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Analysis of the influencing factors of energy consumption growth and the prediction of total energy consumption in Anhui province based on multiple regression

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ABSTRACT. *In order to further seek strategies and ways to reduce energy consumption in Anhui Province, the economic factor statistics of energy consumption data and six related indicators in Anhui province from 2000 to 2018 were collected for empirical analysis. Eviews software was then used to conduct multiple regression analysis and econometrics test, so as to find out the main factors affecting the energy consumption in Anhui Province. The GM (1,1) prediction method was used to predict the total energy consumption of Anhui province from 2020 to 2022.Finally, combining with the above analysis, this paper puts forward specific Suggestions and measures on how to improve the energy utilization efficiency and transform the production structure in Anhui province, aiming at balancing the production and consumption of energy in Anhui province.*

KEYWORDS: *Energy consumption, Parameter estimation, Main factors, Suggested measures*

1. Introduction and research review

Energy problem can be used as an important indicator to measure the economic development of a region, and also an important factor to consider the social development of a region. In recent years, the energy industry in Anhui province develops rapidly, but the total energy consumption also increases year by year, and even the supply is less than the demand. Therefore, it is urgent to further explore the main factors that influence the growth of energy consumption in Anhui province, so as to alleviate the problem of low energy consumption efficiency.

Through reading a large number of references, it is found that some previous scholars have also done corresponding research on the influencing factors of energy consumption. Wang Changjian, Du Hongru et al. used system analysis and dynamic econometric model to conduct empirical analysis on the relationship between energy consumption, economic growth and other factors in Xinjiang[1].Chen Yuanfeng studied the internal relationship between coal consumption and economic growth in Jiangsu Province, and on this basis put forward Suggestions on how to deal with the

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coordinated development of coal consumption and economy in the later period of Jiangsu Province[2].Lin Jingwei mainly discussed the relationship between China's energy consumption, economic growth and industrial structure, and drew the conclusion that the energy consumption elasticity of the secondary industry was the largest[3].Li Weijie, on the other hand, used econometric tools to build relevant models and made an in-depth analysis of the equilibrium relationship between China's economic growth and the consumption of oil, coal, natural gas and other energy resources. Finally, based on this, he made a judgment on the relationship between China's economic growth and energy consumption and gave relevant Suggestions[4].

But can be seen from the above documents we roughly, the research of the relationship between energy consumption and economic growth is more, but the study of a single specific area in the research of the main factors influencing energy consumption growth literature is less, so this article choose energy consumption in Anhui province as the research object, using the multivariate linear regression analysis to explore the main influence factors of energy consumption growth, and adopt the method of grey prediction to the total energy consumption from 2020 to 2022, Anhui province is forecasted, in order to further seek the ways and methods to improve the efficiency of energy consumption.

2. Empirical analysis on influencing factors of energy consumption growth in Anhui Province

2.1 Index selection

Energy is an important support for economic development, but also an important guarantee for economic development. An area energy consumption is affected by many factors, research the main influencing factors of energy consumption growth, the hypothesis is interpreted variable Y is the total energy consumption in Anhui province (Ten thousand tons of standard coal), X_1 GDP in Anhui province (One hundred million yuan), X_2 Anhui provincial government spending (One hundred million yuan), X_3 urban residents disposable income (Yuan), X_4 industrial added value (One hundred million yuan), X_5 import and export amount (Ten thousand of dollars), X_6 amount of energy available for consumption (Ten thousand tons of standard coal) as the explained variable, the remaining factors will be included in the randomized μ_i.

2.2 Data processing

The original data were obtained by sorting out the Statistical Yearbook of Anhui Province and EPS database from 2000 to 2019.

