Analysis on Influencing Factors of Primary Energy Consumption in China

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Keywords: Primary energy consumption; influencing factor; energy efficiency

Abstract: The primary energy consumption is decomposed into five factors: energy structure effect, energy intensity effect, economic structure effect, economic effect and population effect by combining Kaya identical equation and logarithmic mean divisia index model (LMDI), and the development of energy intensity is the key factor to reduce the primary energy consumption. Therefore, the STIRPAT model is further used to analyze the impact of eight factors on improving energy efficiency, such as employed population, coal structure, oil structure, natural gas structure, hydropower structure, per capita GDP, economic structure and investment in the fixed assets.

1. Introduction

Due to the rapid economic development in China, the demand for energy consumption is constantly increasing throughout the country. At present, China has become the largest energy consumer in the world. As a "world factory", the development of foreign trade in China has made China a big net exporter of hidden energy. Many developed countries have left energy consumption and pollution in China by importing products with high energy consumption and high pollution. Therefore, in order to achieve the goal of energy conservation and emission reduction, China must start with the primary energy consumption factors, analyze the primary energy consumption factors, and find out the key factors leading to the increase of primary energy consumption.

2. Analysis on influencing factors of primary energy consumption in China

2.1 LMDI decomposition model of primary energy consumption

Kaya identity was put forward by Japanese scholar Yoichi kaya in 1990 to reveal the relationship between CO_2 emission and economy, policy and population. This chapter constructs the Kaya identical equation of primary energy consumption based on kaya original identical equation. The expression is as follows:

$$E=\sum_{i=1}^{3}\sum_{J=1}^{4}\frac{E_{ij}}{E_i}\times\frac{E_i}{GDP_i}\times\frac{GDP_i}{GDP}\times\frac{GDP}{P}\times P=ES\times EI\times GS\times PG\times P \quad (3-1)$$

Among them, i=1,2,3 represent primary, secondary, and tertiary industries respectively, and j=1,2,3,4 stand for coal, oil, natural gas, and renewable energy respectively; E for total primary energy consumption, E_{ij} for the primary energy consumption for industry i, GDP_i for gross domestic product for industry i, GDP for gross domestic product for all industries, P for total population, $ES=\frac{E_{ij}}{E_i}$ for the primary energy consumption structure of type j, $EI=\frac{E_i}{GDP_i}$ for the intensity of primary energy consumption; $GS=\frac{GDP_i}{GDP}$ for the economic structure; $PG=\frac{GDP}{P}$ for the per capita GDP, which can be used to represent China's economic situation. Therefore, the main factors affecting the total primary energy consumption are energy structure, energy intensity, economic structure, per capita GDP and population. Energy structure refers to the proportion of various types of primary energy consumption to the total primary energy consumption, which can reflect the use of energy in various industries and levels in the country. Energy intensity refers to the energy consumption per unit of GDP, which can reflect the energy efficiency of the country to a

  DOI: 10.25236/epcimms.2019.29

certain extent. Due to the rapid development of urbanization and industrialization in China, the economy of China presents the characteristics of heavy industry, which would require more energy consumption per unit of GDP output. Economic structure refers to the proportion of the economic output of the three major industries in the gross national product, which not only reflects and restricts the development level, direction and speed of a country's economy, science and technology, and society, but also shows the results of the country's long-term economic, scientific and technological, and social development. Per capita GDP refers to the share of GDP owned by each person. It is a factor of economic growth and can objectively reflect the level of economic development of a certain country. P is population, China is the world's most populous country, and population growth will also bring the growth of energy consumption.

