Analysis of Sustainable Development and Electricity Relation in Suqian

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Abstract. In this paper, the static analysis has been carried out on the factors which affect the increase of electric power consumption in Suqian by constructing an error correction model; and the results show that the electric power consumption is affected obviously by the electricity output value, population, urbanization rate and GDP. Besides, from the aspect of dynamic influence, it has been found, with the VAR model built and pulse analysis, that the city GDP and population impact electric power positively and persistently.

1. Introduction

Energy consumption and environmental issues have become the focus of attention in the world today. As the main consumption energy, electric power is replaceable, clean, convenient, efficient, reproducible, and with no opportunity cost, which plays an important role in the economic and social development of many countries. Therefore, sufficient and reliable electric power supply has become a major macro problem which affects the stability of economic, and the analysis of influence factors on electricity consumption is an important research topic.

In recent years, many domestic scholars have conducted a lot of empirical researches on the factors that affect the electric power consumption in China. With co-integration analysis and error correction model, Lin Boqiang has studied the relationship between electricity consumption and economic growth in China by using the production function of capital stock, human capital and electricity consumption [1]. Ni Yuejiang has adopted Granger causality test to analyze the relationship between electricity consumption and GDP in China from 1980 to 2011. The results indicate that electricity consumption and GDP appear to be a one-way causation, that is, the growth of economic follows the growth of electricity consumption, and economic development will be hindered by the shortage of electricity supply [2]. Based on the semi-parametric model and non-parametric model, Chen Wenjing has studied the influence factors of electric power consumption in China, which shows that the economic growth, economic structure and population are important factors that affect the electricity consumption, and the index number of electricity price has a little impact on electricity consumption demand [3]. Zhao Xiaoli has analyzed the influence of the change of industrial structure on the electricity demand in our country, that is, the adjustment of industrial structure, especially the secondary industry, has a large impact on the electricity demand in our country [4]. Fan Yong has pointed out that the macro economic situation, living standard of residents, electricity prices and economic structure are the main factors affecting the demand for electricity in China, based on which, the co-integration analysis and error correction model are used to build long-term equilibrium model and short-term error model for electric power and

economy, and to analyze the demand situation of electricity in China in the future [5]. To sum up, domestic scholars mainly study the influence factors of electricity consumption from the aspects of economic growth, economic structure, population, urbanization, electricity price, energy efficiency and income levels of residents.

According to the actual situation of electricity development in Suqian city, this paper has built an error correction model to take static analysis on the increase of electricity consumption in Suqian city in local GDP, population, industrial structure, urbanization, electricity output value and elasticity coefficient of electricity consumption. And, with the VAR model built, the impulse response function and variance decomposition, the dynamical identification is adopted on the influence of the factor changes on electricity consumption, so to conclude policy suggestions for the electricity development in Suqian city.

2. Static Analysis of Influence Factors on Electricity Consumption in Suqian

In this part, the error correction model is constructed for the static analysis of influence factors on the electricity consumption in Suqian.

2.1. Identification of influence factors on electricity consumption in Suqian

In the process of practical analysis, the following variables are taken as the main factors affecting the electricity consumption(Y) in Suqian through preliminary calculation: GDP (G), population (P), industrial structure (S), urbanization (UR), electricity output value (PE) and elasticity coefficient of electricity consumption (CE). The proportion of product value from the secondary industry is selected to measure industrial structure, the proportion of the non-agricultural population to the total population is used to measure urbanization, and the elastic coefficient of electricity consumption is calculated by the growth speed of output value and the growth speed of electricity consumption.

Because the data used are time series data, it is necessary to check its stability. The unit root test is carried on the first order difference of the above 7 groups of data sequences, which shows that the original hypothesis is rejected with significant level 5%, that is, the original data are all integrated of order. Then, the long-term equilibrium equation is established by using Eviews to generate the following model structure formula (1):

$$\begin{aligned} Y = &-142.2166 + 0.0524G + 0.4900P - 0.8205S + 0.3949UR \\ &- 5.8610PE - 1.74001CE \end{aligned} \tag{1}$$

With the long term equilibrium equation, four significant factors that affect the electricity consumption of the city are identified, which are GDP(G), population(P), urbanization (UR) and electricity output value(PE) respectively. Herein, the electricity output value has a significant negative impact on electricity consumption, and the increase of GDP, population and urbanization rate has a significant effect on the growth of electricity consumption.

