ISSN: 2688-8653

An Empirical Study on the Driving Factors of Fossil Energy Consumption in China

Xin Shang

Institute of Economic Management, North China Electric Power University, Baoding 071000, China

shanxin0705@163.com

Abstract

In order to analysis the driving factors affecting the total energy consumption in our country, this article is based on 2000-2017 energy statistics selected the GDP, industrial proportion, total population, urban population share, three kinds of patent application at home and abroad to accept the number as the main reference index, using multiple regression analysis method, analysis the driving factors of energy consumption in our country, and use the EVIEWS, STATA and finally create a mathematical model of analysis and inspection. According to the final mathematical model, energy consumption can be analyzed. Finally, this paper puts forward some policy suggestions based on the conclusion.

Keywords

National Income; Linear Regression; Energy Consumption.

1. Introduction

Energy is not only one of the necessary conditions for human survival and social progress, but also an important resource for economic development. In recent years, the state has paid great attention to energy consumption and optimization of energy structure, and provided strong financial and policy support for the development and utilization of new energy. However, limited to the level of economic development and energy technology, the ecological and environmental problems caused by energy consumption are still not optimistic. Therefore, the research on the characteristics and influencing factors of China's energy consumption and the improvement of China's energy consumption structure have important theoretical value and practical significance for China to improve the energy utilization rate and realize the coordination and sustainable development among energy, economy and society.

At present, a large number of scholars have carried out a lot of research work based on China's energy consumption data. Based on the data of energy consumption in Shandong Province from 1996 to 2017, Lu Zhang focused on the influencing factors of energy consumption in Shandong Province, and put forward the countermeasures of energy consumption from various aspects. Based on the data of the three regions, Dong Chunshi analyzed the influencing factors mainly based on the differences of energy consumption in the three regions and put forward corresponding optimization strategies. Taking Jilin Province as an example, Anjia calculated the correlation degree between economic development level, scientific and technological level and total energy consumption, providing a theoretical basis for formulating reasonable energy consumption policies. In the research process of energy consumption, the above studies can be divided into two categories: one is to simply analyze energy consumption data and put forward optimization strategies; Another kind of research studies three related factors related to total energy consumption according to experience, but does not fully consider other important

ISSN: 2688-8653

factors related to energy consumption. In view of the shortcomings of the above research, it still needs to be further refined and studied.

Based on the statistical data of energy consumption in recent ten years, this paper selects the important influencing factors of total energy consumption. Then, according to the total energy consumption of main impact factors, multivariate linear regression analysis and test, and the use of econometrics involves a variety of methods of correction between variables multicollinearity, heteroscedasticity, since the correlation, and the function relation equation fitting degree is higher, it forecast the total energy consumption in our country has a certain reference value.

2. Construction of Econometric Model

2.1. Selection of Variables

Theoretically, it is believed that the factors affecting the total energy consumption demand mainly include the level of economic development, the level of industrial development, the improvement of people's living standards, and technological progress. To this end, this paper has collected the total energy consumption (electricity) calculation method of coal consumption (ten thousand tons of standard coal) (y), GDP (one hundred million yuan) (x1), industrial proportion (gross domestic product (GDP) = 100) (x2), total population (ten thousand people) for (x3), urban population share (%) for (x4), three kinds of patent application at home and abroad to accept the number (a) (x5) as the influence factors of energy consumption.

2.2. Data Sources and Descriptive Statistical Analysis

In this paper, total energy consumption is taken as the explained variable. In order to ensure the authenticity of the data and the practicability of the research, the data in this paper are from China Statistical Yearbook and Energy Statistical Yearbook (2000-2017), as shown in Table 1, total energy consumption and its influencing factors.

2.3. Model Building

This paper studies the quantitative relationship between China's energy consumption demand and major influencing factors, selects five major factors that affect the final total energy consumption (Y), and establishes the multiple linear regression prediction model between China's total energy consumption and various influencing factors as follows:

$$y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + u$$

Wherein, Y is China's total energy consumption (10,000 tons of standard coal)

X1 is GDP (hundred million yuan)

X2 is the proportion of industry (GDP =100)

X3 is the total population (ten thousand)

X4 is the proportion of urban population (%)

X5 is the number of domestic and foreign patent applications accepted (pieces)

U is the random error term, which describes the interference factors of factors other than variables to the model

3. Model Results and Related Tests

3.1. Regression Analysis

Using EViews to carry out regression analysis on the model, the model formula is obtained as follows.