The LMDI method proposed by Ang has two kinds of decomposition forms, namely additive decomposition and multiplicative decomposition. In this chapter, the additive decomposition is used to decompose the primary energy consumption change between base year and target year into five factors, including energy structure effect (ΔE_{ES}), energy intensity effect (ΔE_{EI}), economic structure effect (ΔE_{GS}), economic effect (ΔE_{PG}) and population Effect (ΔE_{P}), and the decomposition formula is as follows:

$$\Delta \mathrm{E} = \Delta E_{ES} + \Delta E_{EI} + \Delta E_{GS} + \Delta E_{PG} + \Delta E_{P} \qquad (3-2)$$

According to the LMDI decomposition method, the impact of each factor on the total energy consumption in China can be quantified by the following formulas:

$$\Delta E_{ES} = \frac{E_t - E_0}{\ln E_t - \ln E_0} \times \ln\frac{ES_t}{ES_0} \quad (3-3) \qquad \Delta E_{EI} = \frac{E_t - E_0}{\ln E_t - \ln E_0} \times \ln\frac{EI_t}{EI_0} \quad (3-4)$$

$$\Delta E_{GS} = \frac{E_t - E_0}{\ln E_t - \ln E_0} \times \ln\frac{GS_t}{GS_0} \quad (3-5) \qquad \Delta E_{PG} = \frac{E_t - E_0}{\ln E_t - \ln E_0} \times \ln\frac{PG_t}{PG_0} \quad (3-6)$$

$$\Delta E_{P} = \frac{E_t - E_0}{\ln E_t - \ln E_0} \times \ln\frac{P_t}{P_0} \quad (3-7)$$

2.2 Factor decomposition results

By using Kaya identical equation and LMDI factor decomposition method, the influence of energy structure effect, energy intensity effect, economic structure effect, economic effect and population effect on the total change of primary energy consumption is quantified. The results are shown in table 3-1, figure 3-1 and table 3-2. Table 3-1 shows the specific value of each factor's effect on the total change in primary energy consumption, while figure 2-7 provides more clearly the changing trend and degree of contribution of each factor, and table 3-2 reveals the contribution of various factors to changes in primary energy consumption.

It can be seen from figure 3-1 that the economic effect and energy intensity effect are the most influential factors for the change of primary energy consumption, followed by the economic structure effect. However, the effects of energy structure and population on the change of primary energy consumption are relatively weak. As can be seen from table 3-1, the economic effects have the largest impact on the changes in total primary energy consumption, with the contribution of economic effects to primary energy consumption greater than 100 million tons of standard coal throughout the study period (except for the period from 1997 to 1998); In particular, between 2006 and 2007, economic effects led to an increase in total primary energy consumption of 394 million tons of standard coal, so it can be seen that the economic effect is a key factor leading to the continuous growth of primary energy consumption. This also confirms that the rapid development of China's economy has led to a rising demand for primary energy throughout the country, making China the world's largest energy consumer and largest carbon dioxide emitter. Therefore, the key to reducing the total primary energy consumption is to depress the impact of economic effects on the change of the total primary energy consumption, that is, to realize the decoupling of economic growth and primary energy consumption. In terms of accumulative effect, the second most important factor that leads to the growth of primary energy consumption is the population effect, which is always positive, because China is the most populous country in the world. The population base is large, and the total population is increasing every year. Although China's population growth has slowed down in recent years, it will take some time for the total population to decline. Similar to the population effect, the energy structure effect on the total primary energy consumption is positive throughout the study period. However, compared with the economic and population effects, the impact of the energy structure effect is relatively weak; this is because China's energy structure has been dominated by coal for a long time. Compared with coal, oil, natural gas and renewable energy account for a smaller proportion in the total consumption of primary energy. China's energy structure remains unchanged due to many factors, such as resource endowment and energy utilization technology.

