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Study on the Influencing Factors of Per Capita Energy Production in China

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ABSTRACT

The "14th Five-Year" Plan for Industrial Green Development points out that China is still in the historical stage of in-depth industrialization, facing problems such as an overly heavy industrial structure, a coal-dominated energy structure, and low energy efficiency. Improving energy utilization efficiency and enhancing the efficient use of resources in the production process will be important challenges for a long time to come. This study focuses on analyzing the influencing factors of China's per capita energy production. Based on data of 8 variables (including total GDP, energy production growth rate, electricity production growth rate, primary industry added value, and end-of-year private car ownership) in China from 1991 to 2021 (a total of 31 years), we used Stata software to conduct a multiple linear regression analysis on the data. During the empirical analysis, we first tested the initial model for multicollinearity, then corrected problems like multicollinearity in the model. Finally, we drew conclusions and put forward suggestions based on the data analysis results.

KEYWORDS: *Multiple Linear regression; Per capita energy production; Influencing factors.*

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1. INTRODUCTION

1.1. Research Background

Guided by the "dual carbon" goals, China's energy sector is undergoing profound changes. The "14th Five-Year" Plan for Industrial Green Development clearly states that China still faces problems such as an overly heavy industrial structure and low energy efficiency[1]. In 2020, China's total energy production reached 3.97 billion tons of standard coal, an increase of 45% compared with 2010. However, the per capita energy production was only 82% of the world average. The proportion of household energy consumption rose from 11% in 2010 to 16% in 2020, becoming a new growth point of energy consumption. Against this background, studying the influencing factors of per capita energy production is of great practical significance.

In recent years, China's economic development has entered a new normal, and the focus of sustainable development in the energy sector has gradually shifted to improving the quality of energy production and energy utilization efficiency. It is worth noting that household energy consumption is gradually becoming an important part of China's energy consumption growth, and there is great potential in the residential energy consumption field[2]. At present, the proportion of residential electricity consumption in China's total electricity consumption is about 14%, which is quite low compared with 30% in developed European and American countries. However, if we take new loads such as distributed photovoltaics, energy storage equipment, and electric vehicles into account, the total adjustable resources on the residential side can reach hundreds of millions of kilowatts. Due to the limitations of traditional electricity consumption modes, residents have few ways to participate in power grid interaction, and the coordinated control capabilities of equipment such as smart home appliances and energy storage devices have not been fully utilized. The 1-million-kilowatt residential virtual power plant built in Jiangsu has integrated energy-consuming equipment in various households into a uniformly dispatchable "cloud battery" by using technologies such as the Internet of Things and AI algorithms, providing a feasible technical solution to solve the above problems[3].

According to preliminary calculations, China's total primary energy production in 2024 reached 4.98 billion tons of standard coal, an increase of 4.6% compared with the previous year. In the energy consumption structure, the consumption of clean energy (including natural gas, hydropower, nuclear power, wind power, and solar power generation) accounted for 28.6% of the total energy consumption, an increase of 2.2 percentage points compared with the past. However, it cannot be ignored that China's per capita clean energy production still lags behind that of developed countries[4]. Therefore, in-depth research on China's per capita energy production is not only a practical need to address energy security challenges but also an important strategic measure to promote the green transformation of the economy and society. Looking forward, to achieve the "dual carbon" goals and high-quality development, it is necessary to combine digital technology, policy innovation, and international cooperation to build a dynamic balance mechanism between per capita energy production and consumption.

1.2. Research Significance

In terms of theoretical significance, on the one hand, studying the topic of China's per capita energy production can help us better understand China's energy production structure and make up for the lack of current research on the influencing factors of per capita energy production on total energy production. On the other hand, studying the influencing factors of China's per capita energy production not only helps deepen the understanding of the relationship between energy production, economic development, and environmental protection but also provides theoretical support for optimizing energy policies, promoting technological innovation, and rationalizing regional energy allocation.

In terms of practical significance, studying China's per capita energy production can help us understand China's energy supply-demand relationship, energy structure, and energy intensity, so as to grasp the changes in energy production and the development trend of total energy. This provides a scientific basis for the government to formulate sustainable development strategies. At the same time, improving China's per capita energy production can stimulate domestic demand, drive economic growth, and inject new vitality into economic development. In addition, it is also of great practical significance for ensuring national energy security, promoting economic structure transformation, and participating in global energy governance.

