Decoupling Analysis of the Relationship between Energy and Economic Development in Chongqing

Aixiang Tao
School of Business HuaiYin Institute of Technology Huai an, China
Taxzfytq@sina.cn

Abstract: Since the Chinese government put forward the strategy of ecological civilization construction, great achievements have been made in the construction of ecological civilization in our country. At present, there are a series of uncoordinated phenomena among energy, environment, and economic development in China. Taking Chongqing as an example, this paper uses decoupling theory to study the relationship between energy, environment, and economic development. The results show that the environment and economic development in Chongqing have been decoupled, and the energy consumption and economic development have also been decoupled. The main reasons are as follows: the increase of investment in science and technology; the improvement of personnel quality and the adjustment of economic structure. Chongqing Municipal Government should further increase investment in education, science and technology, take more scientific and effective measures to adjust the industrial structure in order to achieve further coordinated development of energy, environment and economy.

1. INTRODUCTION

Since the Chinese government put forward the strategy of ecological civilization construction, great achievements have been made in the construction of ecological civilization in our country. But there are also a series of problems in the construction of ecological civilization in China. It is of great significance to study the coordination of energy, environment, and economic development in order to improve the level of ecological civilization construction in China.

Many scholars have carried out relevant research on this issue. The results of the study on the relationship between energy and economy are as follows. From the perspective of the low-carbon economy, Xu Shan studied the path design and performance evaluation of energy saving and emission reduction in China [1]. Fan Fengyan studied the influencing factors of carbon emissions and emission reduction policies in Beijing. The results show that there is a long-term interaction among energy intensity, carbon emission intensity and economic growth in Beijing, but the direction and size of the interaction are different. On the basis of empirical research, Fan’s paper puts forward some policy suggestions on carbon emission reduction in Beijing from the aspects of energy intensity, energy structure, industrial structure, low-carbon transportation and low-carbon life[2]. Sun Yanxia used decoupling theory to study the relationship between economic development and energy consumption in Shandong Province. Their results show that the relationship between economic development and energy consumption in Shandong Province is in a weak decoupling state on the whole. Therefore, we should promote the optimization and upgrading of industrial structure, improve energy efficiency and energy structure[3]. Taking Eastern China as an example, Liu Huimin decoupled the relationship between China's economic development and energy consumption. By calculating and comparing the
five-year average of decoupling index in eastern China, the results show that economic growth and energy consumption decoupling are closely related to macro-policy adjustment, so increasing utilization efficiency to reduce total energy consumption and maintaining weak decoupling are the normal relationship between economic development and energy consumption in China[4]. Jiabei and Liu Hongqin conducted a decoupling study on energy consumption carbon emissions and economic development in Yunnan Province. The results show that from 1980 to 2014, except 2000-2005, the decoupling state appeared in other years. The main reason is the adjustment of industrial structure and the improvement of energy efficiency [5]. Wang Zhonglu made an empirical study on the relationship between energy consumption, carbon emissions and economic development in the Beijing-Tianjin-Hebei region. The results show that the weak decoupling between carbon emissions and economic growth in the Beijing-Tianjin-Hebei region is mainly due to the increasing energy efficiency, which leads to the decline of energy-saving elasticity. Therefore, the Beijing-Tianjin-Hebei region should continue to implement energy saving and emission reduction policies, promote industrial structure optimization and upgrading, further enhance energy efficiency, focus on improving energy consumption structure, and increase the proportion of new low-carbon energy sources [6]. Shang Jie used decoupling theory to study the relationship between economic development and energy carbon emissions in Gansu Province. The results show that the economic development and carbon emissions of Gansu Province in recent years are basically in a weak decoupling state, but this state is not stable. Therefore, it is still an important task for Gansu Province to reduce carbon emissions fundamentally by adjusting the industrial structure, energy structure and carbon emissions trading[7]. Based on the decoupling theory, Zhang Junfang studied the relationship between energy carbon emissions and coordinated economic development in Liaoning Province [8].