ISSN 2616-5902 Vol. 2, Issue 6: 120-127, DOI: 10.25236/AJBM.2020.020614

2.3 Model setting

A correlation coefficient matrix is made for the original data to check whether there is a correlation between various influencing factors. The results show that the correlation coefficient between each influencing factor is greater than 0.95. In order to reduce or avoid the impact of multi-slave collinearity on the model, a double-logarithm model is set up:

$$Y_i = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + \mu_i$$

2.4 Estimation and adjustment of models

Eviews9.0 was used for regression analysis of the model, and the model estimation results were obtained as follows:

$$ln\hat{Y} = 5.8106 - 0.0828 lnX_1 + 0.0933 lnX_2 + 0.3421 lnX_3 + 0.1596 lnX_4 - 0.0291 lnX_5 - 0.0927 lnX_6$$

(0. 4630) (0. 1192) (0. 0732) (0. 1462) (0. 0762) (0. 0472) (0. 0604)

t=(12. 5504) (−0. 6946) (1. 2746) (2. 3392) (2. 0939) (−0. 6163) (−1. 5351)

R^2=0. 9989 $\overline{R^2}$=0. 9984 F=1901. 490

The model data showed that R^2 was 0.9989, the goodness of fit of the model was high, and the F statistic was 1901.490, with a significance level of α=0.05, and the F test was passed. The t values of $lnX_1, lnX_2, lnX_3, lnX_6$ are small and insignificant, and the coefficient symbols of lnX_1, lnX_5 and lnX_6 are contrary to expectations, so there may still be serious multicollinearity, which requires further econometric testing and adjustment of the model.

2.5 Econometric testing

2.5.1 Multicollinearity test

(i) Correlation coefficient test

According to the initial measurement results, there is still multicollinearity between the two-logarithm models, so the correlation coefficient matrix is made to test the model, and the correlation coefficient between each influencing factor is greater than 0.95.

(ii) Progressive regression

Since the correlation coefficient between each explanatory variable is still large, the model needs to be adjusted. In this paper, the stepwise regression method is adopted to eliminate the multicollinearity in the model. The available model is:

$$ln\hat{Y} = 5.3259 + 0.0996 lnX_2 + 0.2333 lnX_3 + 0.0934 lnX_4$$

ISSN 2616-5902 Vol. 2, Issue 6: 120-127, DOI: 10.25236/AJBM.2020.020614

(0.2866)(0.0531)(0.0557)(0.0323)

t= (18.5844)(1.8737)(4.1875)(2.8869)

R^2=0.9987 $\overline{R^2}$=0.9985 F=3943.761 D.W=1.265094

(iii) Economic significance test

It can be concluded from the model that the sign of each variable coefficient is positive, consistent with the expectation, and the value range conforms to the economic principle, and the test is passed.

(iv) Statistical test

The judgment coefficient R^2=0.9987, and the model has a good fitting degree. F=3943.761, given significance level of α=0.05, the result of model F test was passed. Given the significance level of α=0.1, the absolute value of t of each explanatory variable in the model is greater than the critical value, indicating that there is a strong linear relationship between the logarithm of explanatory variable and the logarithm of explained variable.

2.5.2 Heteroscedasticity test

The White test was carried out on the model, and the results were shown in Table 1. nR^2=7.274002 is obtained. Under the condition of α=0.05, the test proves that there is no heteroscedasticity in this model.

Table1 White test results

F-statistic	0.620331	Prob. F(9,9)	0.7560
Obs*R-squared	7.274002	Prob. Chi-Square(9)	0.6086

2.5.3 Autocorrelation test

Partial correlation coefficient test was carried out on the model, and the results were shown in Figure1, indicating that the model did not have high-order autocorrelation.