Among all the factors that affect the total amount of primary energy consumption, the key factor that restrains the growth of the total amount of primary energy consumption is the energy intensity effect. The impact of energy intensity effect on the total primary energy consumption is negative from 1994 to 2002 and 2005 to 2016, while the effect of energy intensity on primary energy consumption from 2003 to 2005 is positive. The inhibition of energy intensity effect on the growth of primary energy consumption is mainly due to the progress of energy-saving technology and the improvement of energy efficiency of energy-saving products, which has led to the improvement of energy use efficiency in various industries. As a result, energy consumption per unit of GDP is decreasing. In terms of cumulative effects, the economic structure effect is the second largest factor inhibiting the growth of primary energy consumption, with a reduction of 205 million tons in total primary energy consumption during the study period, but on an annual basis, the economic structure effect on the total primary energy consumption direction is very unstable, it is not always inhibit the growth of total primary energy consumption. However, in recent years, from 2011 to 2016, the economic structure effect has been restraining the growth of the total primary energy consumption. The restraining effect of economic structure is mainly due to the continuous optimization of China's economic structure. China has been successfully transformed from a large agricultural country into an industrial power, and its economy has developed at a high speed. However, due to the development of heavy industry, China's environment has been destroyed, so began economic transformation and optimization of the industrial structure, and vigorously develop the tertiary industry, thus the proportion of China's tertiary industry in GDP continues to rise. By 2012, the proportion of the tertiary industry is basically equal to the secondary industry. After 2012, the proportion of the tertiary industry in China began to exceed the secondary industry, becoming the first industry to stimulate economic growth in China. According to the effect of economic structure on the total primary energy consumption in China, optimizing the economic structure and promoting industrial transformation are powerful measures to reduce the primary energy consumption in China.

Combining tables 1 and 2, we can see that compared with 1994, China's total primary energy consumption has increased by 3.132 billion tons of standard coal by 2016. Among them, the economic effect, as a key factor to promote the growth of the total primary energy consumption, has led to the growth of the primary energy consumption of 4.74 billion tons of standard coal, accounting for 151.31% of the total increase of primary energy consumption. As a key factor to curb the growth of total primary energy consumption, the energy intensity effect offset the growth of 1.742 billion tons of standard coal between 1994 and 2016, accounting for -55.61% of the total increase in primary energy consumption. In the period of 1994 to 1996 and 1997 to 2016, the economic effect on the growth of total primary energy consumption is greater than the energy intensity effect on the total growth of primary energy consumption. From 1996 to 1997, the economic effect promoted the growth of the total primary energy consumption of 111 million tons of standard coal, but the energy intensity effect inhibited the growth of the total primary energy consumption of 125 million tons of standard coal. So the boost of the economic effect is smaller than the inhibition of the energy intensity effect. During this period, the total primary energy consumption still increased by 7.1775 million tons of standard coal. This is because the contribution of population effect and economic effect to the total primary energy consumption is 106.55% and 189.92% of the total added value of primary energy consumption, respectively. From the cumulative effect, the population effect on the growth of total primary energy consumption is greater than the economic structure effect on the growth of total primary energy consumption. The population effect has promoted the increase in the total primary energy consumption of 339 million tons of standard coal, and the economic structure has offset the increase in the total primary energy consumption of 205 million tons of standard coal. The cumulative contribution rates of the two effects to the increase of total primary energy consumption were 10.83% and -6.55% respectively. However, the contribution rate of energy structure effect to the total primary energy consumption is less than 0.04% every year, and the cumulative contribution rate is 0.01%. It can be seen that the energy structure effect has a very small impact on the total primary energy consumption.

According to the result of the factor decomposition of the total primary energy consumption, we can see that the economic growth is the main reason leading to the increase of the total primary energy consumption, but a country cannot reduce the total primary energy consumption at the expense of the economy. China should reduce the total primary energy consumption under the premise of maintaining economic growth, so it is feasible to reduce the total primary energy consumption through the role of other factors, for example, the Chinese government can adopt measures such as optimizing the energy structure, increasing the proportion of natural gas and renewable energy, improving energy conservation technology, raising energy efficiency, reducing energy intensity, optimizing the economic structure, and promoting structural transformation.