ISSN: 2688-8653

$$y = 260137.7 + 0.082393\,x_1 + 8386.567x_2 - 9.457278x_3 + 20267.98x_4 - 0.005477\,x_5$$

The specific regression parameters are shown in Table 2

Table 1. Total energy consumption and its influencing factors

Year	total energy consumption	GDP (one hundred million yuan)	industrial proportion	total population	Proportion of urban population	The number of domestic and foreign patent applications accepted (pieces)
2000	146964	100280.1393	40.1461	126743	36.22	170682
2001	155547	110863.123	39.5571	127627	37.66	203573
2002	169577	121717.4247	39.2506	128453	39.09	252631
2003	197083	137422.0349	40.2862	129227	40.53	308487
2004	230281	161840.1609	40.6419	129988	41.76	353807
2005	261369	187318.9031	41.618	130756	42.99	476264
2006	286467	219438.4748	42.0326	131448	44.34	573178
2007	311442	270092.3237	41.3528	132129	45.89	693917
2008	320611	319244.6128	41.2612	132802	46.99	828328
2009	336126	348517.7437	39.6228	133450	48.34	976686
2010	360648	412119.2558	40.0668	134091	49.95	1222286
2011	387043	487940.1805	39.9924	134735	51.27	1633347
2012	402138	538579.9535	38.7874	135404	52.57	2050649
2013	416913	592963.2295	37.4953	136072	53.73	2377061
2014	425806	643563.1045	36.2353	136782	54.77	2361243
2015	429905	688858.218	34.1099	137462	56.1	2798500
2016	435819	746395.0595	32.8789	138271	57.35	3464824
2017	448529	832035.9486	33.0658	139008	58.52	3697845

Table 2. Regression parameter analysis

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	260137.7	1347192.	0.193096	0.8501
X1	0.082393	0.106368	0.774602	0.4536
X2	8386.567	1930.493	4.344262	0.0010
X3	-9.457278	12.68302	-0.745665	0.4702
X4	20267.98	7964.235	2.544875	0.0257
X5	-0.005477	0.014657	-0.373666	0.7152
R-squared	0.997267	Mean dependent var		317903.8
Adjusted R-squared	0.996129	S.D. dependent var		103776.2
S.E. of regression	6457.031	Akaike info criterion		20.64493
Sum squared resid	5.00E+08	Schwarz criterion		20.94172
Log likelihood	-179.8044	Hannan-Quinn criter.		20.68585
F-statistic	875.8313	Durbin-Watson stat		1.299641
Prob(F-statistic)	0.000000			

ISSN: 2688-8653

3.2. Estimation Results of the Basic Model

According to the regression analysis by the least square method, the closer R2 is to 1, the better fitting between the regression line and the sample observation values. R2=0.997 is close to that, indicating a high degree of fitting between the equation setting and the sample values, which basically conforms to the observation conditions. The significance level is set as α=0.05, and the model statistic F= 875.8313 > Fα (6,11) =2.80, indicating that the regression linear equation is significant, in other words, the set total energy equation is significantly established. Parameter significance test was performed on X1, X2, X3, X4 and X5 respectively. In the equation, not only the t test of coefficients X1, X3 and X5 is not significant, but also the coefficient sign of variable X4 is contrary to the actual change law, which indicates that there may be serious multicollinearity.

3.3. Test Results and Treatment of Multicollinearity, Autocorrelation and Heteroscedasticity

3.3.1. Multicollinearity

Multicollinearity refers to the distortion or difficulty in estimating accuracy of the model due to the existence of precise correlation or high correlation between explanatory variables in the linear regression model.

3.3.2. Multicollinearity Test and Treatment

Simple correlation coefficient matrix method was used to test, and the test results are shown in the table below:

Table 3. Simple phase relation number table

	X1	X2	X3	X4	X6
X1	1.000000	-0.844028	0.977171	0.979651	0.987620
X2	-0.844028	1.000000	-0.743663	-0.743914	-0.898509
X3	0.977171	-0.743663	1.000000	0.999223	0.945536
X4	0.979651	-0.743914	0.999223	1.000000	0.946635
X6	0.987620	-0.898509	0.945536	0.946635	1.000000

As can be seen from the correlation coefficient matrix, the correlation coefficients among all explanatory variables are relatively high, so this model has serious multicollinearity.

