Application Analysis of Short-term Statistical Forecast of Macroeconomic Data

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Abstract: With the increasingly close combination of modern western economics and mathematics, economic statistics, quantitative economics and other disciplines have developed rapidly, and quantitative analysis methods and ideas have gradually become the mainstream of macroeconomic research. This paper uses two different types of data, statistical data and Internet data, to evaluate and predict the quality of economic growth. In the evaluation part of economic growth quality, firstly, on the basis of clarifying the connotation of economic growth quality, theoretical analysis is made on the construction of economic growth quality evaluation index system and quality evaluation keyword database. From the quantitative perspective, the quality test of regional economic statistics is studied, and the traditional statistical data of the next year is predicted. By constructing a macroeconomic indicator system model, the evaluation theory and method of macroeconomic data timeliness are given. Quantitative measurement tools and standards for data timeliness diagnosis are designed, and the quarterly statistical data of national macro-economy are used for research. Long-term prediction is generally more difficult and less credible, while the accuracy of short-term prediction is relatively high, which is more practical and practical than long-term prediction.

1. Introduction

Volatility in financial markets refers to the degree to which the return on assets deviates from its expected return. It is a key variable in investment decisions and portfolio of securities assets. It is an important feature of financial markets and its occurrence is affected by many factors [1]. How to improve the quality of economic growth has become a problem of concern to scholars and governments all over the country. “Quality First” and “Quality Power” are both written in the 19th report of joining the Party, which further reflects our current emphasis on the quality of growth [2]. Economic statistics, quantitative economics and other disciplines have developed rapidly, and quantitative analysis methods and ideas have gradually become the mainstream of macroeconomic research. At the same time, accurate and sufficient statistical information is the basis of decision-making and scientific research, which directly affects whether social science research can produce correct research results [3]. The accuracy and consistency of statistical data have aroused widespread concern from the government and the community, but there is insufficient attention to the timeliness of statistical data [4]. With the gradual improvement of the national economic accounting system, the deepening of economic theory research, the wide application of mathematical methods, and the rapid development of computer technology and modern communication technology, people can use the above technologies to establish macroeconomic indicator analysis and prediction systems [5]. Therefore, distinguishing the normal fluctuations and abnormal fluctuations of the stock market and controlling and adjusting the abnormal fluctuations can play an important role in the stability of the financial market itself and the macroeconomic operation.

At present, Chinese scholars' research on the evaluation and prediction of macroeconomic growth quality is not sufficient. Traditional economic growth quality assessment and forecast data are derived from government reports, statistical yearbooks, etc. Analyze and monitor macroeconomic trends based on macroeconomic statistics to provide an effective reference for current and next phase of macroeconomic regulation and control and other related policies [6]. Therefore, in the current world economy affected by the economic crisis, frequent economic

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fluctuations and unclear overall development trend, the evaluation of the quality of China's macroeconomic statistical data needs to consider both accuracy and timeliness [7]. Its purpose is to improve the scientific level of economic management, reduce the blindness of economic decision-making and improve the correctness of decision-making. On the one hand, the stock market accelerates the diversion of savings to investment and promotes the concentration of capital. On the other hand, the flow of capital and information in the stock market provides a unique operation mechanism, financing mechanism, resource allocation mechanism, regulation mechanism, reflection and guidance mechanism for economic operation, which directly forms the source of economic growth [8]. The impact of data defects on evaluation and prediction results cannot be effectively solved only by improving methods and models. Analyzing from this angle, expanding the data sources plays a greater role in improving the accuracy of evaluation and prediction.

2. Application Status of Short-term Statistical Forecast of Macroeconomic Data

2.1 Short-term Statistical Forecast Based on Leading Indicators

Macroeconomic analysis requires a comprehensive consideration of both supply and demand. In the supply aspect of national economic accounting, it is mainly necessary to grasp the operation of the three industries. But the quality involves the value judgment question. The measure of growth quantity is to examine whether the source and power of economic growth are healthy and whether the speed of economic growth is reasonable [9]. In an effective market, there will be no overvaluation or undervaluation of securities prices, and investors cannot profit from known information [10]. From the supply side, the primary industry mainly inspects the agricultural production indicators such as crop acreage and sowing conditions, as well as animal husbandry output indicators such as pig, cattle, sheep, poultry and meat production. Its leading indicators are climate change, international grain prices and inventory cycle. However, due to the excessive pursuit of performance statistics by local governments for their own interests, the published statistical data are often exaggerated and moisture, which makes the reported data have serious quality problems. The accuracy and consistency of statistical data are important contents of statistical data quality. However, the quality connotation of statistical data not only includes accuracy, timeliness, but also is an important component of statistical data quality [11]. Due to the participation of many people in economic activities, although each person's will and interests are very different, on the surface or from the individual's intention, contingency occupies a dominant position, but on the whole, it has certain regularity.

