Empirical Study on Calculation of Electricity Economic Prosperity Index -- A Case Study of H Province

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Abstract. According to the theory of economic cycle growth, the method of economic prosperity chronology is used to select the appropriate period of economic prosperity research. Time difference correlation analysis, K-L information quantity and peak valley correspondence method are used to compare the trend value of power consumption in various industries with the trend value of economic data. The indicators that can reflect economic fluctuations are selected and divided into the leading, consistent and lagging indicator groups. The composite index method is used to synthesize the electricity economic prosperity index, including leading index, consistent index and lagging index. Finally, taking H province as an example, an empirical study is carried out to demonstrate the practicability of the model.

1. Introduction

In 2020, COVID-19 had come unexpectedly impacts on China's economic development. As the backbone of the national economy, state-owned enterprises is facing many challenges, and the main economic indicators are declining. In the first quarter of 2020, it achieved an business income of 6 trillion yuan, a year-on-year decrease of 11.8%, and a net profit of 130.4 billion yuan, a year-on-year decrease of 58.8%. The economic downturn across the country also has a negative impact on the economic development of H province. In order to cope with the impact of COVID-19 on China's economic development and make full use of big data resources of power enterprises, it is particularly important to monitor and predict economic development ahead of time by means of economic prosperity analysis such as electricity economic prosperity index.

2. Literature review

Electricity economic prosperity index is an important means to look at the economic development from the perspective of electric power. It adopts the form of index, uses industrial power consumption data instead of economic data, analyzes and forecasts different stages of economic development by analyzing and fitting the economic growth trend. First of all, we make a chronology of economic prosperity in years (Gao Tiemei, 1996; Xie Jiabin et al., 2007; R Fiorito, 2013); secondly, select the economic indicators as the benchmark indicators to determine the leading, consistent and lagging indicators; finally, use the diffusion index or composite index to calculate the power economic prosperity index, explain its relationship with the benchmark indicators, and use the leading indicators to predict the trend (Shi Xuemei et al., 2015; Liu Yujiao et al., 2020). The above scholars' research on power economic
index is relatively mature, but there are some problems. For example, if the index synthesizes directly by the actual power consumption data, it gets the result of inaccurate trend or excessive fluctuation of the index.

3. Theoretical model

3.1. Business cycle analysis method
Firstly, the economic cycle chronology is compiled according to the peak and valley turning point dates of economic fluctuations, and then a series of monitoring indicators are divided into the first, consistent and lagging indicators. The peak and valley time of consistent index is the same as that of the overall economic operation; the leading index can predict the peak and valley of the overall economic operation in advance; the lagging index is a confirmation of the peak and valley that has appeared in the overall economic operation.

3.2. Indicators selection method
Time difference correlation analysis and K-L information method are used to select the leading, consistent and lagging indicators.

3.2.1. Time difference correlation analysis. Select an important economic indicator that can sensitively reflect the current economic activities as the benchmark indicator, and then make the selected indicators ahead or behind several periods, and calculate their correlation coefficient $R$.

The indicator of $y$ is the benchmark indicator: $y = (y_1, y_2, ..., y_n)$; The indicator of $x$ is the selected indicator: $x = (x_1, x_2, ..., x_n)$. $R$ is the correlation coefficient:

$$
R_l = \frac{\sum_{i=1}^{n} (x_{i+l} - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n} (x_{i+l} - \bar{x})^2 (y_i - \bar{y})^2}} (l=0, \pm 1, \pm 2, ..., \pm L)
$$

The indicator of $l$ represents lead and lag. When $l$ is a negative number, it means lead; when $l$ is a positive number, it means lag. And $l$ is called time difference or delay number. $L$ is the maximum number of delays, $nl$ is the number of data after data fetching.