Table 1 The factor decomposition results of total primary energy consumption (unit: 10,000 tons of standard coal)

	Energy structure effect	Energy intensity effect	Economic structure effect	Economic effect	Population effect	Total effect
1994-1995	0.25	-3593.77	632.72	10062.88	1338.78	8440.85
1995-1996	0.33	-9347.75	550.51	11426.91	1386.93	4016.93
1996-1997	0.14	-12472.67	764.78	11062.36	1363.14	717.75
1997-1998	0.00	-8131.33	-1172.76	8342.29	1243.33	281.54
1998-1999	0.38	-6546.07	293.69	9516.59	1132.12	4396.70
1999-2000	2.09	-6659.00	1195.35	10769.48	1089.48	6397.40
2000-2001	1.47	-2801.08	-392.02	10726.58	1051.02	8585.97
2001-2002	0.17	-1118.95	258.79	13844.29	1048.06	14032.36
2002-2003	3.74	7057.99	2178.80	17170.98	1099.28	27510.79
2003-2004	0.20	12305.46	-399.49	20040.04	1252.13	33198.33
2004-2005	8.07	2434.95	3257.02	23952.62	1446.19	31098.85
2005-2006	0.85	-11544.35	2481.74	32735.10	1444.82	25118.15
2006-2007	0.99	-15497.22	-504.61	39433.79	1543.91	24976.87
2007-2008	1.31	-21520.84	285.00	28800.09	1605.48	9171.05
2008-2009	0.12	-8588.92	-2615.12	25185.25	1598.06	15579.41
2009-2010	6.10	-11008.42	1390.92	32470.86	1668.71	24528.16
2010-2011	5.10	-5934.79	126.63	30413.33	1790.43	26400.69
2011-2012	3.01	-12993.41	-4460.16	30596.05	1954.17	15099.67
2012-2013	1.15	-7904.62	-5406.91	26072.29	2015.16	14777.07
2013-2014	1.45	-20934.75	-3767.92	31403.06	2192.78	8894.62
2014-2015	0.56	-12385.09	-10055.63	24420.22	2121.76	4101.81
2015-2016	0.87	-17005.62	-5149.47	25531.08	2540.00	5916.87
Cumulative effect	38.3	-174190.2	-20508.1	473976.1	33925.8	313241.8

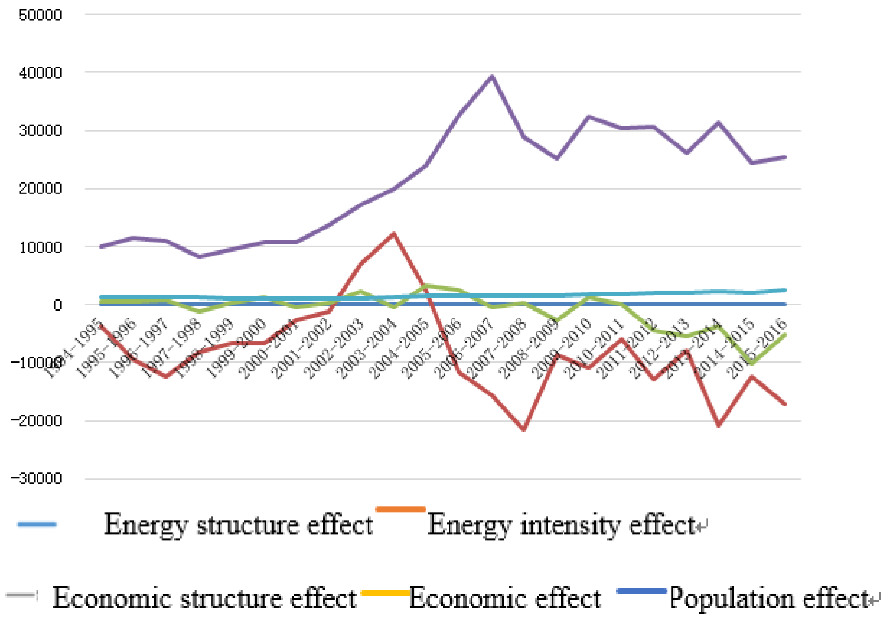

Figure 1 The factor decomposition results of total primary energy consumption (unit: 10,000 tons of standard coal)