Stepwise regression is a commonly used method to eliminate multicollinearity. First of all, a simple regression analysis was performed on each explanatory variable considered by the explained variable, and the estimated coefficient, T statistic, R2, revised R2 and F statistic obtained were summarized in Table 4 below:

Table 4. Statistical scale of each coefficient

	Estimated coefficient	Tstatistic	R^2	modified R^2	F statistic
x1	0.406883	11.67882	0.89501	0.888448	136.3949
x2	-23104.5	-3.34372	0.411341	0.37455	11.18044
x3	27.36973	24.28278	0.973582	0.971931	589.6533
x4	14594.47	26.01316	0.976901	0.975458	676.6845
x5	0.080015	8.057522	0.802283	0.789925	64.92365

ISSN: 2688-8653

As can be seen from Table 2, the variable fitting effect of the fourth regression is the best, and the overall fitting effect is the best. It can be seen that it plays a major role in total energy consumption. The explanatory variable X1 was added first, and then regression analysis was performed. I'm going to use stepwise regression, I'm going to add x1, x2, x3, x5 and I'm going to add new variables if R2 is going to be larger and the other variables are still significant variables, I'm going to keep them. In summary, X1, X3, X4, X5 can be retained. X2 is multicollinearity with other influencing factors, so the X2 which has less influence on Y is deleted.

3.3.3. Autocorrelation Test and Processing

(LM) Lagrange multiplier test was used to conduct autocorrelation test, and the results are shown in the table below

Table 5. LM Checklist

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	5.747254	Prob. F(2,11)	0.0196
Obs*R-squared	9.197852	Prob. Chi-Square(2)	0.0101

From the above two P values, it can be concluded that the serial correlation exists in the model, the generalized difference method is a major solution to eliminate the serial correlation, and the generalized difference model of multiple linear regression is:

$$\triangle y_t = b_0(1-\rho)+b_1\triangle x_{1t}+b_3\triangle x_{3t}+b_4\triangle x_{4t}+b_5\triangle x_{5t}+\varepsilon_t \quad (t=2,3,4,5\ldots) \text{ and } \rho=1-DW/2=0.511$$

3.3.4. Heteroscedasticity Test and Correction

Goldfield-Quandt (G-Q) test is performed by first placing explanatory variables X1 in order of magnitude, and then deleting c=4 samples according to the number of samples in this equation. Regression analysis was conducted on the two subsamples respectively. For the first subsample RSS1=7598268 and for the second subsample RSS2=34821597, the degree of freedom was 2

$F=\frac{RSS_2/(\frac{n-c}{2}-k)}{RSS_1/(\frac{n-c}{2}-k)}\approx 4.58 < F_{0.05}=19$, so this equation does not have heteroscedasticity.

3.4. Estimated Results of the Improved Model

Therefore, after the improvement of multicollinearity and the reduction of variables, R2=0.992969 was closer to 1 than the previous determination coefficient R2, indicating that the goodness of fit result of the modified equation was better.

3.5. Analysis of Key Drivers based on Regression Results

According to the above analysis and test, the multiple regression equation can be concluded as $y=-0.0092x_1+19.39x_3+30453x_4-0.0334x_5+1494612$.

Estimation results show that the model, the influence factors of energy consumption is mainly GDP, population (ten thousand people), urban population share, three kinds of patent application at home and abroad to accept the number, the assumption that other variables are unchanged, under the condition of that year's GDP growth per 100 million yuan of standard coal, resource consumption can reduce 00092 tons of standard coal; Assuming that other variables remain unchanged, resource consumption will increase by 193,900 tons for every 10,000 increase in the total population. Similarly, when other variables are fixed, resource consumption will be reduced by 0.0334 million tons of standard coal for every 1% increase in

ISSN: 2688-8653

the proportion of urban population. Obviously, this is basically consistent with and consistent with theoretical analysis and experience judgment.