Based on this, this paper uses a multiple linear regression model to analyze the factors affecting China's per capita energy production from 1991 to 2021 (31 years), in order to answer the above questions.

2. Literature Review

2.1. Foreign Literature Review

The relationship between energy production and economic development has always been a focus of international academic circles. In early studies, Kraft J. and Kraft A. (1978) were the first to propose a one-way causal relationship between energy consumption and economic growth through an analysis of U.S. data, laying the foundation for subsequent studies[5].

Later, Stern (1993) constructed a production function including energy factors, further verifying the importance of energy to economic growth. He pointed out that technological progress is a key driving force for improving energy efficiency[6]. In recent years, as global climate change has become increasingly prominent, the research focus has gradually shifted to energy structure transformation and sustainable development. For example, Pachauri and Spreng (2002) found through empirical analysis that renewable energy technological innovation can significantly reduce the negative impact of energy production on the environment[7]. At the policy level, a study by the International Energy Agency (IEA, 2010) showed that governments can effectively promote the commercialization of clean energy technologies through means such as subsidies and tax incentives[8].

Regarding China's energy production issues, Fisher-Vanden et al. (2004) pointed out that the improvement of China's energy efficiency is mainly due to technological upgrading and structural adjustment in the industrial sector[9]. However, the backwardness of per capita energy production is still an important factor restricting China's energy security, which is consistent with the results of comparative studies with OECD countries.

2.2. Domestic Literature Review

Domestic scholars started late in researching energy production but have made significant progress in recent years. Lin Boqiang (2003) found that there is a long-term equilibrium relationship between energy consumption and economic growth in China by constructing a vector autoregressive model, and emphasized the importance of energy price reform for optimizing the energy structure[10].

Shi Dan (2006) analyzed the regional differences in China's energy production from the perspective of technical efficiency, pointing out that the energy utilization efficiency in eastern China is significantly higher than that in central and western China[11]. With the proposal of China's "dual carbon" goals, the research focus has shifted to the development of clean energy and the improvement of energy efficiency. For example, Zhang Xiliang et al. (2019) found through scenario simulation that accelerating the development of renewable energy can significantly increase per capita energy production and reduce carbon emission intensity[12]. In terms of technological innovation, Li Lianshui and Zhou Yong (2012) found that energy technological progress contributes more than 40% to China's energy efficiency, and the breakthrough in clean coal utilization technology is particularly critical[13].

It is worth noting that domestic studies generally focus on the relationship between energy production and economic growth, but systematic analysis of per capita energy production is still insufficient. The latest study by Wang Xinxin (2025) pointed out that although China's total energy production ranks among the top in the world, its per capita level is only 1/3 to 1/2 of that of developed countries. This gap is mainly due to structural problems such as a large population base and a coal-dominated energy structure[3].

3. Current Situation of China's Per Capita Energy Production

3.1. Data Selection

The data sources for this paper mainly include relevant statistical yearbooks (such as the China Energy Statistics Yearbook and World Energy Statistics Yearbook), academic databases (such as CNKI, CSMAR Financial Research Database, Wanfang Data Resource System, China Economic and Social Big Data Research Platform, and VIP Chinese Science and Technology Journal Database), and official platforms (such as the National Bureau of Statistics). We collected and sorted out data of indicators related to per capita energy production (including total GDP). At the same time, we collected a large number of literature materials related to per capita energy production and energy consumption growth rate through the Internet, academic works, magazines, papers, and journals to obtain effective information, understand the latest research trends and achievements, and lay a theoretical foundation for this study.

This paper uses a multiple linear regression model, which is used to study the linear relationship between one dependent variable and multiple independent variables, and describes this relationship by establishing a linear equation. The model assumes that there is a linear relationship between the dependent variable and independent variables, and the error term follows a normal distribution with a mean of zero. The parameters of the multiple linear regression equation are estimated using the Ordinary Least Squares (OLS) method. The estimation criterion is to minimize the sum of squared residuals. This model can be used to predict and analyze the impact of independent variables on the dependent variable. Compared with the simple linear regression model, the multiple linear regression model is more universally applicable. In this paper, Stata statistical software is used to study the factors affecting China's per capita energy production, test and correct the multicollinearity problem, and finally analyze the output results.