2.2. Error correction model of electricity consumption in Suqian

Considering the lag effect of the above factors on electricity consumption, Spurious Regression of short-term imbalance may occur. In order to alleviate the short-term imbalance and enhance the accuracy of the model, the error term of co-integration regression is taken as the equilibrium error. And then the error correction model [6] is established, and the structure of the model is shown in formula (2).

$$\begin{aligned} \Delta Y_t = &-4.1926 + 0.0608\Delta G_t + 0.9141\Delta P_t - 0.1235\Delta S_t + 0.4976\Delta UR_t \\ &-4.3620\Delta PE_t + 0.5642\Delta CE_t - 0.8747(Y_{t-1} + 142.2166 - 0.0524G_{t-1} \\ &-0.4900P_{t-1} + 0.8205S_{t-1} - 0.3949UR_{t-1} + 5.8610PE_{t-1} + 1.7440CE_{t-1}) \end{aligned} \tag{2}$$

The result estimated by the error correction model in formula (2) shows that the order for the influence degree of the four factors on electricity consumption is: electricity output value > population > urbanization rate > GDP, in which local GDP (G), population (P) and urbanization rate (UR) have a significant effect on positive growth of electricity consumption, while electricity output value (PE) has a significant effect on the negative growth of electricity consumption. And the proportion of the second industry and the elasticity of electricity consumption have a less obvious impact on the electricity consumption in the two models. That's because these two variables are sensitive to industrial policy guidance and the data capacity is insufficient, which leads to a non-significant impact on electricity consumption. Four main influence factors and the degree of influence are shown in Table 1.

Table 1. Factors and coefficients of static influence on electricity consumption

	GDP	Population	Urbanization rate	Electricity output value
Long-term impact coefficient	0.0524	0.4900	0.3949	-5.8610
Short-term impact coefficient	0.0608	0.9141	0.4976	-4.3620

The results of table 1 show that, by considering the long-term and short-term effects comprehensively, the degree of static influence of four factors on electricity consumption is: electricity output value > population > urbanization rate > GDP. In the past 20 years, the total output value, population and urbanization rate of the whole city have been keeping climbing, and the demand of industrial and residential electricity has also increased, which promotes the continuing growth of electricity consumption. While, the increase of electricity output value means the improvement of production efficiency and power consumption efficiency, which greatly induces the growth of electricity consumption. And it has the greatest influence on the electricity consumption of the whole society. In addition, there exists dilution effect on the long-term effect of GDP, population and urbanization rate, and its influence coefficient is weaker than that of short-term influence coefficient. However, the absolute value of the long-term influence coefficient of electricity output value is bigger than that of the short-term influence coefficient, which indicates that the electricity consuming efficiency brought by the development of production equipment and the promotion of power-saving technology is increased, and the electricity output value has a significant effect on the reduction of electricity consumption. So, it is necessary for electric power companies to trace the development of energy-saving technology and the changes of industrial structure in the whole city, and to adjust the operation and management strategy in time.

3. Dynamic Identification of Influence Factors on Electricity Consumption in Suqian

In this part, the data of GDP, population, industrial structure, urbanization rate, electricity output value and elasticity coefficient of electric power consumption of the whole city from 1996 to 2017 are selected as the relevant factors that affect the change of electricity consumption, and the VAR (Vector auto regressive) model is established. Furthermore, the impulse response function and variance decomposition technique are used to dynamically identify the influence of the change of related factors on electricity consumption.