According to economic theory, this paper holds that regional GDP is mainly affected by two main factors: investment vr and retail consumption M in current or past periods. Therefore, a lag model of regional GDP can be established, which is given by formula (1):

$$\sigma = \sqrt{\ln(1+\frac{\mathrm{v}_r}{m^2})} \tag{1}$$

Similarly, the total retail sales of regional consumer goods is affected by the regional GDP, fiscal revenue and fiscal expenditures of the current or past periods. Therefore, the lag model of the total retail sales of regional consumer goods is constructed, which is given by formula (2):

$$\mu = \ln(\frac{m^2}{\sqrt{v_r + m^2}}) \tag{2}$$

From the demand side, consumption mainly focuses on consumer goods retail and consumer spending. Its leading indicators mainly include employment, household income, and consumer confidence. The extent to which statistical data involved in statistical data satisfies all aspects of user demand and expectations for statistical information [12]. Whether it is a macroeconomic or microeconomic system, its development has this continuity. Past and today's decisions will affect the future more or less. Exports mainly focus on total exports and major goods and service exports.

The leading indicators are mainly coastal port cargo throughput, exchange rate changes, PMI new export order index, consumer confidence and retail growth in major trading countries, and export tax rebate policy. Because the influencing factors of quality-oriented economic growth are complex and the quantitative and non-quantitative factors cross each other, a unified research paradigm has not yet been established. At present, different scholars have different standards on which dimensions to evaluate the quality of economic growth. The weak efficient market hypothesis holds that the current stock price fully reflects the historical price of the stock. The strong efficient market hypothesis holds that the current stock price not only reflects the information contained in the historical price, but also includes the information reflected in the historical price and all publicly available information [13]. By monitoring the above-mentioned leading indicators, we can make short-term predictions of the change trend of the "troika" of the national economy, and then analyze and judge the macro-economic change trend from the demand level.

According to the theory of the econometric model, the average lag time of the influence variable x for the affected variable j can be calculated. The specific calculation formula is given by equation (3):

$$f_1(x) = \sum_{i=1}^{D-1} \left[100(x_{i+1} - x_i^2)^2 + (x_i - 1)^2 \right] \tag{3}$$

If the lag time length published by some index data x is I, f can be defined as the timeliness measuring tool for the decision of the influencing variable x on the affected factor j, and its calculation formula is:

$$f_2(x) = \sum_{i=1}^{D} \left(\sum_{j=1}^{i} x_j \right)^2 \tag{4}$$

Price level is also an important aspect of monitoring macro-economic operation. The main indicators include consumer price level, ex-factory price index of industrial producers, purchase price index, real estate price index, etc. Can reflect a regional government's achievements, but also the most prone to quality problems, and population, average power consumption and other seven other indicators compared to only indirectly reflect the regional macroeconomic operation [14]. The timeliness of macroeconomic statistical data requires government statistical agencies to improve the timeliness of statistical data through the innovation of statistical methods, the application of information technology and other measures, and improve the release system so that users can obtain statistical information in a timely manner. In linear correlations, some are positively correlated and some are negatively correlated. These relationships often reflect their causal relationship in a certain economic system [15]. The most scarce resources are flowed to the places where the most profiTable, and the structural adjustment of the national economy plays an important role, which is conducive to the healthy development of the national economy. Productivity evaluation There are certain limitations in the quality of economic growth, and the evaluation results may deviate from the actual situation, which means that the quality of economic growth should be comprehensively considered from the aspects of social economy and people's life [16]. The leading indicators for observing changes in price levels are mainly domestic economy, monetary credit and investment growth; changes in food and energy prices, and commodity price indices such as international crude oil, iron ore and non-ferrous metals.