3.2. Indicator Selection

By extensively reading literature in related fields and fully referring to previous studies by many scholars, this paper takes per capita energy production (in kg of standard coal) as the dependent variable, and selects 8 variables as independent variables—including total GDP (in 100 million yuan), energy production growth rate (%), energy consumption growth rate (%), electricity production growth rate (%), industrial added value (in 100 million yuan), GDP growth rate (%), primary industry added value (in 100 million yuan), and end-of-year private car ownership (in 10,000 units) — to better reflect the impact of various factors on China's per capita energy production.

Table 3-1 Explanation of Indicators

Indicator	Brief Explanation
Per capita energy production	Measures the average energy production level per person in a country
Total GDP	Represents the final results of production activities of all resident units in a country within a certain period
Energy production growth rate	Reflects the development trend and vitality of the energy industry
Energy consumption growth rate	An important indicator to measure the changing trend of energy demand and the change of economic and social dependence on energy
Electricity production growth rate	Reflects the expansion speed of electricity production scale and the development trend of the electricity industry
Industrial added value	An important indicator to measure the final results of production and operation activities of industrial enterprises and their contribution to the national economy

GDP growth rate	A key indicator to measure the speed of economic growth and the economic operation trend
Primary industry added value	The new value created by primary industry production activities in a country within a certain period
End-of-year private car ownership	Reflects the living standards of residents

3.3. Current Situation Analysis

As shown in Figure 3-1, China's per capita energy production showed an overall upward trend from 1991 to 2021. According to data from the China Statistical Yearbook (released by the National Bureau of Statistics), China's per capita energy production increased from 911 kg of standard coal in 1991 to 3,024 kg of standard coal in 2021, a 3.32-fold increase in just 30 years. However, it can also be seen that the annual growth rate fluctuated significantly. The reasons for this fluctuation are extremely complex, including changes in national policies, changes in the permanent population, and changes in per capita income levels.

In general, the overall upward trend of China's per capita energy production is due to the following reasons: in the early 1980s, limited by technical level and economic conditions, China's national per capita energy production was relatively low, mainly relying on traditional fossil energy such as raw coal. However, with the deepening of reform and opening up, especially since the 21st century, technological progress and industrial structure adjustment have greatly promoted the improvement of energy production capacity. The rapid development of clean energy (such as wind power and solar energy) has significantly increased per capita electricity production and gradually changed China's energy production structure.

