Research on the Influencing Factors of Power Demand in China

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Abstract. Based on the data from 2003 to 2017 of China, this paper analyzes the influencing factors of power demand in China. The results show that the improvement of economic development and the growth of the economic contribution rate of the secondary industry both lead to the increase of electricity demand. The improvement of urbanization level and the reduction of unemployment rate are also important factors driving the electricity demand. While the price of electricity has little impact on the demand, which can be accredited to the electricity price policy of China. Electricity price is mainly regulated rather than fluctuating with the supply and demand of the market, thus it is relatively stable. The conclusions of this research can be used to guide the planning and management of power companies, which is of great significance for them to accurately predict electricity consumption, scientifically plan power grid projects, and further improve investment efficiency.

1. Introduction
The power industry is the fundamental industry of the national economy. Adequate electricity generation and supply is necessary for the steady development of economy, the improvement of living standards and the overall progress of the society. On the contrary, insufficient power supply hinders the development of national economy. The analysis of the influencing factors of power demand is beneficial for accurately predicting the trend of power demand in the future, and is of theoretical and practical significance for scientific power industry planning and management.

So far, both domestic and foreign scholars have carried out a lot of research on the influencing factors of power consumption. Kraft (1978) used the Granger causality test to study the relationship between GNP and electricity consumption in the United States and found a one-way causal relationship between them [1]. An empirical analysis of economic output and electricity consumption in the United States by Thoma (2004) also found that economic growth leads to changes in electricity demand [2]. Steenhof PA and Fulton W (2007) have shown that factors affecting electricity demand of China include economic growth, economic structure, energy efficiency, urbanization, changes of per capita income, electricity supply, and so on [3]. Lin Boqiang used co-integration analysis, error correction model and Granger causality test to study the relationship between electricity demand and economic growth in China. It is found that the power demand and economic growth are endogenous and mutually causal. Wu Yuming (2009) used the cross-sectional data of China's provincial power demand in 2004 to analyze the mechanism of the economic, population, electricity price and the proportion of the secondary industry affecting regional electricity demand [4]. Chen Wenjing (2009) studied the influencing factors of China's power demand based on semi-parametric model and non-parametric model. He found that economic growth, economic structure and population are important
factors affecting power demand, while the electricity price index has little impact on electricity demand [5]. Through correlation analysis, Wang Xiaohua et al. (2010) found that there is a strong correlation between per capita electricity demand and per capita income [6]. Xie Pinjie et al. (2014) used the ARDL-ECM model and the Granger causality test to analyze the dynamic relationship between power demand, economic growth and urbanization levels in Shanghai. They found a one-way causal relationship between economic growth and electricity demand and a two-way causal relationship between urbanization and power demand in the short term, while the relationship doesn’t not hold in the long term [7].

Generally speaking, the current research on the influencing factors of power demand has not reached a unified conclusion. This paper uses the national data from 2003 to 2017 as a sample to analyze the factors affecting power demand, which we believe can support power companies to make better decisions.

2. Theoretical analysis of factors affecting power demand

The power industry is an important pillar for economic and social development. The power industry is a public service industry that provides safe and reliable power for economic and social development. Electricity demand and consumption are affected not only by economic development, but also by factors such as social development, people’s living standards and energy policy. Therefore, the factors affecting power demand are classified into three categories: macroeconomic factors, social development factors, and energy policy factors.

2.1. Macroeconomic factors

Macroeconomic factors constitute the socio-economic situation of electricity supply and consumption, reflecting regional income levels and economic levels. Electricity is the fundamental resource for the development of the national economy, thus macroeconomic factors have a direct impact on electricity demand. With high level of economic development, high efficiency of economic operation and growth trend, power demand usually increases accordingly to meet the need of economic growth. From the perspective of economic structure, since industrial power consumption has always been a major part of power consumption, the acceleration of industrialization will also lead to a substantial increase of power consumption. As China is currently experiencing rapid developing, industrialization has a strong impact on power consumption. Therefore, we make the following assumptions:

Hypothesis 1.1: The higher the level of economic development, the greater the demand for electricity.

Hypothesis 1.2: The higher the degree of industrialization, the greater the demand for electricity.

2.2. Social development factors

With the development of society and the progress of human civilization, people's income has gradually increased, and the material and cultural living standards have also been improved. People are more willing to consume clean and convenient energy, such as electricity. The demand for high-power household appliances, such as air conditioners, electric heaters and microwaves is also increased. At the same time, emerging electrical equipment such as electric vehicles are increasingly being adopted, bringing comfortable life to human beings in multiple ways. In rural areas, residents use less traditional non-commercial energy sources such as fuelwood and straw, and increase the use of commercial energy, especially electricity. Moreover, in recent years, China's urbanization has been accelerated. On one hand, urbanization process drives the demand for electricity, which is the infrastructure for development. On the other hand, urbanization creates more jobs and improves income, incentivizing the consumption of electricity. Therefore, the following assumption is made:

Hypothesis 2.1: The higher the degree of urbanization, the lower the unemployment rate and the greater the demand for electricity.
2.3. Energy policy factors
Among the energy policy factors, the price policy has an obvious impact on electricity demand. Price is one of the key factors affecting demand and utilization. With the further deepening of electricity price reform, the impact of electricity price on electricity demand is growing. To some extent, the decline of electricity price will stimulate residents' electricity consumption, and will also affect the electricity consumption of some industrial users. At present, China's transmission and distribution price reform is implemented, and the price of electricity is being adjusted. The impact of electricity price on electricity demand will be more obvious, therefore the following assumption is made:

Hypothesis 3.1: The higher the electricity price, the lower the electricity demand.