3.1. VAR model of influence factors on electricity consumption

In order to study the dynamic influence of GDP (G), population (P), industrial structure (S), urbanization (UR), electricity output value (PE) and elasticity coefficient of electricity consumption (CE) on the electricity consumption in Suqian city, several trials calculation are conducted. Four endogenous variables, that is, GDP (G), population (P), industrial structure (S) and urbanization (UR) are selected and treated for lag process of period 2, and the electricity output value (PE) and elasticity coefficient of

electricity consumption (CE) are fixed as exogenous variables. Thus, the VAR (2) model with seven variables is established as below [7]:

Equation 1 of electricity consumption(Y):

$$\begin{aligned} Y = {} & C(1,1)*Y(-1)+C(1,2)*Y(-2)+C(1,3)*G(-1)+C(1,4)*G(-2)+C(1,5)*P(-1)+ \\ & C(1,6)*P(-2)+C(1,7)*S(-1)+C(1,8)*S(-2)+C(1,9)*UR(-1)+C(1,10)*UR(-2)+ \\ & C(1,11)+C(1,12)*PE+C(1,13)*CE \end{aligned} \quad (3)$$

The equations of G, P, S and UR are the similar.

The estimation results of the above VAR (2) model are calculated by Eviews. Then, the Granger causality test is conducted on endogenous variables on the basis of the estimated results, which shows that the original hypothesis is rejected with significant level 5%, that is, four endogenous variables (G/P/S/UR) have a significant dynamic impact on electricity consumption in the sense of Granger, and the economic system constructed has certain practical significance.

The VAR (2) model with seven variables shows that GDP (G), electricity consumption variable (Y) and industrial structure variable (S) of the whole city in lag period 1 have a significant effect on the current electrical power consumption, and the population variable (P) and urbanization rate variable (UR) in lag period 2 also have significant influence on the current electricity consumption. The increase and decrease of the variables meet the criteria of AIC and SC, and the combined interpretation degree of all endogenous variables on electricity consumption reaches 99.8%. On this basis, the dynamic effect of each interpretive variable on the electricity consumption in Suqian can be further identified.

3.2. Impulse response of influence factors on electricity consumption

Based on the VAR model constructed in the last section, this section analyzes the dynamic effect on the whole electrical power consumption system when an influence factor is shocked. The pulse response function diagram of power consumption in the whole city is obtained by the use of generalized pulse method [7]. In the following figures, the horizontal axis represents the lag period (year) caused by shock, the vertical axis refers the response of electricity consumption on the corresponding factors (billion kilowatt hours), the solid line means the impulse response function, and the dashed line is the deviation zone of positive or negative double standard deviation.

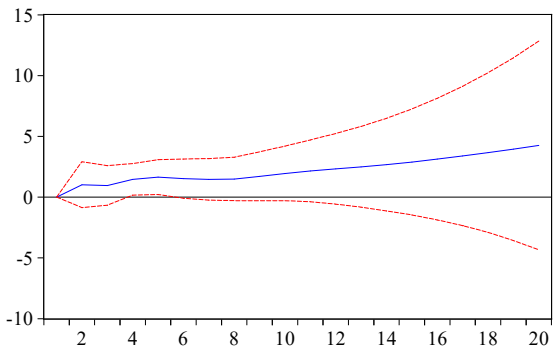

Figure 1. Response function of electricity consumption to GDP shock

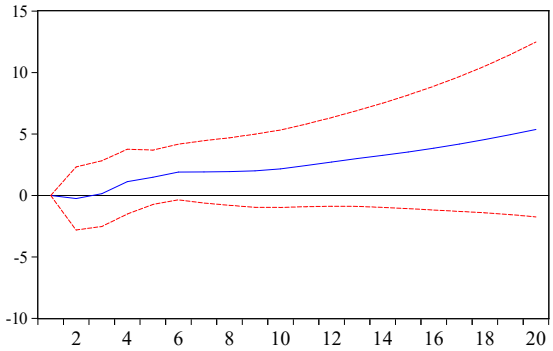

Figure 2. Response function of power consumption to population shock

It can be seen from the response of electricity consumption to GDP shock, as shown in figure 1, that when GDP is given positive shock in the current period, electricity consumption will climb slightly in the first five periods and reach the highest point in period 6 with the response value θ (6) = 1.6; then, the shock on electricity consumption increases steadily after period 8, which reflects that GDP has a significant promoting effect and a strong sustained effect on electricity consumption.