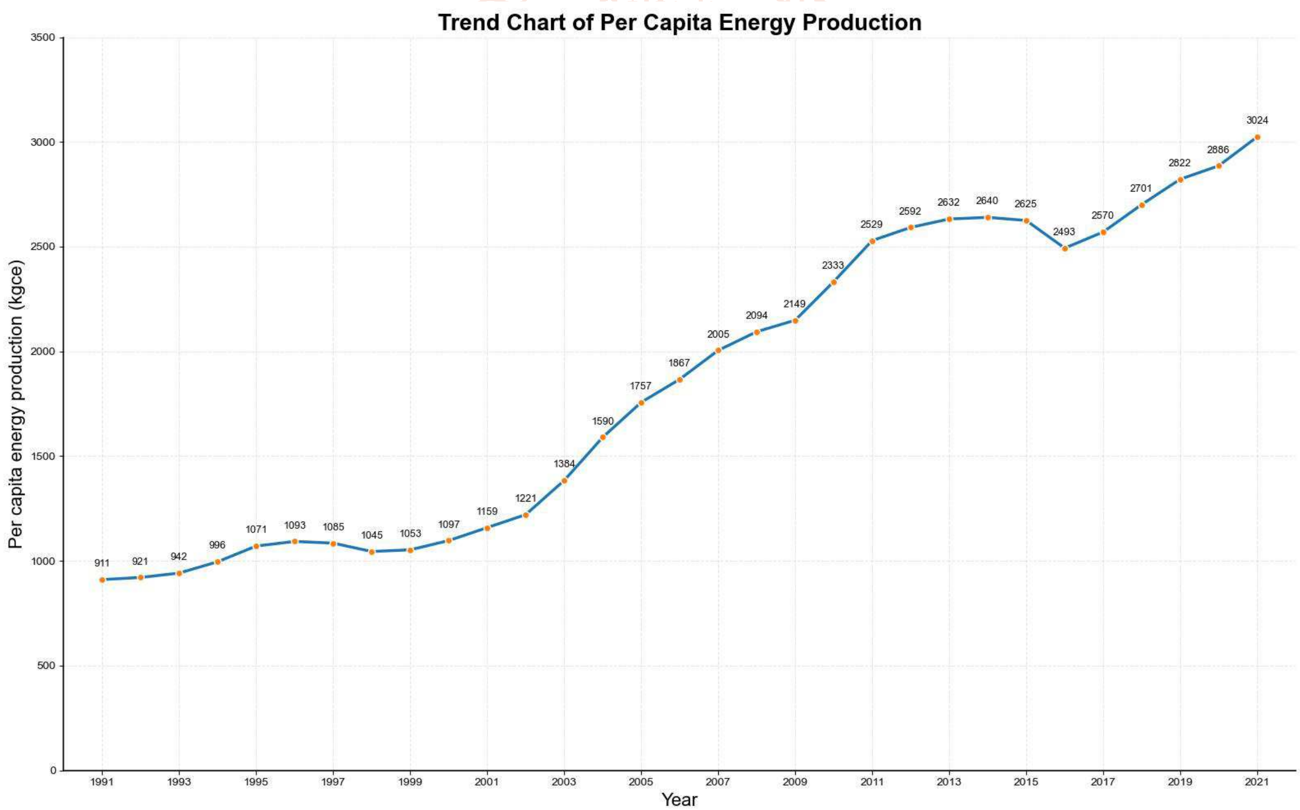

Figure 3-1 Growth of China's per capita energy production from 1991 to 2021

The historical changes in China's per capita energy production and consumption not only witness the rapid development of the national economy and society but also point out the direction for future energy development. Facing new opportunities and challenges, we need to continue to deepen energy reform, strengthen international cooperation, jointly address global energy challenges, and promote the global energy governance system to develop in a more fair, reasonable, and green and low-carbon direction[14].

4. Empirical Analysis of Influencing Factors of China's Per Capita Energy Production

4.1. Data Preprocessing: Logarithmization

First, all variables were renamed in Stata. Per capita energy production, total GDP, energy production growth rate, electricity production growth rate, energy consumption growth rate, industrial added value, GDP growth rate, primary industry added value, and end-of-year private car ownership were named y, x1, x2, x3, x4, x5, x6, x7, and x8 respectively. We drew time series charts for each variable. By observing the time series charts of each variable (Figure 4-1), we found that logarithmization was not meaningful for other variables except x1, x5, x7, and x8. Therefore, we chose to take the logarithm of x1, x5, x7, and x8 (denoted as lnx1, lnx5, lnx7, and lnx8 respectively).

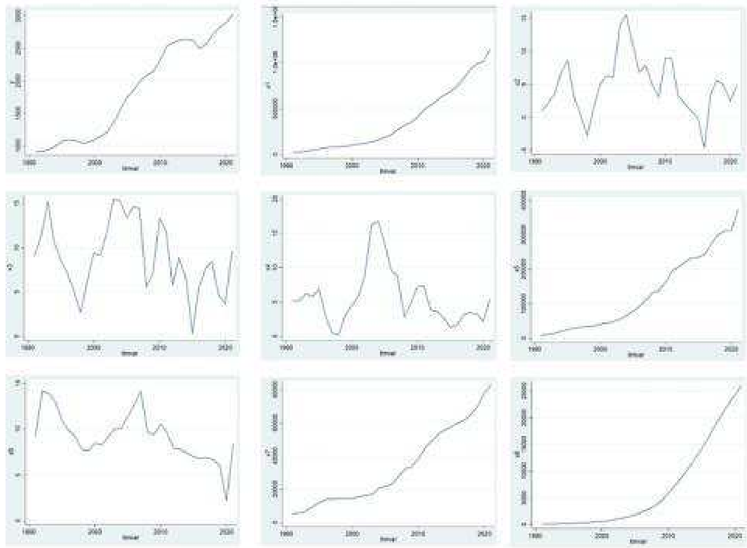

Figure 4-1 Time series of variables

4.2. Correlation Analysis

According to the correlation analysis of indicator variables in Table 4-1, per capita energy production (y) showed a significant positive correlation with total GDP (x1), industrial added value (x5), primary industry added value (x7), and end-of-year private car ownership (x8). In contrast, it showed a negative correlation with energy production growth rate (x2), electricity production growth rate (x3), energy consumption growth rate (x4), and GDP growth rate (x6).