2.2 Short-term Statistical Prediction Based on Statistical and Econometric Models

At present, a large number of government agencies, research think tanks and academic researchers have developed and used econometric models to make predictions. The fluctuation of any single index is not enough to represent the change of the overall economic growth quality. The quality of high economic growth should first be intensive rather than extensive [17]. On the whole, the commonly used models include multiple regression model, time series model, panel data model and general equilibrium model. It is believed that the sooner the user obtains the data, the better. It

has not been evaluated from the perspective of meeting the user's needs and expectations for statistical data time, and its effectiveness cannot be specifically evaluated [18]. Therefore, by analyzing the contingency in the process of economic development, it is possible to reveal the law of inevitability hidden within the economic system. From the accident, it is found that there are rules to follow. This law is the statistical law commonly used by people [19]. Economic fluctuations come from all aspects of economic operation. The contribution of different aspects or the same factors to economic fluctuations is not the same. The study of economic fluctuations is to decompose the main factors that cause economic fluctuations. The dimension of growth efficiency also includes the measurement of resource utilization efficiency. Economic development will inevitably consume resources. However, from the experience of economic development in various countries, there is a negative feedback mechanism of resources to economic growth, and excessive resource consumption.

If the original indicators are directly used to calculate the quality of economic growth, it may result in unreasonable weight assignment of different indicators, which can not be simply added and compared among the indicators. Therefore, data should be processed before principal component analysis, and standardization method is most commonly used in dimensionless research. The formula is as follows:

$$f(x)=\sum_{i=1}^{D}\left|x_i\right|^{(i+1)} \tag{5}$$

For the processed data, the method of principal component analysis is used to calculate the economic growth quality evaluation index based on statistical data, which is divided into two steps. The first step is to calculate the index values of the five dimensions. Due to space limitation, this article takes the growth efficiency dimension index as an example to calculate. Table 1 below shows the statistical characteristics of growth efficiency principal component analysis.

Table 1 Statistical characteristics of principal component analysis of growth efficiency

Component	Initial eigenvalue			Component matrix load number
	Total	Variance%	Cumulative%	Indicators
1	5.36	90.11	92.14	Amount of patent authorization
2	0.38	89.64	87.83	capital productivity
3	0.24	98.33	90.12	Labor productivity

In the second step, the principal component analysis method is used again to calculate the total index of economic growth quality for the calculated index values of each dimension. Dividing by the arithmetic square root of the eigenvalue of the corresponding principal component to obtain the variable coefficient vector of each index, and taking the variance contribution rate as the weight of each principal component to calculate the weight of each index; Finally, the index value of growth efficiency dimension is calculated according to the weight. Table 2 below shows the statistical characteristics of principal component analysis in each dimension of economic growth quality.

Table 2 Statistical characteristics of principal component analysis in different dimensions of economic growth quality

Component	Initial eigenvalue			Component matrix load number
	Total	Variance%	Cumulative%	Indicators
1	4.31	87.52	86.69	Growth efficiency
2	0.76	80.11	79.34	economic structure
3	0.83	89.37	88.15	Economic stability

Using the above methods, government departments, research institutions and scholars have built a large number of prediction models. In order to be in an invincible position in the fierce market competition, the relevant government, units and individuals need to have an objective judgment on the current economic operation and make effective predictions and suggestions on the changes in the market and the economic development situation. The “China Macroeconomic Annual Model” jointly developed by the Institute of Quantitative Economics and Technological Economics of the Chinese Academy of Social Sciences and the General Department of the National Bureau of Statistics, and the “Simultaneous Equations” developed by the National Information Center all effectively predict the annual GDP. Statistical data timeliness evaluation is aimed at evaluating the effectiveness of users' use of statistical data to predict and make decisions on future situations. If users get published statistical data to make effective predictions and decisions on future situations, it shows that the statistical data has timeliness [20]. Production efficiency in a specific time can reflect different economic development patterns. If factor productivity continues to exceed a certain threshold, it may represent the transformation and upgrading of economic development patterns. That is to say, high factor productivity represents the transformation from extensive economic growth to intensive economy. The fixed asset investment amount is the workload of building and purchasing fixed assets activities in monetary performance. It is a comprehensive indicator reflecting the scale, speed, proportional relationship and direction of use of fixed assets. Some researchers have proposed a mixed data model. The model can effectively utilize high-frequency information in macroeconomic data, avoid information loss in the process of predicting low-frequency indicators, and improve the accuracy of prediction.