Table 2 The contribution rate of various influencing factors to total primary energy consumption

	Energy structure effect	Energy intensity effect	Economic structure effect	Economic effect	Population effect	Total effect
1994-1995	0.00%	-42.58%	7.50%	119.22%	15.86%	100.00%
1995-1996	0.01%	-232.71%	13.70%	284.47%	34.53%	100.00%
1996-1997	0.02%	-1737.73%	106.55%	1541.24%	189.92%	100.00%
1997-1998	0.00%	-2888.17%	-416.55%	2963.10%	441.62%	100.00%
1998-1999	0.01%	-148.89%	6.68%	216.45%	25.75%	100.00%
1999-2000	0.03%	-104.09%	18.68%	168.34%	17.03%	100.00%
2000-2001	0.02%	-32.62%	-4.57%	124.93%	12.24%	100.00%
2001-2002	0.00%	-7.97%	1.84%	98.66%	7.47%	100.00%
2002-2003	0.01%	25.66%	7.92%	62.42%	4.00%	100.00%
2003-2004	0.00%	37.07%	-1.20%	60.36%	3.77%	100.00%
2004-2005	0.03%	7.83%	10.47%	77.02%	4.65%	100.00%
2005-2006	0.00%	-45.96%	9.88%	130.32%	5.75%	100.00%
2006-2007	0.00%	-62.05%	-2.02%	157.88%	6.18%	100.00%
2007-2008	0.01%	-234.66%	3.11%	314.03%	17.51%	100.00%
2008-2009	0.00%	-55.13%	-16.79%	161.66%	10.26%	100.00%
2009-2010	0.02%	-44.88%	5.67%	132.38%	6.80%	100.00%
2010-2011	0.02%	-22.48%	0.48%	115.20%	6.78%	100.00%
2011-2012	0.02%	-86.05%	-29.54%	202.63%	12.94%	100.00%
2012-2013	0.01%	-53.49%	-36.59%	176.44%	13.64%	100.00%
2013-2014	0.02%	-235.36%	-42.36%	353.06%	24.65%	100.00%
2014-2015	0.01%	-301.94%	-245.15%	595.35%	51.73%	100.00%
2015-2016	0.01%	-287.41%	-87.03%	431.50%	42.93%	100.00%
Cumulative contribution rate	0.01%	-55.61%	-6.55%	151.31%	10.83%	100.00%

3. Analysis on influencing factors of primary energy consumption efficiency in China

3.1 STIRPAT model of primary energy consumption efficiency

The STIRPAT model was developed from the IPAT model. The IPAT equation was first proposed by Ehrlich et al [108] in 1971 to study how the growing population affects the natural environment. The expression is as follows:

$$I = P \times A \times T \qquad (3-8)$$

Among them, d, s, p and f respectively represent environmental load, population size, per capita wealth and technology. However, the limitation of IPAT model is that the proportional effect of this factor on environmental change can only be estimated by changing one factor while keeping other factors unchanged. In order to overcome the unit elasticity assumption in the IPAT model and facilitate the empirical analysis, Dietz [109] added randomness to the IPAT model and proposed the STIRPAT model in 1994, the expression of which is as follows:

$$I = a \times P^b \times A^c \times T^d \times e \qquad (3-9)$$

The logarithmic form of formula (2-9) can represent the linear relationship between population, wealth and technology, and can be further expressed as follows:

$$lnI = lna + blnP + clnA + dlnT + lne \qquad (3-10)$$

In formulas (2-9) and (2-10), I, P, A and T are the environmental load, population, wealth and technology, respectively, and a is the coefficient of the model; b, c and d are exponents of population, wealth, technology and other driving factors, reflecting the extent to which changes in factors affect environmental stress. The larger the exponent, the greater the influence of the driving factors on the environmental pressure; e is the error term of the model.