Table 4-1 Correlation Coefficient Table of Variables

	y	x1	x2	x3	x4	x5	x6
y	1.0000						
x1	0.9315	1.0000					
x2	-0.0764	-0.1991	1.0000				
x3	-0.2769	-0.3850	0.7423	1.0000			
x4	-0.1949	-0.3219	0.8877	0.8386	1.0000		
x5	0.9632	0.9937	-0.1727	-0.3589	-0.3001	1.0000	
x6	-0.5394	-0.6619	0.3846	0.7044	0.4749	-0.6331	1.0000
x7	0.9568	0.9932	-0.1987	-0.4014	-0.3205	0.9962	-0.6742
x8	0.8719	0.9893	-0.2341	-0.4034	-0.3459	0.9671	-0.6779

4.3. Unit Root Test

We conducted unit root tests on y, lnx1, x2, x3, x4, lnx5, x6, lnx7, and lnx8 in Stata. The results showed that their corresponding P-values were 0.9875, 0.0016, 0.1102, 0.0678, 0.0006, 1.0000, 0.2159, 0.2580, and 0.0004 respectively. Except for lnx1, lnx5, and lnx8, the P-values of other variables were greater than the significance level of 0.05. This means we could not consider these cases as small-probability events, so we failed to reject the null hypothesis and concluded that these sequences were non-stationary. Therefore, we conducted first-order differencing on y, x2, x3, x4, x6, and lnx7. At this time, their P-values were 0.0824, 0.0000, 0.0000, 0.0037, 0.0000, and 0.0405 respectively. Among them, the P-value of the first-order difference of y was still greater than 0.05, so we needed to conduct second-order differencing. The P-value obtained after second-order differencing was 0.0000, which was less than the significance level of 0.05. Therefore, we could conclude that the time series was now stationary.

4.4. Multicollinearity tests

As shown in Table 4-2, the total sum of squared deviations of the dependent variable is 136,571.034. The regression sum of squares and variance are 125,782.728 and 15,722.841, respectively, while the residual sum of squares and variance are 10,788.3061 and 539.415307. The observed F-statistic value is 29.15, with a p-value approximating 0.0000. Based on this table, we can conduct a significance test for the regression equation. If we set the significance level α at 0.05, since the p-value is less than the significance level α, we should reject the null hypothesis of the regression equation's significance test. This indicates that the regression coefficients are not all zero, and the linear relationship between the dependent variable and all explanatory variables is significant. Therefore, a linear model can be established.

Table 4-2 Multiple Linear Regression Analysis Results of Per Capita Energy Production (I)

Source	SS	df	MS
Model	125782.728	8	15722.841
Residual	10788.3061	20	539.415307
Total	136571.034	28	4877.53695

We could conduct a significance test of the regression coefficients based on Table 4-3. It can be seen that if the significance level α was set to 0.05, the probability P-values of the t-tests for the significance of most variables' regression coefficients were greater than α. Therefore, we should not reject the null hypothesis, meaning that these partial regression coefficients had no significant difference from 0, and there was no significant linear relationship between them and the explained variable (per capita energy production). Whether they should be retained in the equation still needed to be analyzed based on actual conditions. It can be seen that the overall significance test of the model passed, but the t-test for individual coefficients was not significant. Therefore, we suspected that the model had serious multicollinearity. Furthermore, from the condition index in Table 4-4, the VIF values of the 1st, 5th, and 8th variables were all greater than 10, indicating that there was indeed multicollinearity between variables. This showed that the model retained some variables that should not be retained, so the model was currently unavailable and needed to be re-established.