3. Problems and Prospects of Short-term Statistical Forecast of Macroeconomic Data

Statistical prediction based on single statistical index or composite leading index has the characteristics of easy operation, but there are also obvious problems. The improvement of total factor productivity is generally determined by system reform, technological progress, management optimization and other factors, and the improvement of these factors cannot be separated from the role of science and technology. Technological progress can be realized through scientific and technological innovation, thus completing production activities more efficiently. Management efficiency can be optimized through system and management innovation. Generally speaking, in the initial stage of inflation, prices are gradually rising and the currency in circulation is beginning to depreciate. Investors may hold stocks to avoid inflation risks in order to preserve their value, thus increasing the demand of the stock market and stimulating the stock price to rise. On the other hand, single statistical indicators and leading index constituent indicators are relatively limited, and it is difficult to include complete information on the overall macroeconomics. On the contrary, the statistical data does not meet the timeliness requirement. This paper argues that a certain economic factor will have a lasting impact on future economic conditions. The key point is not to comprehensively summarize the historical achievements of the macro economy, but to judge the current hot and cold degree of the economic situation or the normality through the comparison of economic indicators, and give appropriate warnings. Therefore, the impact of inflation on the stock market can not be simply summarized as positive or negative correlation, which depends on the degree of inflation development, a certain degree of inflation is beneficial to the stock market. Even the cost of recovery is enormous, which makes the economic development that depends on high resource input is often unsatisfactory and unproductive, and the extensive economic development model with high resource factor input can not achieve sustainable growth.

The variable coefficient vectors of each index are obtained by dividing the load number of component matrix by the arithmetic square root of the characteristic value of the corresponding principal component, and the weight of each index is calculated by taking the contribution rate of variance as the weight of each principal component. Finally, the index values of each dimension of the statistical index of economic growth quality are obtained by calculating the weight of each index. The principal component analysis method is used to measure the four dimensions and total indexes of China's economic growth quality from 2016 to 2018. The results are shown in Table 3:

Table 3 Economic growth quality statistical index

Year	Economic structure	Economic stability	Living standard	Growth efficiency
2016	-1.33	0.61	-1.17	-0.56
2017	0.32	-0.82	-1.38	1.25
2018	-0.55	1.75	-.031	-0.87

An Empirical Study on Economic Growth Quality Forecast. The predicted explained variables are low-frequency data, while the explained variables are high-frequency Internet data. The update frequencies of the two variables are not the same. In this paper, when forecasting the quality of economic growth, the economic growth quality Internet index is used as the high-frequency explanatory variable, and the economic growth quality comprehensive index is used as the low-frequency explanatory variable. The difference in the frequency of data updates used is shown in Figure 1.

