Empirical Analysis of the Impact of Energy Consumption on Industrial Structure- Take Sichuan Province, China as an example

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Abstract: In recent years, the growth rate of GDP in Sichuan Province has continued to exceed the national average, and its economic aggregate has also achieved leapfrog development. This paper combines the data of total energy consumption in Sichuan Province to conduct an empirical analysis of the impact of energy and industrial structure in Sichuan Province, and finally gives policy recommendations. The study found that the continuous increase of carbon emissions in Sichuan Province in recent years is mainly caused by the excessive dependence on coal-based fossil energy development economy. By increasing the ratio of oil and natural gas, the increase of carbon emissions can be effectively reduced.

1. Introduction

China promised in the Paris Agreement that carbon emissions will peak in 2030.At the same time, the carbon dioxide emissions per unit of GDP decreased by 60%-65% compared with 2005, and non-fossil energy accounted for about 20% of primary energy consumption. At present, China's carbon emissions are still far from the expected value, and carbon emission reduction has a long way to go.Among them, Sichuan Province, as a populous province and a region with growing economic growth, consumes a large amount of energy and continues to grow. The coal-based energy structure has not changed. The current energy conservation and emission reduction work is imperative, so it is necessary to make predictions on the future carbon emission peaks in Sichuan Province and provide a path reference for optimizing energy structure. The methods and results selected in the research process are useful for other studies on carbon reduction d in Sichuan Province.

2. Current Status of Total Energy Consumption in Sichuan Province

With the continuous upgrading of economic transformation and the continuous reform of supply-side structural reforms, the total energy consumption of Sichuan Province is still in the process of growth, but its growth rate has slightly decreased, while the proportion of green energy consumption has increased. In general, the energy consumption structure of Sichuan Province and China's total energy consumption structure are similar. Table 1 is a comparison table of total energy consumption between China and Sichuan Province.

Table. 1 Overview of energy consumption in Sichuan Province

2000	2001	2002	2003	2004	2005	2006	2007
5744.935464	5647.149944	6547.745232	8500.969856	9735.816288	9505.172784	10526.87274	11775.22828
146964.00000	155547.00000	169577.00000	197083.00000	230281.00000	261369.00000	286467.00000	311442.00000
3.93%	3.63%	3.86%	4.31%	4.23%	3.64%	3.67%	3.78%

2008	2009	2010	2011	2012	2013	2014	2015
13199.41965	14846.14121	14654.89699	14862.14274	15520.4076	15751.99736	15848.13026	14378.35882
336126	360648	320611	387043	402138	416913	425806	429905
4.12%	4.42%	4.06%	3.84%	3.86%	3.78%	3.72%	3.34%

The data in Table 1 comes from the Energy Department of the National Bureau of Statistics of China. The three rows of data are the total energy consumption in Sichuan Province and the total energy consumption in China. According to the comparison, the total energy consumption in China shows a general growth trend. Although the individual years have different degrees of decline compared with the previous year, the overall energy consumption of Sichuan Province is consistent with the national trend, and even the growth rate is even higher. Fast the data shows that the total energy consumption of Sichuan Province reached a high peak in 2003 and 2009 respectively, and fell to the lowest in 2015. The overall price was between 3.5% and 4.5%, and the increase was not obvious. There are a total of 30 provinces and cities with statistical data in the country, while Sichuan accounts for about 4%, which means that the total energy consumption in Sichuan Province is higher than the average of other provinces. According to statistics, China will achieve peak carbon emissions in 2030. In order to achieve the relevant development goals and key tasks of China's 13th Five-Year Plan, China's total carbon emissions must decline year by year. As a province with a relatively high proportion of total energy consumption, Sichuan Province can foresee that its pressure on emission reduction will increase year by year.

3. Empirical Analysis of the Impact of Energy and Industrial Structure in Sichuan Province

Table 2 is based on the carbon emission coefficient and the total energy consumption in the Sichuan Statistical Yearbook, the proportion of each type of primary energy consumption, and the number of permanent residents in Sichuan Province. From 2000 to 2016, the carbon emissions of coal in Sichuan's per capita carbon emissions were the largest, followed by oil and natural gas. It shows that Sichuan Province is more dependent on primary energy such as coal. Before 2013, carbon emissions showed a general growth trend, but after 2013, this growth trend gradually slowed down and even began to show negative growth, and per capita energy consumption also showed the same trend.