In this chapter, in order to further quantify the relationship between primary energy consumption and economic growth, we use primary energy efficiency to represent economic change per unit of primary energy consumption, and adopt STIRPAT model to quantify the driving factors of primary energy efficiency in China to explore how to improve primary energy efficiency more specifically. STIRPAT multivariable nonlinear model can be used to construct the econometric model of the relationship between primary energy efficiency and its driving factors, which can be expressed as follows:

$$EE = a \times EP^{a_1} \times CS^{a_2} \times PS^{a_3} \times NS^{a_4} \times HS^{a_5} \times PG^{a_6} \times ES^{a_7} \times I^{a_8} \times e \quad (3-11)$$

In order to determine the relevant parameters by regression analysis, the following formula is obtained by taking the logarithm on both sides of the equation at the same time:

$$\mathrm{Ln}EE = lna + a_1 lnEP + a_2 lnCS + a_3 lnPS + a_4 lnNS + a_5 lnHS + a_6 lnPG + a_7 lnES + a_8 lnI + lne \qquad (3-12)$$

Where $a_1, a_2, a_3, a_4, a_5, a_7$ and a_8 are coefficients of elasticity, indicating that each change of 1% in EP,CS,PS,NS,HS,PG,ES and I results in a change in energy efficiency of $a_1\%, a_2\%, a_3\%, a_4\%, a_5\%, a_7\%$ and $a_8\%$, respectively. The meanings of the symbols in formulas (3-11) and (3-12) are showed in the table 3.

After the energy efficiency STIRPAT model is established, the elastic coefficient is determined. In order to eliminate the multicollinearity of independent variables, partial least-squares method is used for regression fitting in this chapter. The mechanism is as follows: principal component analysis is used for the analysis and screening of the original data, extracting the most comprehensive variables which explain the dependent variables. Then taking energy efficiency as dependent variable, regarding comprehensive variable as explanatory variable, using the least square method for regression fitting, so as to get the elastic coefficient of primary energy efficiency driving factors.

Table 3 Symbolic meanings in formulas (3-11) and (3-12)

Abbreviation	Meaning	Calculation formula	Unit
EE	Energy efficiency	$\frac{\text{Total energy consumption}}{\text{GDP}}$	Ten thousand yuan / standard coal
EP	Employed population	—	Ten thousand people
CS	Coal structure	$\frac{\text{Coal consumption}}{\text{Total energy consumption}}$	Percentage
PS	Oil structure	$\frac{\text{Oil comsumption}}{\text{Total energy consumption}}$	Percentage
NS	Natural gas structure	$\frac{\text{Natural gas consumption}}{\text{Total energy consumption}}$	Percentage
HS	Hydropower structure	$\frac{\text{Hydropower consumption}}{\text{Total energy consumption}}$	Percentage
PG	Per capita GDP	$\frac{GDP}{\text{Total population}}$	Ten thousand yuan per person
GS	Economic structure	$\frac{\text{Industrial GDP}}{\text{GDP}}$	Percentage
I	Investment in fixed assets	—	Billions of dollars

3.2 Factor decomposition results

In order to explore how to improve energy efficiency more concretely and effectively by quantifying the driving factors of energy efficiency in China with STIRPAT model, the starting point of this chapter is China's accession to the World Trade Organization (WTO), that is, from 2001. Since 2001, China's economic development has entered a new period, economic growth makes the national demand for primary energy consumption is also growing. The data of coal structure, oil structure, natural gas structure and hydropower structure in this chapter are sorted out according to China Energy Statistics Yearbook. Data on gross domestic product (GDP), fixed asset investment, employment and total population are from the China Statistical Yearbook. In order to eliminate the effects of inflation, GDP and investment in the fixed assets data were converted to constant prices in 2001. This chapter uses the STIRPAT model to quantify the driving factors of primary energy efficiency in China, as shown in tables 4 to 9.