Table 4-3: Multiple Linear Regression Analysis Results of Per Capita Energy Production(II)

d2y	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnxl	124.4232	95.17488	1.31	0.206	-74.10807	322.9546
dx2	20.73085	1.917142	10.81	0.000	16.73176	24.72994
dx3	1.388404	1.908843	0.73	0.475	-2.593373	5.370181
dx4	-7.77523	3.378654	-2.30	0.032	-14.82298	-.7274826
lnx5	-8.399866	73.43468	-0.11	0.910	-161.5819	144.7822
dx6	5.353648	3.22107	1.66	0.112	-1.365385	12.07268
dlnx7	-27.05412	66.75053	-0.41	0.690	-166.2933	112.1851
lnx8	-72.84353	45.39405	-1.60	0.124	-167.5339	21.8468
cons	-869.3916	538.2405	-1.62	0.122	-1992.142	253.3585

Table 4-4 Multiple Linear Regression Analysis Results of Per Capita Energy Production (III)

Variable	VIF	1/VIF
Lnxl	516.91	0.001935
lnx8	295.20	0.003388
lnx5	269.81	0.003706
dx4	4.20	0.238190
dx3	2.71	0.369354
dx2	2.66	0.375422
dx6	1.82	0.549349
dlnx7	1.35	0.739504
Mean VIF	136.83	

4.5. Multicollinearity Correction

This paper used a stepwise regression method to allow Stata to automatically screen the explanatory variables, observe the changes in each step, and conduct residual analysis.

It can be seen from Table 4-5 that the total sum of squared deviations of the explained variable was 136,571.034, the regression sum of squares and its variance were 123,948.068 and 41,316.0225 respectively, and the residual sum of squares and its variance were 12,622.9669 and 504.918675 respectively. The observed value of the F-test statistic was 81.83, the adjusted multiple determination coefficient was 0.8965, and the approximate probability P-value was 0.0000, indicating that the regression equation was significant. In addition, according to Table 4-6, the t-test for each individual coefficient was significant, so we believed that the correction of multicollinearity in the model was effective.

From the process of establishing the equation, it can be seen that as the explanatory variables decreased, the goodness of fit of the equation decreased. On the one hand, this reflected the inherent characteristics of the coefficient of determination; on the other hand, it showed that establishing a regression equation does not take pursuing a high goodness of fit as the only goal, and it is also important to check whether the explanatory variables contribute to the explained variable. The variables eliminated from the equation were total GDP, electricity production growth rate, industrial added value, primary industry added value, and end-of-year private car ownership. If the significance level α was set to 0.05, it can be seen that the probability P-values of the partial F-tests for these eliminated variables were all greater than α. Therefore, we could not reject the null hypothesis of the test, meaning that the partial regression coefficients of these variables had no significant difference from zero, and they made no significant contribution to the linear explanation of the explained variable, so they should not be retained in the equation. Finally, the variables retained in the equation were the first-order difference data of energy production growth rate, the first-order difference data of energy consumption growth rate, and the first-order difference data of GDP growth rate.

Table 4-5: Results of Multivariate Linear Regression Analysis of Per Capita

Source	SS	df	MS
Model	123948.068	3	41316.0225
Residual	12622.9669	25	504.918675
Total	136571.034	28	4877.53695

Table 4-6: Multivariate Linear Regression Analysis Results of Per Capita Energy Production (V)

d2y	Coef.	Std. Err.	t	P>|t|	[95%Conf.	Interval]
dx4	-7.338309	2.609708	-2.81	0.009	-12.7131	-1.963514
dx2	20.28786	1.744012	11.63	0.000	16.696	23.87972
dx6	6.744578	2.607162	2.59	0.016	1.375028	12.11413
cons	4.01971	4.207729	0.96	0.349	-4.646269	12.68569

4.6. Heteroscedasticity Test

For the equation after stepwise regression, we still suspected heteroskedasticity. Therefore, we conducted a White's test in Stata, where the squared residuals were modeled as a quadratic function of independent variables. As shown in Figure 4-2, the P-value of 0.0162 was below the significance level of 0.05, confirming the presence of heteroskedasticity in the equation.

White's test for Ho: homoskedasticity

against Ha:unrestricted heteroskedasticity

chi2(9) = **20.28**
Prob > chi2 = **0.0162**

Figure 4-2 Results of White Test

4.7. Heteroscedasticity Correction

Although heteroscedasticity does not undermine the unbiasedness and consistency of OLSE (Ordinary Least Squares Estimator), it undermines its efficiency and asymptotic efficiency, making the usual hypothesis testing procedures unreliable. Therefore, it is necessary to deal with the heteroscedasticity problem. In this paper, we used the WLS (Weighted Least Squares) method to estimate the model and made corrections using Stata software. The results are shown in Tables 4-7 and 4-8.

