

Summary of Macro-Economic Research Direction Based on Electric Power Data

Guang Chen^{1,a*}, Cheng Cheng Fu^{1,b}, Wan Ting Yin^{1,c}, Xiao Nan Gao^{1,d}

¹State Grid Energy Research Institute Co. Ltd., Beijing 102209, China;

*The corresponding author

ABSTRACT: The main problem of the development of the power industry is whether it can accurately grasp the growth trend of power demand combined with the background of China's economic development, and provide a reliable basis for the rational development of the power industry. In recent years, economists and policy makers have increased their attention and research on the relationship between economic growth and the development of the power industry, and give a brief review in detail to provide a reference for the research of power and economic relations.

1. research background

With the rapid development of the national economy, the power industry plays an increasingly important role in the national economy. Accurately grasp the position and role of power in the national economy can provide a basis for formulating reasonable power development plans and related industrial policies, and has an important significance for promoting the sustainable development of power and economy.

GDP (gross domestic product) is the most important indicator of reflecting the macro economy. A country's sharp growth in GDP reflects the country's booming economy, the increase in national income and the increase of consumption capacity. In the other hand, if a country has negative GDP, it shows that the economy is in recession and its consumption power decreases. It can be said that GDP can most intuitively reflect the macroeconomic operation of the country.

Therefore, the macroeconomic analysis is mainly to judge and predict the current macroeconomic situation and development trend through the comparative analysis of the main GDP. At present, the macroeconomic indicators mainly used by macro economists are the statistical data provided by the statistical departments, mainly including GDP-national economic overall indicators, CPI-consumer price indicators, PPI-producer price indicators, etc., and the power data can directly or indirectly respond to these important indicators.

2. Power elasticity coefficient was used to study the correlation between electricity and economic growth

Power elasticity coefficient is the most direct embodiment of the correlation between power and economic development, and is one of the important factors considering the long-term development planning of power industry.

The power elasticity coefficient is divided into power production elasticity coefficient and power consumption elasticity coefficient, the former is related to the growth rate of installed capacity or power generation, and the latter is related to the growth rate of electricity consumption. The power elasticity coefficient generally refers to the power consumption elasticity coefficient, which refers to the ratio of the growth rate of power consumption and the GDP growth rate over a period of time. Power elasticity coefficient is usually used to investigate the degree of energy development and economic development.

When all developed countries are in the development period, the power elasticity coefficient is greater than 1, that is to say, energy production is advanced development. However, the annual elasticity coefficient of power consumption in China fluctuates greatly. The lowest value since 1980 is 0.382 in 1998, while the highest value has reached 1.882 in the first half of 2003. Therefore, the change law of power elasticity coefficient has been a hot topic of domestic researchers.

Yang Mingying [1] analyzed the impact of industrial structure changes, power consumption per unit output value and economic growth rate on the elasticity of

^a chenguang@sgeri.sgcc.com.cn, ^b fuchengcheng@sgeri.sgcc.com.cn,

^c yinwanting@sgeri.sgcc.com.cn,

^d gaoxiaonan@sgeri.sgcc.com.cn

power consumption, and on this basis analyzed the change trend of central China and East China.

Hao Weiping [2] and other people analyzed the historical law of the change of power elasticity coefficient in China since the founding of the People's Republic of the Republic of China, analyzed the power elasticity coefficient of developed countries in China and abroad in different stages of economic development, and on this basis analyzed the change trend of power elasticity coefficient in China in the future.

Limberqiang [3] estimated the long-term elasticity coefficient of China's electric power on the basis of establishing the long-term power demand model, which showed that the elasticity coefficient was estimated at 0.78 between 1978 and 2001, slightly lower than 0.86 between 1952-2001, which is consistent with the promotion of energy conservation and economic structure optimization and adjustment after the reform and opening up.

