

# Calculate of hunan industrial early warning index

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**Abstract.** Electric Power data has the characteristics of strong real-time, fine granularity and high accuracy. It can more accurately reflect the current industrial structure and is suitable for the monitoring of high-quality economic development. In order to better play the role of power data monitoring and early warning, based on the prosperity signal lamp method, combining the principle of mathematical probability method, the early warning index system of electric power economic monitoring is constructed. The results show that the index can monitor the power situation of Hunan Province, and can be used in the construction of green energy and promote the energy conservation and high-quality economic development of Hunan Province.

**Keywords:** Power economy early warning index; Early warning monitoring; Hunan Province.

## 1 Introduction

Electric power demand is closely related to economic and social development. Electric power demand is regarded as the "barometer" and "thermometer" of macro-economy. Electric power demand involves all aspects of economic operation and people's life. In view of the accuracy of data collection, electric power data can more truly reflect the economic operation compared with traditional macroeconomic data (Tan et al. 2016<sup>[1]</sup>).

The index construction method has always been one of the important means for domestic and foreign scholars to judge the macro and industrial development. The main methods of macroeconomic early warning include prosperity index method and prosperity signal lamp method. From the perspective of macroeconomic early warning, Yu and Zhang (2020)<sup>[2]</sup> used the idea of signal light to build a foreign exchange reserve risk system in order to effectively monitor foreign exchange risk; Liu (2021)<sup>[3]</sup> constructed the early warning framework of China's Urban Smart supply chain based on the improved signal lamp model. Give early warning information according to the status of the signal light, and effectively provide suggestions for the development of smart supply chain for government departments; Yan et al. (2021)<sup>[4]</sup> monitored and warned the macroeconomic operation based on support vector machine.

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From the perspective of the industry early warning system, Shi and Wang (2017)<sup>[5]</sup> introduced the prosperity analysis into the electric power market, and compiled the leading index of electric power prosperity, predicted the turning point of future electric power demand development and speculated the future trend of electric power demand by observing the index; Chen and Wang (2019)<sup>[6]</sup> analyzed the fluctuation of service industry by constructing a monthly consistent prosperity index of China's service industry through six service industry related indicators. The results show that the growth of China's service industry generally presents the characteristics of "slow growth and rapid decline" in the 21st century, which improves the early warning research of the service industry; Zhou et al. (2021)<sup>[7]</sup> built an MF-MS-SW model that can analyze seasonal and monthly frequencies at the same time, selected the leading, consistent and lagging mixing sample data composed of 21 indicators, and built China mixing electric power prosperity index and early warning signal system. Sun (2021)<sup>[8]</sup> proposed and constructed a regional electric power prosperity early warning system based on multi-dimensional big data such as economy, energy, electric power and environment on the basis of analyzing common electric power prosperity indexes and early warning methods; However, the research on early warning index mostly starts from the macro-economy, so it often only includes various macroeconomic indicators in the selection of indicators, or studies the early warning system of different industries. Few studies start from the correlation between electric power and economy, look at economic development with electric power, and force electric power with economy. This paper starts from the two aspects of electric power and economy, The early warning index of Hunan electric power economy is constructed to monitor the economic development of Hunan Province.

## 2 Construction of early warning index of electric power economy in Hunan Province

The design of prosperity signal system is based on the selection of advance and consistent system. The specific process includes the selection of signal indicator, the determination of indicator threshold and weight, and the calculation of comprehensive alarm index.

The early warning index in this paper is used to measure the economic prosperity of Hunan. It needs to use all the indicators in Hunan Province, covering the main aspects of Hunan economy. According to the data indicators selected by China to establish the early warning index and the economic development of Hunan Province, the index system of Hunan macroeconomic early warning index is finally determined, as shown in table 1, with 15 data in total.