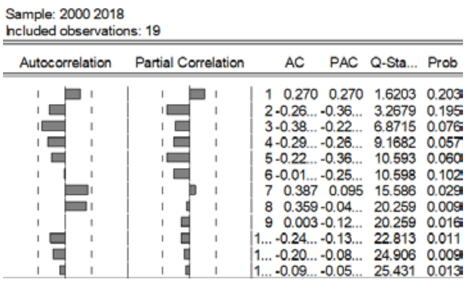

Fig.1 Partial correlation test results

ISSN 2616-5902 Vol. 2, Issue 6: 120-127, DOI: 10.25236/AJBM.2020.020614

2.5.4 Analysis of research results

After the above tests, the influencing factors of energy consumption growth in Anhui Province are determined as follows:

$$\ln\hat{Y} = 5.3259 + 0.0996 lnX_2 + 0.2333 lnX_3 + 0.0934 lnX_4$$

$$(0.2866)(0.0531)(0.0557)(0.0323)$$

$$t = (18.5844)(1.8737)(4.1875)(2.8869)$$

$$R^2=0.9987 \quad \overline{R^2}=0.9985 \quad F=3943.761 \quad D.W=1.265094$$

The model shows that if the fiscal expenditure of Anhui province increases by 1%, the energy consumption of Anhui province will increase by 0.0996% when other variables remain unchanged. For every 1% increase in urban disposable income, energy consumption will increase by 0.2333%. For every 1% increase in industrial added value, energy consumption will increase by 0.0934%.

3. Forecast of total energy consumption in Anhui province based on GM (1,1) model

3.1 Model assumptions

Prior to the establishment of GM (1,1) model, the following assumptions were made: the growth of energy consumption in Anhui province follows a certain rule, and the impact factor during the development period from 2020 to 2022 does not change much compared with the impact factor from 2000 to 2018, while other random factors have little influence.

3.2 Data processing and inspection

The time series data of total energy consumption in Anhui province from 2000 to 2018 were selected as the original series data. All data were obtained from The Statistical Yearbook of Anhui Province. $x^{(0)} = (x^{(0)}(1), x^{(0)}(2), \cdots, x^{(0)}(19))$ =(4878.82,5118.33,5315.97,5457.09,6016.89,6505.98,7069.39,7739.33,8325.40,8895.90,9414.00,10251.86,11015.00,11696.39,12011.02,12331.97,12694.96,13051.87,13228.91). Calculation level than and its scope is (0.90696, 0.98662), when n=7, level than in the capacity of coverage Θ = (0.90484, 1.09992), and can do a satisfactory GM (1, 1) prediction model.

3.3 Model construction

If I sum the original sequence $x^{(0)}$, then get:

$x^{(1)}$=(4878.82,9997.15,15313.12,20770.21,26787.1,33293.08,40362.47,48101.8, 56427.2,65323.1,74737.1,84988.96,96003.96,107700.35,119711.37,132043.34,1447

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38.3,157790.17,171019.08).By the least square method,$u=[a,b]^T$. With the help of Matlab software, a=-0.0569,b=5050.5575.Then get:

$$\frac{dx^{(1)}}{dt}-0.0569x^{(1)}=5050.5575$$

$$\hat{x}^{(1)}(k+1)=93633.4e^{0.0569047k}-88754.6$$

$$\hat{x}^{(0)}(k+1)=93633(e^{0.0569047k}-e^{0.0569047(k-1)})$$

3.4 Model inspection

To test the predicted values of the above models, the results of each test index are shown in Table 2.

Table2 GM (1,1) model verification

Number	Year	Original value	Predictive value	Residual	Relative error	Class ratio dispersion
1	2000	4878.82	4878.82	0	0	—
2	2001	5118.33	5482.70	-364.37	0.0712	-0.0090
3	2002	5315.97	5803.74	-487.77	0.0918	-0.0192
4	2003	5457.09	6143.58	-686.49	0.1258	-0.0312
5	2004	6016.89	6503.32	-486.43	0.0808	0.0399
6	2005	6505.98	6884.12	-378.14	0.0581	0.0210
7	2006	7069.39	7287.22	-217.83	0.0308	0.0258
8	2007	7739.33	7713.92	25.41	0.0033	0.0331
9	2008	8325.40	8165.61	159.79	0.0192	0.0159
10	2009	8895.90	8643.75	252.15	0.0283	0.0093
11	2010	9414.00	9149.88	264.12	0.0281	-0.0003
12	2011	10251.86	9685.65	566.21	0.0552	0.0279
13	2012	11015.00	10252.79	762.21	0.0692	0.0148
14	2013	11696.39	10853.15	843.24	0.0721	0.0031
15	2014	12011.02	11488.65	522.37	0.0435	-0.0308
16	2015	12331.97	12161.37	170.60	0.0138	-0.0310
17	2016	12694.96	12873.48	-178.52	0.0141	-0.0283
18	2017	13051.87	13627.28	-575.41	0.0441	-0.0296
19	2018	13228.91	14425.23	-1196.32	0.0904	-0.0444