3. Empirical analysis of factors affecting power demand

3.1. Data source and model construction
Firstly, appropriate indicators are chosen for dependent variables and influencing factors. Electricity demand is measured by the total amount of electricity consumption. In terms of macroeconomic factors, we adopt gross domestic product (GDP) and the economic contribution rate of the secondary industry as proxies for the level of economic development and the economic structure, respectively. The level of urbanization, a social development factor, is represented by the unemployment rate. Electricity price, an energy policy factor is measured by the average price of electricity. Data from 2003 to 2017 of China is utilized as a sample in this research, which is collected from the National Bureau of Statistics and related research reports.

| Dimensions                  | Variables            | Indexes               | Symbols |
|-----------------------------|----------------------|-----------------------|---------|
| Dependent Variable          | Electricity demand   | Electricity consumption | Y       |
| Macroeconomic factors       | The level of economic development | GDP | GDP |
| Macroeconomic factors       | Economic structure   | Contribution rate of the secondary industry to the economy | SIP |
| Social development factor   | Urbanization level   | Unemployment rate     | URB     |
| Energy policy factor        | Electricity price    | Average sales price   | PRI     |

To eliminate the heteroscedasticity and linearize the relationship between dependent variable and independent variables, we apply Cobb-Douglas production function to build the model, as shown following:

$$\ln Y = a_0 + a_1 \ln GDP + a_2 \ln SIP + a_3 \ln URB + a_4 \ln PRI + \varepsilon$$

3.2. Analysis of empirical results
Firstly, the descriptive trend analysis is presented in table 2. It shows that from 2003 to 2017, the economy of China grew rapidly, as GDP increasing from 13742 billion yuan to 82075 billion yuan. The degree of industrialization gradually increased, and the contribution rate of the secondary industry to GDP decreased from 57.9% to 35.7%. With the increase of urbanization rate, the development of urbanization accelerated, and the unemployment rate decreased from 4.3% to 3.9%. The average electricity price increased from 0.426 yuan/kWh to 0.646 yuan/kWh. For electricity demand, the electricity consumption of the whole society has progressively increased year by year, from 1889 billion kWh to 6308 billion kWh.
Secondly, regression analysis is conducted. A multivariate regression analysis method is used to perform regression analysis on the model by ordinary least squares method and the results are shown in Table 3. The adjusted R-squared of the model is 0.997, meaning the fitness of the model is over 90%. In terms of the coefficients, GDP and contribution of secondary industry are positively related with electricity consumption, and are significant under significance level of both 0.001 and 0.05. Therefore, Hypothesis 1.1 and 1.2 can be accepted, meaning economic growth and economic structural changes are the main factors for the growth of electricity consumption. Economic growth has driven the growth of national electricity consumption, especially that of the secondary industry. There is a negative correlation between unemployment rate and power consumption, and is significant at the 0.05 level. Thus hypothesis 2.1 can be accepted, indicating the impact of urbanization on electricity consumption. The acceleration of urbanization leads to the improvement of people's living standards and the growth of electricity consumption. The regression results reject hypothesis 3.1, showing that the impact of average electricity price on electricity consumption is not significant. This result can be explained by the fact that in China electricity price is mainly regulated rather than determined by market, hence the price doesn't fluctuate with the demand.

### Table 3. Results of Ordinary Least Squares Regression

|                | Coefficient | t    | P value |
|----------------|-------------|------|---------|
| Constant       | 3.186*      | 3.11 | 0.011   |
| GDP            | 0.631***    | 12.11| 0.000   |
| SIP            | 0.203*      | 2.68 | 0.023   |
| URB            | -1.020*     | -2.75| 0.021   |
| PRI            | 0.119       | 0.66 | 0.527   |
| Adjusted R-squared | 0.997    |      |         |

*** indicates significance at 0.001 level.
** indicates significance at 0.01 level.
* indicates significance at 0.05 level.

### 4. Conclusion
Based on the data from 2003 to 2017 of China, this paper analyzes the influencing factors of power demand in China. The results show that the improvement of economic development and the growth of the economic contribution rate of the secondary industry both lead to the increase of electricity demand. The improvement of urbanization level and the reduction of unemployment rate are also important factors driving the electricity demand. While the price of electricity has little impact on the demand, which can be accredited to the electricity price policy of China. Electricity price is mainly regulated rather than fluctuating with the supply and demand of the market, thus it is relatively stable. The conclusions of this research can be used to guide the planning and management of power companies, which is of great significance for them to accurately predict electricity consumption, scientifically plan power grid projects, and further improve investment efficiency.

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