systems.

Table 4 The Simulation Result of Enhancing the Interest Rate of Real Estate Development Loans

TIME	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
DEMAND	340.8	379.8	489.0	548.6	576.4	641.2	646.8	618.5	628.1	641.4	561.2	595.3	464.7	611.5
Bargain area	340.8	379.8	489.0	548.6	576.4	641.2	646.8	659.7	635.6	606.7	581.1	555.6	522.1	509.7
Changing rate	0	0	0	0	0	0	0	-0.0625	-0.0118	0.0573	-0.034	0.0713	-0.1098	0.19969
SUPPLY	643.8	806.8	968.3	1072.	1174.	1284.	1295	1207	1123.	1138.	1134.	1135.	1094.	1156.
Housing supply	643.8	806.8	968.3	1072.	1174.	1284.	1295	1267	1208.	1160.	1130.	1113.	1108	1117.
Changing rate	0	0	0	0	0	0	0	-0.047	-0.0704	-0.019	0.0035	0.0199	-0.0119	0.03517
HOUSEP	6250	5986.	5648.	6012.	6161.	6058.	6153.	6483.	6479.	6385	6682.	6417.	6680.	5976.
Housing price	6250	5986.	5648.	6012.	6161.	6058.	6153.	6205.	6435.	6560.	6594.	6570.	6481.	6293.
Changing rate	0	0	0	0	0	0	0	0.04484	0.00680	-0.026	0.0133	-0.023	0.03059	-0.0504

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