According to the nature of energy efficiency, the employment population, coal structure, oil structure, natural gas structure, hydropower structure, per capita GDP, economic structure and investment in the fixed assets are selected as the alternative driving factors of primary energy efficiency in China. First, a partial correlation analysis of the eight alternative driving factors is performed, as shown in table 3-4. It can be seen that there is a high correlation between the eight alternative driving factors and energy efficiency, with a significant level of less than 1%, which leads to the conclusion that the employment population, coal structure, oil structure, natural gas structure, hydropower structure, per capita GDP, economic structure and investment in the fixed assets are the driving factors of energy efficiency.

The principal component analysis of the eight driving factors of primary energy efficiency is shown in tables 3-5 and 3-6. As shown in Table 3-5, after analyzing and screening the eight driving factors, two principal components (i.e., composite variables) can be extracted and expressed in terms of FAC1 and FAC2. These two comprehensive variables can explain 97.167% of the original variables. Based on the score coefficient matrix of principal component analysis, the relationship between the composite variable FAC1,FAC2 and the original driving factors can be expressed as follows:

$$FAC1 = 0.1662LNEP - 0.0870LNCS - 0.1194LNPS + 0.1653LNNS + 0.1095LNHS + 0.1678LNPG + 0.1528LNGS + 0.1675LNI \qquad (3-13)$$

$$FAC2 = -0.0698LNEP - 0.4624LNCS + 0.3638LNPS + 0.0744LNNS + 0.3919LNHS - 0.0366LNPG - 0.1816LNGS - 0.0388LNI \qquad (3-14)$$

With LNEE as dependent variable and FAC1 and FAC2 as explanatory variables, the results are shown in tables 3-7, 3-8 and 3-9 by using the least square method. As shown in tables 3-7 and 3-8, the R square of the model is 0.991, the F value is 717.670, and the Sig value of the T test is less than 0.01.Thus, it can be concluded that the fitting degree of the model is very good. Based on the model coefficients in Table 2-9, the equations for the explanatory variable FAC1,FAC2 and the dependent variable LNEE are as follows:

$$LNEE = 0.4169FAC1 + 0.5190FAC2 \qquad (3-15)$$

Substituting equations (2-13) and (2-14) into equation (2-15), the following measurement model of the driving factors of energy efficiency in China is obtained:

$$EE = a \times EP^{0.0331} \times CS^{-0.2763} \times PS^{0.1390} \times NS^{0.1075} \times HS^{0.2490} \times PG^{0.0509} \times GS^{-0.0306} \times I^{0.0497} \times e \qquad (3-16)$$

As shown in formula (2-16), the elasticity coefficients of driving factors of employed population, coal structure, petroleum structure, natural gas structure, hydropower structure, per capita GDP, economic structure and investment in fixed assets of primary energy efficiency in China from 2001 to 2015 are 0.0331, -0.2763, 0.1390, 0.1075, 0.2490, 0.0509, -0.0306 and 0.0497, respectively, indicating that when the number of employed population increases by 1%, the primary energy efficiency will increase by 0.0331%; When the proportion of coal consumption increases by 1%, the primary energy efficiency will decrease by 0.2763%; when the proportion of oil consumption increases by 1%, the primary energy efficiency will increase by 0.139%; when the proportion of natural gas consumption increases by 1%, the primary energy efficiency will increase by 0.1075%; when the proportion of hydropower consumption increases by 1%, the primary energy efficiency will increase by 0.2490%; When GDP per capita increases by 1%, the primary energy efficiency increases by 0.0509%; when the proportion of industrial output to total output increases by 1%, the primary energy efficiency will decrease by 0.0306%; when fixed assets investment increases by 1%, the primary energy efficiency will increase by 0.0497%. Hydropower structure, oil structure, natural gas structure, employment personnel, per capita GDP and investment in the fixed assets have played an important role in improving China's primary energy efficiency, while coal structure and economic structure are the main factors of energy efficiency decline. Hydropower structure is the main factor to improve China's energy efficiency, followed by oil structure and natural gas structure, while coal structure is the main restraining factor to improve primary energy efficiency. It can be concluded that the most effective measure to improve the efficiency of primary energy is to change the structure of energy consumption, water is a clean energy, and oil and natural gas can produce more calorific value than coal in the process of burning. Therefore, there is a need to increase the share of hydropower, oil and gas in the energy mix and to reduce the share of coal in primary energy consumption. In addition, increasing employment and improving per capita gross domestic product (GDP) and investment in fixed assets are effective measures to improve energy efficiency. On the contrary, an increase in the ratio of industrial gross domestic product to gross domestic product is not conducive to improving energy efficiency. Therefore, properly improving the industrial structure and increasing the proportion of services will improve energy efficiency.