Mao Jibing and Hua Ruxing [4] focused on the evolution process and change law of power consumption structure and power consumption elasticity coefficient in Beijing and Shanghai with high urbanization rate, and predicted that the elasticity coefficient of Chinese residents' life and tertiary industry will be greater than 1 in a quite long period.

Wu Jiang [5] from the analysis of 1998-2008 China's power consumption elasticity coefficient characteristics, analyzed the industrial structure, power use efficiency and terminal demand changes for long-term and short-term changes different impact mechanism, compared with our three economic cycles since 1978 and other countries in the world, pointed out that China's power consumption and GDP growth will continue to maintain a relatively strong correlation, power consumption elasticity coefficient "often high", "slow", "allergy" and other characteristics will continue for a certain period.

Si Zengchuo [6] analyzed the correlation between the process of industrialization process and the evolution of the elasticity coefficient of power consumption. His research found that because China is in the period of heavy industrialization, the elasticity coefficient of power consumption is significantly greater than 1, and the proportion of power energy consumption in the secondary industry continues to rise.

The Guo Ying [7] study confirmed that the positive correlation between industrial electricity consumption and economic growth in Zhejiang Province, and the elasticity coefficient of industrial electricity consumption to economic growth is 1.55.

By establishing a regression analysis model between electricity consumption and economic growth, He Yonggui [8] measured every 1% increase in China's electricity consumption, and the GDP also increased by 1%.

The quantitative analysis of the relationship between Chinese electricity consumption and economic growth conducted by scholars at home and abroad has laid a foundation for us to use electric power big data technology for macroeconomic analysis and macroeconomic prediction.

However, there are many disputes about the role of power elasticity coefficient and whether academia can truly reflect the relationship between economic development and power consumption. Power elastic coefficient is the comprehensive result of the mutual promotion and restriction of various social factors and economic factors, and the development of power elastic coefficient is a complex dynamic process.

3. Using cointegration analysis and causality test to study the long-term relationship between power consumption and economic development

Of all the unconventional macroeconomic statistics, the most important concern for scholars at home and abroad is the relationship between electricity consumption and economic growth (GDP). At present, academic studies have preliminarily confirmed that there is a long-term equilibrium relationship (coconsolidation relationship) and a short-term causal relationship between electricity consumption, especially industrial electricity consumption and economic growth (GDP). However, due to the different selected data objects and the different methods used, the parties have different views on the directionality of the causal relationship between electricity consumption and economic growth (GDP) in the short term.

For example, Asafu-Adjaye[9] studied the correlation between power consumption and economic development based on the data from more than 100 countries, and concluded that there is a strong correlation between power consumption and economic development, and developed countries have a stronger correlation between power consumption and economic development than backward countries. Among them, the correlation between Chinese power consumption and economic development is very high, and explains this correlation as the role of industrialization. However, the strong correlation between power consumption and economic growth is not a "causal relationship". The relationship between power consumption and economic development may be that power consumption promotes economic growth, or that economic development drives power consumption, which needs to be further studied.

Since the relationship between electricity and economic development is unstable in the short term, electricity development plans should be formulated on the long-term relationship between GDP and electricity demand to avoid excessive lead or shortage and minimize impact.

In recent years, due to the non-stationary characteristics of the actual power economic time series, the non-stationary series theory has become the main method to study the long-term relationship between power and economy.

In the framework of production three-factor function, [10] studied the relationship between power consumption and economic growth in 1952 by co-

consolidation analysis and error correction model technology in 2001. The empirical results show that Chinese power consumption is endogenous with economic growth, and that the two variables are interrelated. In terms of time, power is ahead of the overall economy, electricity consumption is the Granger in of economic growth, but short-term economic growth is not the Granger in in of electricity consumption. The study believes that in the short term, China's "economy development, power first" development strategy is still effective while the market mechanism is still unsound. Proper "go" first can avoid economic losses from periodic power shortages.