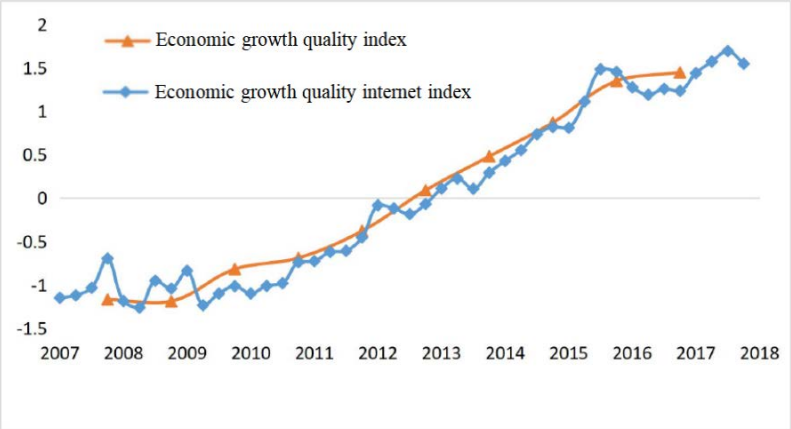

Fig.1. Mixing data graphs in predictive models

Short-term forecast based on prosperity survey has the advantages of relatively complete information, sufficient sample size and convenient structural analysis. In fact, obtaining the current data is the most effective data for decision-making, but in reality it is impossible to collect and publish the data in real time, and the longest lag period determined according to the model is not suiTable for the decision-making target variables, so the effectiveness of obtaining the data is almost insignificant. The ultimate goal of macroeconomic analysis and prediction is to timely regulate the abnormal state of economic operation so that the economy can develop normally. Users will know whether their own regulation methods and resource allocation are appropriate and feasible through the results given by the prediction model. It reflects the integration of the market value of all the final products and services produced and provided by a country or region in a certain period of time, and also reflects the contribution of the production units or departments to GDP. The transformation and upgrading of economic structure is one of the ways to change the driving force of China's growth. Under the new normal background, we also need to adjust and optimize the economic structure, vigorously develop services and emerging industries, and the economy has more development potential. Since the business climate index is a comprehensive index based on discrete indices, it has great limitations in accurately reflecting the extent of economic fluctuations. It is relatively influenced by entrepreneurs or consumers' emotions. It may also be that there is no abnormal data for non-compliance. It is caused by effective technical processing; on the other hand, it may be that the data quality of these indicators does have problems to be diagnosed.

Based on the above analysis, this paper believes that the future improvement of macro-economic short-term statistical prediction should start from the following two aspects:

Improve the authenticity, accuracy, completeness and timeliness of statistical data. Statistical data is the most basic constituent element in statistical analysis and the most core basis in

macro-control. Violent economic fluctuation will do great harm to economic growth. On the one hand, it will have a negative impact on the coordination of production among departments within the industry, resulting in the reduction of factor utilization efficiency and production efficiency, and may even affect sustainable development. There are many indicators of macroeconomic variables, which are far greater than the number of dependent variables. On the one hand, it will increase the amount of calculation, resulting in the accumulation of errors. On the other hand, it will increase the possibility of multicollinearity of independent variables. At present, China's statistical system still needs to be improved, and efforts should be made to solve the problems of insufficient statistical scope and scientific statistical standards. Therefore, the release period of the indicator is smaller than the average lag time required for the decision to meet the decision-making needs of the target variable. The development of computer technology has provided a powerful tool for the organization, storage, use and completion of complex economic information, and created favorable conditions for the establishment of a large econometric model. The result of using the backward stepwise regression method is that the results of the selected variables can be understood as follows. The consumer price index is representative of the consumption power in the national economy and a certain degree of inflation, while fixed asset investment is representative. Entity production capacity in the national economy. Price fluctuations, employment fluctuations, output fluctuations, and macroeconomic policies will all affect the stability of economic growth to some extent.

Combine the first indicator monitoring, the prosperity survey, and the measurement model prediction, and at the same time give full play to the advantages of the prosperity survey and the measurement forecast, and on the basis of fully considering the exogenous impact, the situation will be decomposed and the prediction elasticity will be enhanced. Economic growth must be conducive to the improvement of the living standards of all residents. Only when the living conditions of all members have made significant progress, is it the goal of economic development, and it is meaningless to talk about economic development from the improvement of people's living standards. The financial market is only a part of the capital market, its changes are not enough to affect the overall, but the impact of fixed assets investment on the stock market is very long-lasting, and the most significant impact on the stock market volatility is two years behind, indicating that fixed assets investment has been returned. At present, China's consulting service industry has expanded to engineering, economy, science and technology, society and management and other fields. The Advisory decision-making fever led by the information industry directly serves the market, which has brought unprecedented vitality to China's consulting industry. The improvement of welfare level refers to the increase of people's per capita wealth while the increase of income leads to the increase of consumption level, which helps to expand domestic demand, solve the problem of insufficient economic aggregate demand and reduce external dependence. At the same time, in the process of statistical or econometric modeling, it is not only necessary to use conventional statistical data, but also to make full use of the advantages of boom survey data to better analyze the structure of sub-regions and sub-industries.

4. Conclusion

Discussing the diagnosis of the timeliness of macroeconomic statistical data quality is the main content of evaluating the statistical data to play the prediction and decision-making functions of macroeconomic data. This paper constructs the diagnosis model of the timeliness of economic data quality based on the idea that the internal factors of macroeconomic system influence each other. The analysis guide of each analysis method is implemented in the system, which enables users to flexibly select the data to be analyzed, set analysis parameters, and give display charts and data reports of the final analysis results. This paper first established the econometric group model of simultaneous equations based on the same year's index data, which has many advantages over the previous model of forecasting this year's economic data based on the previous year's data. In practice, it is necessary to comprehensively evaluate the quality and timeliness of macroeconomic data in order to systematically evaluate the timeliness level of a set of macroeconomic data quality. In addition, the exogenous variable index selection of the model may also be optimized, and the

statistical data of some indicators may be better applied to the model fitting effect after professional technical processing. At the same time, we should continue to study in depth, how to combine Internet data with statistical data, establish and use models and methods more suiTable for Internet data, and tap the application potential of Internet data.