3.2.2. K-L information method. The event $P$ about the benchmark indicator is the probability distribution of random variables. $P = \{p_1, p_2, ..., p_m\}$, where $p_i$ is the probability of occurrence of event $P$. The event $Q$ about the selected indicator is the probability distribution of random variables. $Q = \{q_1, q_2, ..., q_m\}$, where $q_i$ is the probability of occurrence of event $Q$. Then the expectation is defined as:

$$
I(p, q) = \sum_{i=1}^{m} p_i \ln \frac{p_i}{q_i}
$$

$I(p, q)$ is the K-L information quantity of distribution column $Q$ about distribution column $P$. K-L information quantity can be calculated by the following equation:

$$
k_l = \sum_{i=1}^{n} p_i \ln(p_i / q_{i+l}), \quad l=0, ..., L
$$
When \( l \) is negative, it is leading. When \( l \) is positive, it is lagging. The indicator \( l \) is called time difference or delay number. \( L \) is the maximum delay number. And \( nl \) is the number of data after data is collected. When all of K-L information quantity is calculated, the minimum value of K-L is selected as the K-L information quantity of the selected index \( x \) with respect to the benchmark index \( y \), i.e.

\[
k_r = \min_{-L \leq l \leq L} k_i
\]

3.3. Calculation method of electricity economic prosperity index

The first step is to calculate the symmetric change rate of the indicators and standardize it. The second step is to calculate the standardized average change rate of each indicator group. The third step is to calculate the composite index, that is to say, electricity economic prosperity index.

4. Empirical analysis

4.1. Analysis on the relationship between economy and electric power

H province is a big industrial province with good industrial development and occupies an important position in the national industry. In 2019, the annual added value of industries above designated size has increased by 6.2% over the previous year. Industrial electricity consumption accounts for 81.0% of the total electricity consumption of the whole industry. Industrial power consumption is closely related to the output of industrial products. Taking an industry as an example, the fluctuation of industrial power consumption is basically consistent with the output of main products, with a slight deviation in the later stage. It is showed in Figure 1.

![Figure 1. Power consumption and output of an industry in H Province](image)

Industry has a strong correlation with the economic development of the province, and the year-on-year growth rate of industrial added value represents the economic development of the province. Therefore, the year-on-year growth rate of industrial added value is taken as the benchmark index.

4.2. Calculation electricity economic prosperity index in H Province

The data of the benchmark indicator and 68 alternative indicators in H province from January 2015 to December 2019 is calculated through time difference correlation analysis and K-L information method.
Nine industries including oil and gas exploitation industry and so on are selected as the consistent indicators. Seven industries including coal mining and washing industry and so on are selected as the leading indicators to calculate the leading index. This paper selects six industries of metal products industry as lag indicators to calculate lag index. After calculation, R between the consistency index and the benchmark index of H province is 0.976, which has strong correlation. The leading index and lagging index are calculated to form leading indicators and lagging indicators, and compared with consistent index. From the trend chart of the three, we can see that the leading index, consistent index and lagging index have the same trend, and have obvious time difference (such as A, B, C). The leading index is about 6 months ahead of the consistent index, and the lagging index is about 5 months behind the consistent index.

![Figure 2. Consistency index, leading index and lagging index of H Province](image)

According to the electricity economic prosperity index, the economy of H province develops steadily, showing cyclical fluctuations. At the end of 2017, there was a relatively obvious decline, with the consensus index reaching 83.6 at one time. It began to pick up in the second half of 18, and stabilized in 2019, with an effective recovery of economic growth. The leading index has a certain predictive effect. In the first half of 2019, the leading index has a stable trend with small fluctuation. Therefore, it can be inferred that the economic trend of H province will continue to be stable in the second half of 2019, which is consistent with the actual situation in the second half of 2019.

5. Conclusions
After a certain correction, the electricity economic prosperity index model of H province can be used to analyze the interactive relationship between power and economy of H province. According to the selected index pool, calculation method and calculation process, combined with big data analysis tools, it can greatly shorten the index calculation time, quickly synthesize consistent, leading and lagging indexes, and provide necessary technical support for timely release of power prosperity index.

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