Yuan Jiahai, Ding Wei, Hu Zhaoguang [11] using coconsolidation theory to study the relationship between 1978-2003 China's power consumption and economic growth, verify the long-term relationship between power consumption and GDP growth, in the short term there is a one-way ranger from power consumption to G D P growth, but there is no ranger from economic growth to power consumption, industrial output and coconsolidation relationship between industrial power inspection strongly supports the conclusion. We analyze the reasons of the above conclusions from a deep perspective, that is, China is experiencing the industrialization process of economic development. From 1978-2003, the proportion of industrial output value in GDP has been steadily rising, and industrial electricity consumption accounted for 70% -80% of the whole social electricity consumption. Industrial output accounts for a large proportion of the national economy, meaning that the growth of industrial electricity consumption leads to the growth of industrial output, thus leading to the growth of GDP. This shows that the growth of power consumption increases China's income level through the growth of industrial electricity consumption; otherwise, the insufficient power supply will affect the growth of industrial output, and thus inhibit the growth of income level. On the other hand, the growth of industrial electricity consumption is affected not only by the growth of industrial output, but also by the industrial structure, electrification level, energy efficiency and other factors, so there is no short-term Granger cause from GDP to power consumption.

He Yongxiu using Granger causality and error correction model of 10 major industrial sector power consumption and the two-way causal relationship between GDP is analyzed, the results show that the GDP growth will significantly pull ferrous metal smelting, non-ferrous metal smelting, textile industry, paper and paper products, machinery, electrical and electronic manufacturing equipment industries such as the increase of electricity consumption. But the increase in electricity consumption in different industries is not equally related to GDP.

When conducting the research on economic growth and power consumption, Chen Han Li selected 1949 to 2004 as the study scope. Through the interval data analysis, on the basis of the Granger, they analyzed the relationship between the two, and concluded that economic growth has a greater effect on power consumption.

On power consumption and economic growth causality between a large number of literature research conclusion contradictory, the main reason is: research methods, most domestic scholars use is a pure time series data, application of ADF, PP unit root inspection traditional methods, these methods have been more and more criticism in recent years, however, the reason is that their "potential" is too low, the test results lack of robustness, especially considering the economic data span is short, the problem is more prominent.

Some scholars have put forward the unit root test and co-integration test method of panel data to study the relationship between power consumption and economic growth in China.

Jiang Lei and Wu Yuming used panel data to carry out unit root inspection, co-integration inspection and Granger causality test. While considering the relationship between national power consumption and economic growth, the country was also divided into eastern, central and western regions. It is found that China's power consumption and economic growth are in a stable equilibrium state, and the relationship is mutually causal, but the lag period is unstable. In the eastern region, there is neither cooperation nor causality; in the central and western regions, both have a long-term cooperation relationship, the central power consumption is the cause of economic growth, while in the west.

Luo hanwu used annual data from Henan province to prove that there is a stable long-term equilibrium relationship between social electricity consumption and economic growth, and he found that there is a short-term one-way Granger relationship from social electricity consumption to economic growth.

Li qiang using provincial panel data from 1990 to 2011, based on the production function of neoclassical, using by the cointegration inspection and vector error correction model of multiple analysis framework, the east and west China causality between economic growth and power consumption was studied, the results show that the relationship between the east and west, and overall convergence.

Zhou Shaojie also use the provincial panel data 1990-2011, but based on growth regression model, the dynamic panel analysis method, with power investment rate and power generation capacity as a measure of power development, test the influence of power development on economic growth and the impact between regional differences, empirical found that power development has a significant positive impact on economic growth, and its long-term impact is significantly higher than short-term impact, the influence of electric power development on economic growth has significant regional differences, the economic growth of the eastern region is significantly higher than the western region.