Table 4-7: Multivariate Linear Regression Analysis Results of Per Capita Energy Production (VI)

Source	SS	df	MS
Model	106451.389	3	35483.7962
Residual	10850.0183	25	434.000733
Total	117301.407	28	4189.33597

Table 4-8 Multivariate Linear Regression Analysis Results of Per Capita Energy Production (VII)

d2y	Coef.	Std.Err.	t	P>|t|	[95% Conf.	Interval]
dx4	19.28168	1.729182	11.15	0.000	15.72036	22.84299
dx2	-5.99312	2.762408	-2.17	0.040	-11.68241	-.3038356
dx6	6.71466	1.92516	3.49	0.002	2.74972	10.6796
cons	4.57568	3.885856	1.18	0.250	-3.427391	12.57875

4.8. Analysis of Regression Results

Table 4-8 shows the partial regression coefficients of each explanatory variable in the final model and the results of the significance test for the partial regression coefficients. If the significance level α was set to 0.05, all regression coefficients of the equation were significant. The final regression equation is:

$$D_2(Y) = 4.576 - 5.993D(X_2) + 19.282D(X^4) + 6.715D(X_6)$$

This means that under the condition that other explanatory variables remain unchanged:

For every 1-unit increase in energy production growth rate, per capita energy production decreases by an average of 5.993 units;

For every 1-unit increase in energy consumption growth rate, per capita energy production increases by an average of 19.282 units;

For every 1-unit increase in GDP growth rate, per capita energy production increases by an average of 6.715 units.

The adjusted multiple determination coefficient of the equation is 0.8964, which indicates a good fit. However, considering the limitations of variable selection in practice, many factors that have an important impact on per capita energy production (such as technological innovation, energy policies, and changes in industrial structure) were not fully included, which reduced the explanatory power of the model. Secondly, the sample size was too small to accurately reflect the overall characteristics, resulting in a less than ideal goodness of fit of the model. Finally, there may be certain deviations in the model setting. Multiple linear regression assumes a linear relationship between variables, but in reality, the relationship between variables may be more complex, and the model cannot describe it accurately, which reduces the coefficient of determination to a certain extent.

Figure 4-3 takes fitted values as the horizontal axis and residuals as the vertical axis. Judging from the distribution of the points, there is no obvious trend or clustering pattern. The residuals are randomly scattered around the zero value, which indicates that there is no heteroscedasticity or other violations of classical assumptions in the model's residuals. The fitting effect is good, and the residual fluctuations of each observation are relatively uniform.

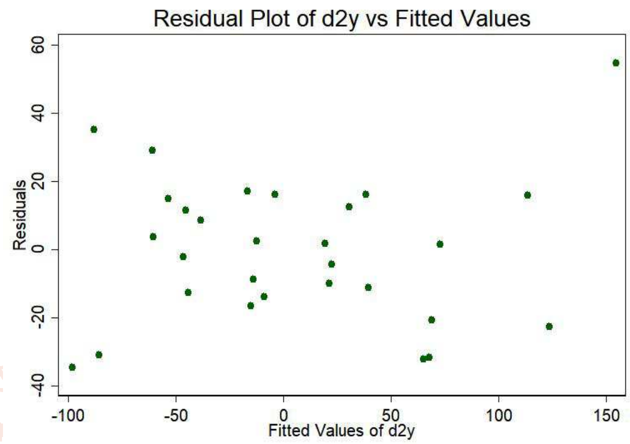

Figure 4-3 Scatter Plot of Residuals Vs. Fitted Values

The residual points in figure 4-4 basically lie along a straight line, which shows that the residuals approximately follow a normal distribution. This is in line with the assumption of residual normality in the classical linear regression model, indicating that the model is relatively reasonable in terms of residual distribution, which is conducive to the reliability of subsequent statistical inferences based on the normal distribution.