Table 2 Data on per capita carbon emissions and per capita energy consumption in Sichuan Province

2000	516.6	487.1	27.2	2.3	637.4	47.3	5.1
2001	518.2	482.8	32.8	2.4	630.9	5.7	5.5
2002	604.1	566.1	35.1	2.8	740.2	60.9	6.2
2003	779.1	736.0	40.0	2.9	963.7	69.4	6.6
2004	902.5	851.1	48.2	3.2	1112.7	83.5	7.2
2005	866.9	810.4	53.0	3.5	1057.8	91.9	7.8
2006	963.4	894.6	64.6	4.2	1167.4	111.9	9.3
2007	1081.9	999.3	78.1	4.4	1303.6	135.4	9.9
2008	1208.8	1114.0	90.5	4.3	1455.7	156.6	9.6
2009	1348.7	1239.0	104.7	5.0	1621.2	181.5	11.2
2010	1352.0	1226.3	118.7	7.0	1600.3	205.7	15.7
2011	1367.6	1228.4	132.9	6.3	1601.6	230.7	13.9
2012	1423.7	1276.7	141.0	6.1	1663.6	244.6	13.6
2013	1437.2	1274.5	156.7	5.9	1657.7	272.2	13.2
2014	1428.3	1221.5	200.3	6.5	1585.9	346.4	14.6
2015	1275.2	1049.0	219.4	6.7	1358.1	379.5	15.0
2016	1205.3	980.8	217.4	7.1	1271.6	376.2	15.8

Starting from the actual situation of Sichuan's rapid economic development, energy consumption will not be improved in a short period of time. The existing economic model still relies mainly on fossil energy to provide economic support for economic development.

analysisΔn_0、Δn_CwithΔn_SThe relationship between the two is plotted and the results obtained from Table 3 are plotted. Figure 1 shows the decomposition of the additive factors between the carbon emissions per capita and the carbon emission coefficient and the energy structure.According to the analysis, the trend of the carbon dioxide addition decomposition value and the energy structure addition decomposition value is very consistent, indicating that the energy structure has a significant impact on carbon emissions.The picture shows that the economic downturn from 2007 to 2008 caused a certain decline in the per capita carbon emission value of Sichuan Province, resulting in no increase in energy consumption; carbon emissions suddenly increased from 2008 to 2010, due to the Wenchuan earthquake. The reconstruction and renewal of infrastructure in Sichuan Province has led to a significant increase in energy consumption, which has continued until around 2011.2012 was a year of major breakthroughs in the “Twelfth Five-Year Plan” energy plan, and the per capita carbon emission value of Sichuan Province began to decline significantly.With the continuous advancement of the “13th Five-Year Plan” energy plan and the continuous optimization of the energy structure, the per capita carbon emission value of Sichuan Province has begun to be controlled.

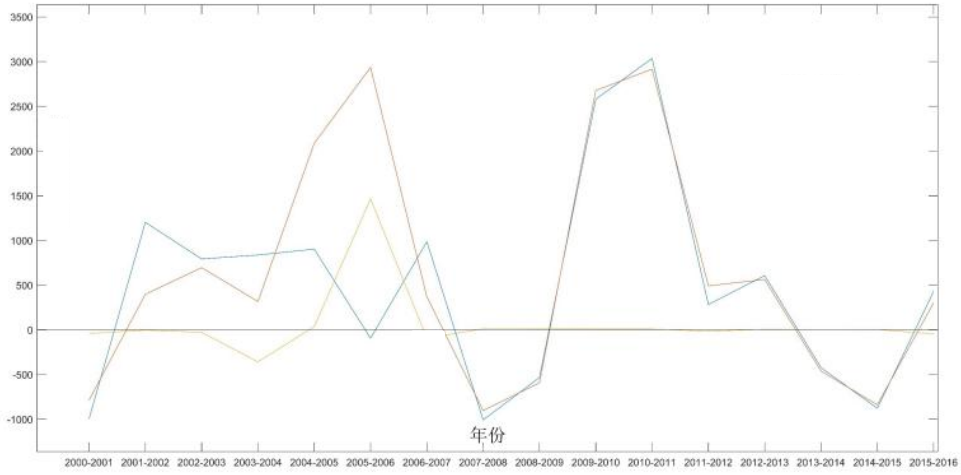

Fig.1 Schematic diagram of additive decomposition of factors affecting carbon emissions per capita