It can be seen from the response of electricity consumption to the population shock, as shown in figure 2, that when population is given positive shock in the current period, electricity consumption will climb slightly in the first six periods and reach the highest point in period 7 with the response value θ (7) = 1.9; then, the shock of population on electricity consumption increases steadily, which reflects that It shows that the positive shock of population will bring positive shock on electric power consumption, that is, the increase of population in Suqian has a stable pulling effect on electricity consumption.

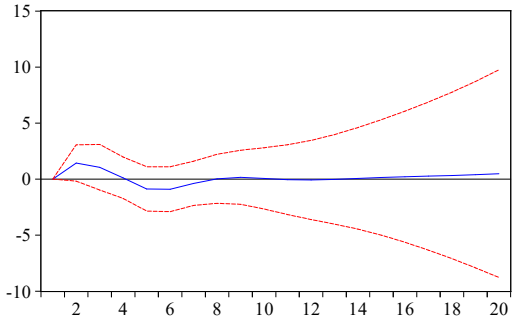

Figure 3. Response function of power consumption to industrial structure shock

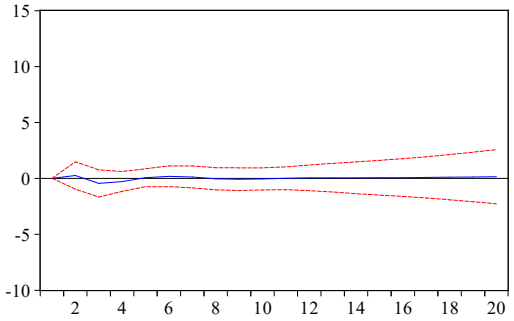

Figure 4. Response function of power consumption to urbanization shock

From the response of electricity consumption to the shock of industrial structure (measured by the proportion of the output value of the secondary industry) and urbanization, as shown in figures 3 and 4, it can be seen that when the population and urbanization are given a positive shock in the current period, their dynamic impact on electricity consumption is basically similar, which acts in sine wave in the first seven periods, reaches the highest point in the seventh period, and starts to attenuate after the ninth period. The difference is that the short-term shock of industrial structure on electricity consumption is greater than that of urbanization. The highest point θ (2) of short-term shock of industrial structure is 1.4, while the highest point θ (2) of short-term shock of urbanization is θ (2) = 0.3. The industrial structure and urbanization promote the electricity consumption to some extent in short term, and they have a limited contribution to the growth of electric power consumption.

In conclusion, the positive impact of GDP and population in the whole city will have a positive impact on the electricity consumption, and it will have a long-term sustainable promotion impact on electricity consumption. Therefore, power companies should make long-term planning. Besides, the short-term and long-term effects of industrial structure and urbanization rate on electricity consumption are relatively limited.

3.3. Variance decomposition of influence factors on electricity consumption

Based on the analysis of the dynamic impulse response of electricity consumption described in the last section, this section calculates the relative contribution degree (RVC) of the shock variance of a variable to the variance of electricity consumption based on the basic idea of variance decomposition, and quantitatively discusses the influence degree of various factors on electricity consumption.

In this section, four endogenous variables, that is, GDP (G), population (P), industrial structure (S) and urbanization rate (UR) are selected and treated in lag period 2. In addition, the electricity output value (PE) and the elasticity coefficient of electricity consumption (CE) is fixed as exogenous variables, and the four endogenous variables are decomposed by variance, as shown in figure 5, 6, 7 and 8. In the figures, the horizontal axis represents the number of lag period (year) and the vertical axis represents the contribution of this factor to electricity consumption (RVC, %).