**Table 1.** Early warning index system.

Order	Name of Index
	<b>Economic Indicators</b>
X <sub>1</sub>	Growth of industrial added value
X <sub>2</sub>	Money supply (M1) increases
X <sub>3</sub>	Loan balance growth in local and foreign currencies
X <sub>4</sub>	Fixed asset investment growth rate
X <sub>5</sub>	Growth rate of total retail sales of consumer goods
X <sub>6</sub>	Import growth
X <sub>7</sub>	Export growth
X <sub>8</sub>	Growth in fiscal revenue
X <sub>9</sub>	Growth in consumer price
X <sub>10</sub>	Real estate investment growth
	<b>Power Data</b>

Y <sub>1</sub>	Industrial electricity consumption was used year on year
Y <sub>2</sub>	Ferrous metal smelting and rolling processing industry
Y <sub>3</sub>	Manufacture of non-metallic mineral products
Y <sub>4</sub>	Transportation, electrical, and electronic equipment manufacturing
Y <sub>5</sub>	Production and supply of electricity, gas and water

We use mathematical statistics to determine the boundary of early warning indicators and divides the boundary of early warning indexes according to the specific steps of:

(1) The score is determined by determining a single warning indicator critical value. Note: Sample mean and sample standard deviation  $\sigma$  were calculated from the sample data of each boom warning indicator. The critical values of the warning index are shown in Table 2. Then, according to the interval of indicator value in each period, the signal light color of each indicator in each period is judged. Each signal is given different points, 5 for "red", 4 for "yellow", 3 for "green", 2 for "light blue" and 1 for "dark blue".

**Table 2.** Cut-off value of Hunan electric power economic early warning index.

Metrics	Critical Value			
	red←yellow ( $u+2\sigma$ )	yellow←green ( $u+\sigma$ )	greenlight←blue ( $u-\sigma$ )	lightblue←blue ( $u-2\sigma$ )
X <sub>1</sub>	9.998	8.68	6.06	4.742
X <sub>2</sub>	4.302	3.20	1.00	-0.102
X <sub>3</sub>	18.84	14.49	5.79	1.44
X <sub>4</sub>	32.77	20.10	-5.24	-17.91
X <sub>5</sub>	106.06	68.61	-6.29	-43.74
X <sub>6</sub>	77.57	51.03	-2.05	-28.59
X <sub>7</sub>	40.35	29.26	7.08	-4.01
X <sub>8</sub>	24.19	19.70	10.72	6.23
X <sub>9</sub>	26.33	18.55	2.99	-4.79
X <sub>10</sub>	18.46	16.95	13.93	12.42
Y <sub>1</sub>	24.72	14.61	-5.61	-15.72
Y <sub>2</sub>	11.31	5.90	-4.92	-10.33
Y <sub>3</sub>	35.21	20.24	-9.70	-24.67
Y <sub>4</sub>	46.7	26.36	-14.32	-34.66
Y <sub>5</sub>	46.43	26.24	-14.14	-34.33

(2) Determine the valve value of the composite index score. After determining the score of the composite index, the boundary value corresponding to the composite index is determined, and then the signal light color corresponding to the composite index is determined. The formula is below. The specific results are shown in Table 3.

$$\left. \begin{aligned}
 I_{\text{yellow} \rightarrow \text{red}} &= 15 \times 5 \times 85\% = 63.75 \\
 I_{\text{green} \rightarrow \text{yellow}} &= 15 \times 5 \times 74\% = 55.5 \\
 I_{\text{light blue} \rightarrow \text{green}} &= 15 \times 5 \times 50\% = 37.5 \\
 I_{\text{blue} \rightarrow \text{light blue}} &= 15 \times 5 \times 36\% = 27
 \end{aligned} \right\} \quad (1)$$

**Table 3.** Threshold setting of Hunan electric power economic early warning index.

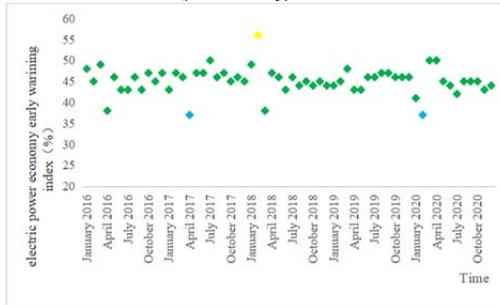
Warning status	superheat	Hot	stabilize	Cold	supercooling
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signal lamp threshold	Red	Yellow	Green	Light blue	Blue
	>63.75	[55.5,63.75]	[37.5,52.25]	[27,37.5]	<27