Among the effects of carbon emission factors, the trend of coal's carbon emission coefficient is almost synchronous with carbon emissions, indicating that coal's carbon emission coefficient has the most serious impact, as shown in Figure 2, before 2001 and 2007-2008. The addition decomposition value of emissions is less than zero. Before 2001, the negative indicates that the coal utilization technology is slower, but it can alleviate the increase of per capita carbon emissions to a certain extent. The analysis in 2008-2009 may be due to the 2008 Wenchuan earthquake. The cause of the coal discharge addition decomposition value is negative.The additive decomposition value of the petroleum carbon emission coefficient has been in a state of fluctuation, and the fluctuation state shows a slowly decreasing trend.The additive decomposition value of natural gas carbon emission coefficient has been in a non-negative state, and only the addition decomposition value of natural gas carbon emission coefficient has been positive, and the value is relatively small, indicating that the carbon emission generated by natural gas utilization technology is at a minimum.

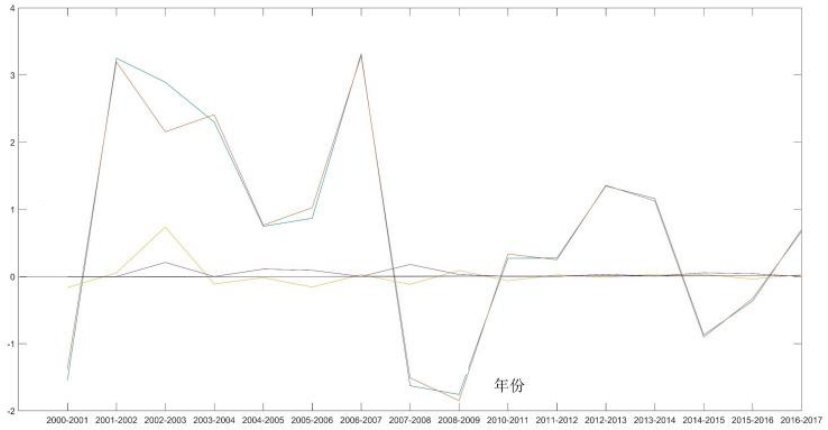

Fig. 2 Effect of carbon emission coefficient on effect decomposition

The distance between per capita coal consumption and energy structure curve is very close and the trend is basically the same; the decomposition value of per capita oil consumption increased year by year from 2001 to 2003, and continued to decline after reaching the peak, but all were positive; the per capita natural gas consumption changed little. It is almost negligible and remains positive.This directly indicates the vast majority of the effects of coal's impact on the energy consumption structure.