Table 4 Partial correlation analysis of driving factors

Driving factors	Energy efficiency	Employed population	Coal structure	Oil structure	Natural gas structure	Hydropower structure	Per capita GDP	Economic structure	Investment in fixed assets
Correlation coefficient	1.000	-0.985**	-0.916**	0.841**	0.914**	0.885**	0.953**	-0.814**	0.883**
Sig (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000

Note: **. Significant at 0.01 level; *. Significant at 0.05 level

Table 5 Principal component analysis to explain total variance

Component	Initial eigenvalue			Extract the sum of squares load		
	Total	Variance%	Cumulative%	Total	Variance%	Cumulative%
1	5.942	74.271	74.271	5.942	74.271	74.271
2	1.832	22.896	97.167	1.832	22.896	97.167
3	.174	2.179	99.347	-	-	-
4	.027	0.337	99.684	-	-	-
5	.022	0.271	99.955	-	-	-
6	.002	0.029	99.984	-	-	-
7	.001	0.014	99.998	-	-	-
8	.000	0.002	100.000	-	-	-

Extraction method: principal component analysis

Table 6 Principal component analysis score coefficient matrix

	Component	
	1	2
LNEP	0.1662	-0.0698
LNCS	-0.0870	-0.4624
LNPS	-0.1194	0.3638
LNNS	0.1653	0.0744
LNHS	0.1095	0.3919
LNPG	0.1678	-0.0366
LNGS	0.1528	-0.1816
LNI	0.1675	-0.0388

Extraction method: principal component analysis

Table 7 Model summary

Equation	Multiple correlation coefficient	0.996
	R square	0.991
	Adjustment of R square	0.990
	Standard error of estimation	0.033

Table 8 ANOVA

		Quadratic sum	df	Mean square	F	Sig.
Equation	Regression	1.528	2	0.764	717.670	0.000
	Residual error	0.014	13	0.001	-	-
	Total	1.542[a]	15	-	-	-

Table 9 Model coefficient

		Unstandardized coefficient		Beta	t	Sig.
		B	Standard deviation			
Equation	FAC1	0.4169	0.030	3.639	13.883	0.000
	FAC2	0.5190	0.030	4.547	17.345	0.000

4. Conclusion

In this paper, the influence factors of primary energy consumption are analyzed by the combination of Kaya identical equation and LMDI decomposition method, and the key factor that restrains the growth of primary energy consumption, namely energy intensity, is further decomposed, in addition, the key factors of reducing energy intensity are found by establishing the STIRPAT model of primary energy consumption efficiency, so that the following conclusions are drawn:

The analysis on influencing factors of the primary energy consumption in China shows that the economic effect is the biggest contributing factor to the growth of the primary energy consumption, and the energy intensity effect is the key factor to restrain the growth of the total primary energy consumption; the effect of population on primary energy consumption is positive throughout the study period, and the economic structure effect is the second most important factor to restrain the growth of primary energy consumption; while the energy structure effect on the change of primary energy consumption is relatively weak.

The analysis on influencing factors of primary energy consumption efficiency in China shows that hydropower structure, oil structure, natural gas structure, employed population, per capita GDP and investment in fixed assets have played an important role in improving China's primary energy efficiency; while the coal structure and economic structure are the main factors of energy efficiency decline.

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