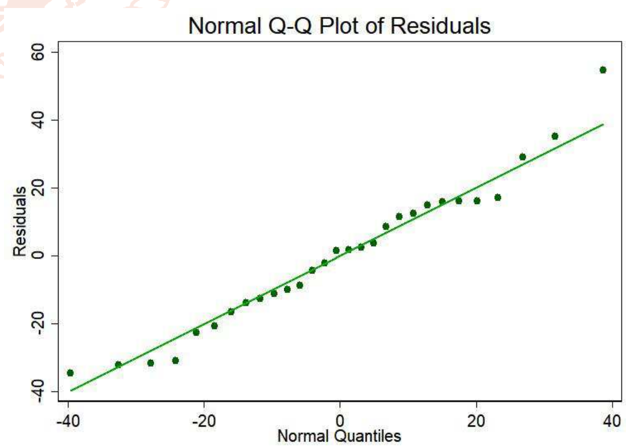

Figure 4-4 Normal Q - Q Plot of Residuals

5. Conclusions and Suggestions

5.1. Conclusions

Through the analysis of relevant data from 1991 to 2021, this study found that China's per capita energy production showed a continuous increase with fluctuating growth over the past 31 years. By using a multiple linear regression model and correcting problems such as multicollinearity and heteroscedasticity in the model, we identified the key factors affecting China's per capita energy production. Among them, total GDP, energy consumption growth rate, GDP growth rate, and primary industry added value showed a positive correlation with per capita energy production. This indicates that:

An increase in total GDP means the expansion of the overall economic scale, and the energy demand and production capacity of various industries increase, which in turn drives up per capita energy production;

A faster growth rate of energy consumption stimulates energy production enterprises to expand production scale and increase energy output. Under the condition that factors such as labor are relatively stable, per capita energy production also increases accordingly;

GDP growth rate reflects the vitality of the economy. When the economy grows rapidly, energy production also expands accordingly, promoting the growth of per capita energy production;

An increase in primary industry added value indicates more active production activities in the primary industry, which has a positive impact on the utilization and production of energy, thereby increasing per capita energy production.

In contrast, end-of-year private car ownership showed a negative correlation with per capita energy production. This is mainly because China's current energy structure is still dominated by fossil energy. The substantial increase in the number of private cars has led to a sharp rise in the consumption of fossil energy such as oil. To meet the energy demand of cars, it may be necessary to increase the exploitation of limited fossil energy, which not only affects the energy supply in other fields but also disrupts the rational arrangement of energy production, ultimately leading to a decrease in per capita energy production.

5.2. Suggestions

5.2.1. Optimize the Energy Consumption Structure

Strengthen the development and utilization of clean energy and gradually reduce dependence on fossil energy. For example, the national policy provides more support for the development of clean energy such as solar energy, wind energy, and hydropower, including subsidies and preferential loans, to encourage enterprises and individuals to actively participate in clean energy projects[15]. We can also build more wind farms and solar power stations to increase the proportion of clean energy in total energy consumption. This not only reduces the consumption of traditional fossil energy, eases the pressure on energy supply but also reduces carbon emissions and achieves sustainable energy development[16].

5.2.2. Improve Energy Utilization Efficiency

In the automotive manufacturing industry, promote enterprises to increase R&D investment, adopt advanced energy-saving technologies, and improve the fuel efficiency of cars. For example, develop more efficient engine technologies and lightweight body materials, so that cars consume less energy when traveling the same distance[17]. In other energy-consuming fields, we should also promote energy-saving technologies and equipment and strengthen energy management. Enterprises can optimize production processes, arrange energy use rationally, and reduce energy waste. For energy-intensive industries such as iron and steel and chemical industry, improve energy utilization efficiency through technological transformation, thereby reducing energy consumption per unit of product.

5.2.3. Promote Sustainable Economic Growth

Continue to maintain stable economic growth, optimize the industrial structure, and promote the coordinated development of various industries. Encourage the development of high-tech industries and the service industry, which have relatively low energy consumption and high added value. Increase investment in scientific and technological innovation to improve the quality and efficiency of economic growth. Through scientific and technological innovation, promote the progress of energy production technology, improve energy production efficiency, and obtain more energy output with less energy input, so as to further increase per capita energy production. For example, develop smart grid technology to improve the efficiency of power transmission and distribution and reduce energy loss during transmission.

The report of the 20th National Congress of the Communist Party of China emphasizes that "achieving carbon peaking and carbon neutrality is a broad and profound economic and social systemic transformation." Through the comprehensive implementation of the above measures, we are expected to achieve positive results in optimizing the energy structure, improving energy utilization efficiency, and promoting sustainable economic development. This will effectively promote the steady improvement of China's per capita energy production, lay a solid foundation for achieving the "dual carbon" goals, ensuring national energy security, and promoting the green transformation of the economy and society. It will also help China play a more important role in global energy governance and achieve the coordinated coexistence of the economy, energy, and the environment.

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