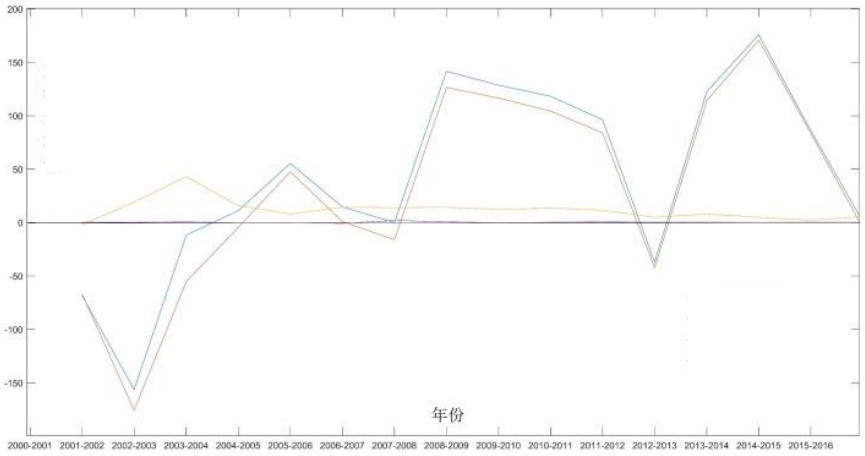

Fig. 3 Energy structure effect decomposition

According to the analysis, per capita carbon emissions are determined by the energy structure and carbon emission coefficient, but the effects of the two are different.The carbon emission coefficient is mainly due to the technical efficiency of energy utilization, so the overall impact on per capita carbon emissions is inhibited; and the energy consumption of each type has a significant increase, so the impact of energy structure on per capita carbon emissions is the driving effect. .

4. Policy Recommendations

Based on the above analysis, it can be found that due to the inertia of energy consumption and the reverse relationship between energy conservation and emission reduction and economic development, the total energy consumption is difficult to change in the short term, but the per capita energy consumption can be controlled.The energy consumption structure and carbon emission coefficient have different effects on per capita energy consumption, and the current energy structure is not conducive to emission reduction.Based on this, this paper proposes the following suggestions:

First, promote the optimization and upgrading of the economic structure, improve the use of clean energy, especially natural gas, and reduce the proportion of coal in the energy consumption structure.According to the Sichuan Statistical Yearbook, the current energy consumption elasticity

coefficient of Sichuan Province is 0.31, and this data has not declined in recent years, indicating that Sichuan's economic development relies heavily on energy consumption, and the secondary industry has been adjusted in a short period of time. It is not feasible to optimize the energy consumption structure with the proportion of the tertiary industry. Therefore, the energy consumption structure can be further optimized by adjusting the use of clean energy within the industry.From the above analysis results, it is not difficult to find that increasing the use of natural gas has a positive effect on optimizing energy structure and reducing carbon emissions. Sichuan has abundant natural gas reserves, and in recent years, natural gas extraction has also increased, as of 2017, official statistics. The amount of natural gas developed in Sichuan has reached 33.93 billion cubic meters.Therefore, optimizing the energy consumption structure by improving the use of clean energy, especially natural gas, is achievable at the current level of economic development and technology.

Second, improve energy utilization technology.Since per capita carbon emissions are greatly affected by coal emission factors, the driving force of technological advancement for energy conservation and emission reduction is obvious.According to the latest statistics, the investment in r&d in the petroleum processing, coking and nuclear fuel processing industries in Sichuan Province in 2018 was 22.737 million yuan, and the input intensity was 0.03%.However, the current Sichuan province is still very weak in promoting the development of low-carbon technology, and the energy conversion efficiency is 77.6%. Therefore, it is possible to appropriately introduce advanced technologies from other regions, increase investment in research and development of low-carbon technologies, and encourage multi-party market participants to actively participate. Advance the advancement of energy utilization technology.

Third, improve the inter-regional market-based trading mechanism, focus on promoting regional cooperation in energy consumption, and promote clean energy consumption.At present, the phenomenon of water abandonment in Sichuan is more prominent, and in the process of clean energy delivery, it involves multiple regional and multi-party market entities. Therefore, cross-regional coordination is more difficult.The country has also formulated the Clean Energy Consumption Action Plan (2018-2020), which has set a goal for clean energy consumption in various regions, and proposes to basically solve the problem of clean energy consumption by 2020.Promoting the solution of clean energy consumption can stimulate the production of clean energy to a certain extent and optimize the energy consumption structure.

5. Conclusion

This paper comprehensively analyzes the effects and trends of the energy consumption structure of Sichuan Province on carbon emissions through four aspects: per capita carbon emission and energy consumption per capita, factors affecting carbon emission coefficient, decomposition effect of carbon emission coefficient, and decomposition of energy structure effect. .Studies have shown that the relationship between carbon emissions and energy structure in Sichuan is very close, among which coal has the most important impact on carbon emissions, while oil and natural gas are smaller.Although it is difficult to reduce carbon emissions based on the current economic development background, it can start to reduce carbon emissions per capita, that is, reduce carbon emission factors of various energy sources and change existing energy structures.

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