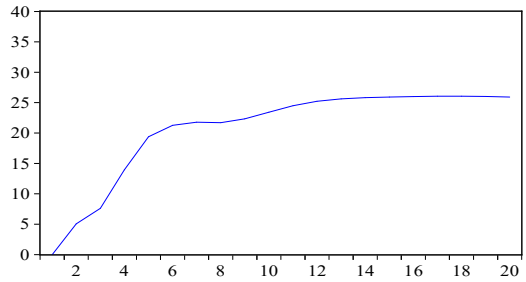

Figure 5. Contribution rate of GDP shock to power consumption

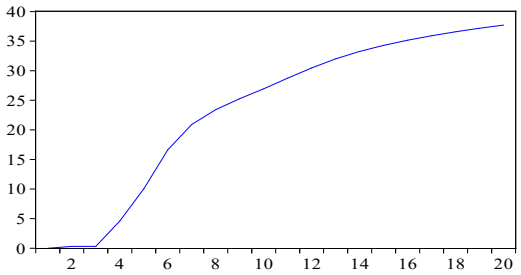

Figure 6. Contribution rate of population shocks to electricity consumption

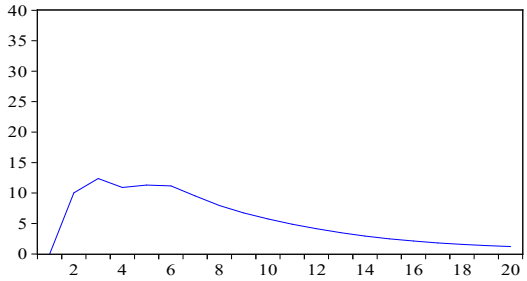

Figure 7. Contribution rate of industrial structure impact to power consumption

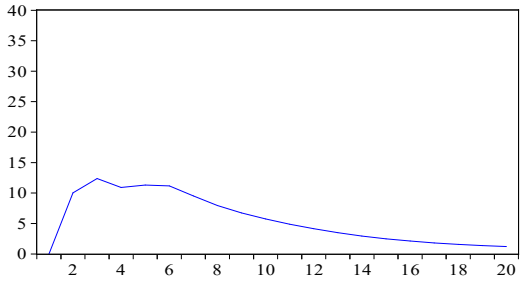

Figure 8. Contribution rate of urbanization shock to power consumption

It can be seen from the above four figures that the effect of population shock on electricity consumption is the biggest, the contribution rate is up to RVC (20) = 38%, and the contribution rate tends to rise after period 20; the effect of GDP shock on electricity consumption occupies the second, and the contribution rate stays steadily at RVC (13) = 26% after period 13; the effect of the industrial structure shock measured by the proportion of the secondary industry gradually attenuates after reaching the peak value in the period 3-7, and the highest contribution rate is RVC (3) = 12%, which indicates that the secondary industry that is dominated by industry, is gradually developing into energy saving and electricity saving type in long term, and the electricity demand continues to attenuate; and the effect of urbanization on electricity consumption is the smallest, however, it keeps climbing in years and reaches RVC(12) = 3% after period 12, which indicates that the positive effect of urbanization on electricity consumption is not obvious in short terms and will appear significant in long terms.

4. Conclusion

In this paper, the static/dynamic identification of influencing factors on electric power consumption in Suqian shows that the city GDP and population impact the electric power consumption positively and persistently; while, industrial structure and urbanization rate have a limited impact on the power consumption, no matter in short-term or long-term. The order for the contribution rate of the above factors on electric power consumption is: population > GDP > industrial structure > urbanization, wherein, the effect of population and GDP on electric power consumption will be strengthened with time. In the short term, the increase of the secondary industry proportion has a great contribution to the consumption of electricity; But, with the promotion of power saving technology and the policy of Green Development, the effect of higher proportion of secondary industry cannot last in long term. Therefore, it will stimulate the long-term growth of electricity consumption by optimizing the industrial structure to promote the coordinated development of three industries. The company should keep track of related industrial policies and economic indicators, and adjust the short-term and long-term power supply plans flexibly.

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