4. Conclusion

4.1. Main Conclusions

In general, energy consumption is negatively correlated with the improvement of people's living standard and gross national income. With the improvement of residents' living standard, people will have more home appliances and other energy-consuming products. But at the same time, with the increase of national income, more and more investment are put into the technological improvement and utilization rate of energy in the process of economic production, so there is a negative correlation on the whole. With the further development of urbanization and the improvement of residents' living standards, most urban families use gas fuel for all aspects of life, but at the same time, we have also carried out measures to transform the energy structure, so that the proportion of urbanization population and energy consumption are negatively correlated. Population clearly has a positive effect on energy consumption; The number of patent applications represents the change of technology. The more advanced the technology is, the more funds are invested in the improvement of energy utilization, and the less energy consumption will be. Therefore, the number of patent applications is also negatively correlated with energy consumption. We should face up to the environmental pollution caused by coal and promote the diversification of energy use. We will accelerate efforts to increase the efficiency of coal use.

4.2. Policy Implications

According to the above conclusions, we can make energy consumption plans more scientifically, improve the effective utilization of energy, and reasonably adjust the relationship between energy consumption and economic development, so that China's energy utilization will not affect economic growth, nor will it affect the sustainable development of the economy. Based on the above econometric analysis, this paper puts forward several simple policy suggestions:

First: energy-saving priority. The general policy of energy development strategy should be to "attach equal importance to development and conservation, and put conservation in the first place". In the relationship between energy exploitation and energy conservation, energy conservation should be placed in the first place. This is the important way that economic growth mode transforms from extensive type to intensive type. Continue to reduce the level of energy consumption per unit of GDP, and improve the efficiency of energy development and utilization. Compared with developed countries, China's energy efficiency is very low. The current energy efficiency is about 33%, about 10 percentage points lower than the advanced world level, and the overall efficiency of the energy system is very low, only 11.1%. That is to say, only 1/10 of the recoverable energy reserves are turned into useful terminal energy, and about 90% of the energy is lost or wasted in the process of mining, processing, conversion, storage and transportation, and terminal utilization. Therefore, China's energy development strategy should adhere to development and conservation, ensure the priority of energy conservation, and improve energy efficiency. First of all, the country needs to formulate relevant policies to encourage more use of more efficient energy varieties, appropriately reduce the proportion of coal consumption, and focus on the improvement of energy structure in the long term. Secondly, promote the development of coal purification technology, use more coal for power generation rather than direct combustion and other ways to improve the coal utilization efficiency, improve the secondary energy consumption structure; Finally, maintain a moderate economic growth rate, reduce the pressure on energy supply, and create an appropriate environment for adjusting the energy structure, reducing energy consumption and pollution.

ISSN: 2688-8653

Second: structural optimization. Structural optimization is to gradually change the situation of excessive reliance on coal in the energy mix and accelerate the development of new energy sources. We will develop clean and high-quality energy, initially diversify the energy mix, and make breakthroughs in the clean use of coal. In general, for the energy consumption in our country, is to be in accordance with the requirements of the comprehensive, coordinated and sustainable development, through effective macro policy guidance, set up to optimize energy structure, save energy consumption mechanism, accelerate energy technology progress, strengthen energy management and properly solve the problem of energy supply is facing a series of problems, ensure the energy needs of the modernization construction.

References

[1] Jiang Lingling, Liu Xiaolong, Ge Qin, Cui Leilei, Du Xiangwan. Research on the trend and countermeasures of China's energy structure transformation J. China Energy,2020,42(09):15-19 + 27.

[2] Zhang Lu, Li Yong 'an, Wang Chong. Study on the influencing factors of energy consumption based on correlation analysis and regression analysis J. China Energy,2020,42(06):42-47.

[3] Dong Chunshi, Wang Jing. Research on the influencing factors of energy consumption in China: Based on the panel data analysis of East, Central and Western regions J. Journal of Xi 'an Shiyou University (Social Science Edition),2020,29(02):16-20+36.

[4] Lang Wei, Chen Yingzi. Empirical analysis of energy consumption structure in China's high-energy consuming industries J. Economic Review,2019(04):95-102.

[5] Empirical analysis on the relationship between China's economic growth and energy consumption J. Journal of Business Economics,2018(17):36-39.

[6] SHI Huiling. Analysis on the influencing factors of China's energy consumption standard coal J. Energy Conservation,2018,37(08):96-97.

[7] An Jia, Bian Haoyu, Wang Weiheng, Lu Yang. Empirical analysis on the influencing factors of energy consumption in Jilin Province J. Forum of Industry and Science&Technology, 2015, 14(07): 81-82.

[8] Huo Zongjie, Zhou Caiyun. An empirical analysis of the relationship between China's economic growth, energy structure and energy consumption [J]. Contemporary Economic Management, 2010, 32 (05):10-14.