(3) Determine the color of the comprehensive index signal light. See (2) for constructing comprehensive index targets.

$$Y_{ti} = Y_{t1} + Y_{t2} + Y_{t3} + Y_{t4} + Y_{t5} + Y_{t6} + Y_{t7} + Y_{t8} + Y_{t9} + Y_{t10} + Y_{t11} + Y_{t12} + Y_{t13} + Y_{t14} + Y_{t15} \tag{2}$$

Among them, Y is the comprehensive index score, t=1,2, ... 60, representing different periods, i=1,2, ... 15, representing 15 early warning indicators,  $Y_{t1}, Y_{t2}, Y_{t3}, Y_{t4}, Y_{t5}, Y_{t6}, \dots, Y_{t15}$ , representing the signal light score of 15 early warning indicators in period t, adding them to indicate the Hunan early warning index score.



**Fig.1.** Trend chart of electric power economy early warning index in Hunan Province.

Hunan province electric power economy early warning index is mainly in green state, indicating Hunan province economic development is in normal state, the current economic and electric power development is very stable. As can be seen from Figure 1, the warning index of Hunan province was stable in 2016. In April 2016, it changed from the green light area to the light blue light area and then fell back to the green light area, indicating that the economic development of Hunan Province changed from normal to cold and then normal operation. According to the analysis of various indicators in April 2016, industrial electricity consumption and non-metallic mineral products industry electricity consumption are in the "light blue light" area, while the electric power consumption of transportation, electrical and electronic equipment manufacturing industry and electricity, gas and water production and supply industry are in the "blue light" area. On the one hand, it shows that Hunan electric power plays an important guiding role in economic development, and the economic development of Hunan Province needs the drive of electric power; On the other hand, except for the real estate industry and import and export growth in Hunan Province, other economic indicators are in the "green light zone " or "yellow light zone ", and the economic development of Hunan Province is relatively stable. Subsequently, the signal light of Hunan Province turned green after May 2016, and the early warning index rebounded and entered the "yellow light zone" in February 2018. The economy in 2018 became hot because of the influence of the growth of Hunan province's export and local fiscal revenue. These two indicators entered the "red light zone" in February 2018; influenced by the Spring Festival effect, the growth rate of social consumer goods in Hunan province is in a hot state; the growth rate of power consumption in ferrous metal smelting and calendaring industry in Hunan province increased in February 2018, indicating that the economy in 2018 was mainly influenced by fiscal policy, export and holiday effect. In February 2020, the electric power economic index of Hunan Province fell into the "light blue light zone", and the electric power economy was cooling down, mainly due to the cooling of the electric power market and the impact of the decline in export and fiscal

revenue growth rate. In general, the economic growth of Hunan Province during 2016-2020 has achieved stable growth in the safe and stable zone. Although the economic growth is hot, it has not reached the safety warning line, and the overall safety is achieved.

### 3 Conclusions and recommendations

Judging the economic development of Hunan Province according to the prosperity signal, it can be seen that Hunan Province is mainly under the condition of green light(In April 2016, the electric power economy early warning index entered the light blue light zone, in February 2018, the electric power economy early warning index entered the "yellow light zone", and in February 2020, the electric power economy early warning index of Hunan Province fell into the "light blue light zone"), The main reason for the change of Hunan electric power economic early warning index is the change of Hunan electric power economy and the impact of finance, import and export, but on the whole, Hunan's economy is stable. Based on the above research, the following suggestions are put forward for the development of Hunan Province:

(1) Ensure the stability of the electric power market and meet the economic development and consumer demand of residents.

(2) With high-quality economic development to force electricity, change the household electricity consumption pattern to improve the quality of life.

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