4. Using the cycle theory to study the short-term relationship between electric power and economic development consumption and economic development

In addition to the long-term stable relationship between electricity and economic development, the short-term fluctuation relationship is also worthy of attention. In addition, the relationship between short-term fluctuations can be essentially attributed to the relationship between cyclical items, and short-term fluctuations have an important impact on the long-term supply and demand relationship of power. In different stages of economic development, the economic cycle fluctuation and power cycle fluctuation have different characteristics; when the economy spans different stages of development, the long-term relationship cannot meet the actual needs.

Under the condition of market economy, if the power system cannot accurately grasp the profound causes of the fluctuation of the power cycle and the relationship between the power cycle and the macroeconomic cycle, it will bring negative impact to the power planning work and cannot meet the power demand of the national economy.

Power boom analysis is based on the related analysis of statistics, combined with economic, finance, industry, foreign trade and other areas of mature methods, complete boom analysis into the electric power industry, through the establishment of power boom index reflects the contradiction between supply and demand, for power planning, construction, production and management of macroeconomic regulation and scientific decision-making to provide important basic information, and provide quantitative indicators for economic operation.

So far, there have been few studies to systematically study the link between China's power and short-term economic fluctuations. However, a small number of scholars have studied the cycle fluctuation of power demand in China.

Liang Yali analyzed the characteristics of the fluctuation of the power demand cycle in the whole society and in different industries; Yang Shuxia uses the structural time series model and spectral analysis method to measure the power demand cycle in China, Relevant analysis and cluster analysis of the regional power demand cycle in China, And measured the turning point of China's power demand cycle; Based on the maximum entropy estimation method, Zhang Yu et al. made a preliminary study and discussion on the periodic interaction relationship between urban power and economy, It is concluded that there is a long-term equilibrium relationship between electricity consumption and economic growth in the typical cities in China, Urban economy and electricity consumption both show the characteristics of "long-wave transformation"; They found that, There are certain differences in the economic cycle and the electricity consumption cycle of the typical cities, The GDP in some cities is ahead of electricity consumption, Other cities are ahead of GDP in electricity consumption, They believe that power load

forecasting and urban planning should consider the periodic fluctuation relationship between economy and electricity consumption.

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Reference

1. Yang Mingyong. Analysis of power consumption in Central and East China [J]. Quantitative economic and economic research, 1991 (07): 66-70.
2. Hao Weiping, Li Qionghui, Zhao Yinong. Practical significance of the electric power elasticity coefficient in China [J]. China Electric Power, 2003, 36 (5).
3. Lin Boqiang, Yang Fang. The Influence of the Electric Power Industry on the Sustainable Economic Development of China [J]. The World Economy, 2009 (7): 3-13.
4. Mao Jibing, Hua Ruxing. Evolution of Power Consumption in Urbanization [J]. China Electric Power, 2004, 37 (9): 8-8.
5. Wu Xinjiang. The Electricity Consumption and the Economic Cycle [J]. China Energy, 2009 (4): 26-32.
6. is more. Elasticity coefficient of industrialization and power consumption in China [J]. Production Review, 2011 (1): 22-32.
7. Guo Ying. Regional Difference Analysis of Zhejiang Economic Growth Driving Forces -- based on panel data of 11 cities in Zhejiang [J]. The Theory of Finance and Economics (Journal of Zhejiang University of Finance and Economics), 2010, V150(2): 19-23.
8. He Yonggui. The intrinsic relationship between the power industry and national economic growth [J]. Statistics and Decision Making, 2004 (10): 97-97.
9. Asafu-Adjaye, J. The relationship between electricity consumption, electricity prices and economic growth: time series evidence from developing countries [J]. Energy Economics, 2000, 22: 615-625
10. Lin Boqiang, Moudun State. The impact of energy prices on the macroeconomic -- is based on a computable General Equilibrium (CGE) analysis [J]. Economic Research, 2008 (11): 88-101.
11. Yuan Jiahai, Ding Wei, Hu Zhaoguang. Analysis of coconsolidation and fluctuation of power consumption and China's economic development [J]. Power Grid Technology, 2006, 30 (9): 9-14