According to the above table, from 2000 to 2018, $\varepsilon(k)<0.2$, meets the general prediction accuracy requirements; $\rho(k)<0.1$,the prediction accuracy is relatively high, so this model can be applied to the prediction.

3.5 Model prediction and result analysis

Therefore, this model is used to predict the total energy consumption of Anhui province from 2020 to 2022. When k=20,21,22, which is substituted into the model, and the results are respectively 161.6393 million tons of standard coal, 171.1041 million tons of standard coal and 181.123 million tons of standard coal, which will

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continue to grow at a rate of about 5.9% per year.

4. Conclusion

4.1 Article summary

In this article, through multiple regression analysis to determine the main factors affecting the impact of energy consumption in Anhui province, is mainly with fiscal expenditure, the disposable income of urban residents of Anhui provincial government, industrial added value and other factors, and GM (1, 1) prediction method is adopted to predict the total energy consumption from 2020 to 2022, Anhui province roughly balance at an annual rate of 5.9% growth. To further improve the energy efficiency of Anhui Province, the following Suggestions are put forward.

4.2 Suggestions

4.2.1 Develop projects for energy conservation operations and implement preferential policies for energy conservation investment

Anhui province needs to create a good development atmosphere to encourage the development of energy-saving operations. With the progress of science and technology and the development of economy, many traditional energy-intensive industries are about to be eliminated. At this time, it is the draught of the development of new energy industry. Colleges and universities should cooperate with relevant enterprises to train a large number of outstanding college students and technical personnel in line with market needs, and promote the research, development and implementation of related energy-saving products and projects. At the same time, the government's support and preferential policies for the energy conservation industry should also be put into practice, which needs to constantly improve and optimize the investment and financing environment for the development of supporting industries, and provide a good background for the development of the energy conservation industry.

4.2.2 Strengthening management of energy utilization and improving energy production efficiency

The macro management of the energy industry in Anhui province should also develop simultaneously, and the related work in the energy field should be carefully managed, so as to form a complete and efficient energy management system. In addition, considering the current development and future energy utilization in Anhui province, we should develop and utilize energy reasonably and moderately to ensure that the production and consumption of energy reach a relatively balanced state. In addition, it is also necessary to implement supporting policies to improve the

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external development environment of energy to help it improve production technology and management level. At the same time, it focuses on improving the energy utilization efficiency of various industries, especially the secondary industry[5], and promotes the industrial structure upgrading through the development and promotion of new energy technologies, thus inhibiting the energy consumption[6].

4.2.3 To strengthen publicity and guidance on their own initiative and promote innovation in the ways in which people use energy

People's living energy is also a significant part of the total energy consumption in Anhui Province, so it is necessary to strengthen the publicity and guidance of people's energy-saving and green consumption ideas independently. Modern network platforms, offline publicity columns and other media are used to popularize knowledge related to energy conservation and environmental protection among the masses, so that they can consciously apply the awareness of low carbon and energy conservation in their daily life and work, so as to reasonably reduce the energy consumption of the masses[7].At the same time, preferential and incentive policies will be adopted to guide people to switch to renewable energy sources such as solar, geothermal and wind power, and adopt a model of multi-type energy complementing each other, so as to promote innovation in people's energy use, optimize the energy consumption structure in daily life, and promote green development of people's energy use in daily life.

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