References

[1] Tingguo Z, Kai X. Macroeconomic data releasing and methodology research on measuring China's business cycle in the real-time[J]. Systems Engineering-Theory & Practice, 2017, 37(4):817-830.

[2] Cai M, Rueda-Cantuche, José Manuel. Bridging macroeconomic data between statistical classifications: the count-seed RAS approach[J]. Economic Systems Research, 2018:1-22.

[3] Misch F, Olden B, Poplawskiribeiro M, et al. Nowcashing: Using Daily Fiscal Data for Real-Time Macroeconomic Analysis[J]. Social Science Electronic Publishing, 2017, 17(227):1.

[4] Chow Y P, Muhammad J, Noordin B A A, et al. Macroeconomic dataset for generating macroeconomic volatility among selected countries in the Asia Pacific region[J]. Data in Brief, 2018, 16(C):23-28.

[5] Marinko Škare. Macroeconomic noise removal algorithm (MARINER)[J]. Technological & Economic Development of Economy, 2017, 23(3):549-565.

[6] Makris I A. The effect of innovative activity in firm performance and development: Analysing data from eurozone[J]. Social Science Electronic Publishing, 2016, 9.

[7] Givens G. Do data revisions matter for DSGE estimation?[J]. MPRA Paper, 2016, 49(6):1385-1407.

[8] Podleski, Genevieve. Streamlining metadata for economic time series data: A project report[J]. Proceedings of the Association for Information Science and Technology, 2015, 52(1):1-4.

[9] Bresson G, Etienne J M, Mohnen P. How important is innovation? : A Bayesian factor-augmented productivity model on panel data[J]. MERIT Working Papers, 2014, 20(8):1987-2009.

[10] D'Orazio, Paola. Big data and complexity: Is macroeconomics heading toward a new paradigm?[J]. Journal of Economic Methodology, 2017:1-20.

[11] Choi S, Furceri D, João Tovar Jalles. Fiscal Stabilization and Growth; Evidence from Industry-level Data for Advanced and Developing Economies[J]. IMF Working Papers, 2017, 17(198):1.

[12] João Marcos Lima, Guetter A K, Freitas S R, et al. A Meteorological–Statistic Model for Short-Term Wind Power Forecasting[J]. Journal of Control Automation & Electrical Systems, 2017, 28(5):679-691.

[13] Ezzat A A, Jun M, Ding Y. Spatio-temporal asymmetry of local wind fields and its impact on short-term wind forecasting[J]. IEEE Transactions on Sustainable Energy, 2018:1-1.

[14] Bugała A, Zaborowicz M, Boniecki P, et al. Short-term forecast of generation of electric energy in photovoltaic systems[J]. Renewable and Sustainable Energy Reviews, 2018, 81:306-312.

[15] Stepchenko A, Chizhov J, Aleksejeva L, et al. Nonlinear, Non-stationary and Seasonal Time Series Forecasting Using Different Methods Coupled with Data Preprocessing[J]. Procedia Computer Science, 2017, 104:578-585.

[16]] Sagaert Y R, Aghezzaf E H, Kourentzes N, et al. Temporal Big Data for Tactical Sales Forecasting in the Tire Industry[J]. Interfaces, 2017:inte.2017.0901.

[17] Young C J, Bumshik L. Combining LSTM Network Ensemble via Adaptive Weighting for

Improved Time Series Forecasting[J]. Mathematical Problems in Engineering, 2018, 2018:1-8.

[18] Tapia Cortez C A, Coulton J, Sammut C, et al. Determining the chaotic behaviour of copper prices in the long-term using annual price data[J]. Palgrave Communications, 2018, 4(1):8.

[19] Tian C, Tian C, Hao Y, et al. A Novel Nonlinear Combined Forecasting System for Short-Term Load Forecasting[J]. Energies, 2018, 11.