From the above research results, we can see that the scholars' research is more comprehensive. Based on the achievements of scholars and taking Chongqing as an example, this paper uses decoupling theory to study the relationship between energy, environment, and economy, then draws corresponding conclusions. The research results of this paper have positive significance for the coordinated development of energy, environment, and economy in other regions.

2. Data and methods

2.1. Data

Chongqing is a provincial administrative region of the People's Republic of China. It is the only municipality directly under the Central Government, a national central city, a mega-city and an international metropolis in the central and western regions of China. It is the economic, financial, technological, shipping and commercial logistics center in the upper reaches of the Yangtze River. It is an important strategic fulcrum for the development of the western region, and an important link between the "one belt and one road" as well as the Yangtze River points, and inland open highlands.

In recent years, Chongqing's economic and social development momentum is good, while the construction of ecological civilization has also made great achievements. But Chongqing still has problems in energy, environment, and economic development. This paper studies the relationship among energy, environment, and economy in Chongqing through decoupling theory. Chongqing's energy consumption level is expressed by previous years' energy consumption and environmental quality is expressed in two aspects, namely chemical oxygen demand emissions from wastewater and sulfur dioxide emissions from exhaust gas, and economic development level is expressed by annual GDP. By consulting Chongqing Statistical Yearbook 2008-2018, we got various data of Chongqing as follows, shown in Tables 1-4.

Table 1. Total energy consumption in Chongqing, unit: 10,000 tons of standard coal

| Year | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|------|------|------|------|------|------|------|------|------|------|------|
Table 2. Chongqing's annual GDP gross unit: 1000 million Yuan

| Year | GDP   |
|------|-------|
| 2008 | 583   |
| 2009 | 657   |
| 2010 | 798   |
| 2011 | 1008  |
| 2012 | 1150  |
| 2013 | 1289  |
| 2014 | 1439  |
| 2015 | 1587  |
| 2016 | 1774  |
| 2017 | 1950  |

2.2. Methods

This paper uses decoupling theory to study the relationship between energy and economic development in Chongqing. The theory of decoupling (DECOUPLING) is a basic theory put forward by the Organization for Economic Cooperation and Development (OECD) to describe the relationship between economic development and resource consumption or environmental pollution.

At the end of the 20th century, OECD introduced the concept of decoupling into agricultural policy research and gradually extended it to the field of environment. The term "decoupling" denotes the interruption of the relationship between the two aspects. Economic development and resource consumption or environmental pollution are decoupled to achieve decoupling development. Referring to the calculation model of the decoupling index proposed by OECD and the research results of foreign scholars TAPIO and domestic scholars, this paper constructs the following decoupling elastic coefficient model:

\[ En+1 = \frac{(GP_{n+1} - GP_n)}{(YF_{n+1} - YF_n)} \]

In formula (1), n is the nth year, En+1 is the elasticity coefficient of decoupling total energy consumption from total GDP in the nth + 1 year. GP_{n+1} is the total energy consumption in the nth + 1 year. GP_n is the total energy consumption in the nth year, YF_{n+1} is the total GDP in the nth + 1 year and YF_n is the total GDP in the nth year.

In this paper, the decoupling elastic coefficient 0.8 and 1.2 are used as the critical values to divide the decoupling state, and the decoupling state is divided into the following eight types, shown in Tables 3.

Table 3. Types of Decoupling between Total Energy Consumption and Total Economic Development in Chongqing

| Decoupling condition | Decoupling status           |
|----------------------|-----------------------------|
| E ≤ 0                | absolute decoupling(AD)     |
| E ≤ 0                | absolute negative decoupling(AND) |
| 0 < E ≤ 0.8          | weak decoupling(WD)         |
| 0 < E ≤ 0.8          | weak negative decoupling(WND) |
| 0.8 < E ≤ 1.2        | expansion connection(EC)    |
| 0.8 < E ≤ 1.2        | decline connection(DC)      |
| E > 1.2              | expansion negative decoupling(END) |
| E > 1.2              | recessive decoupling(RD)    |

3. Data analysis results

Using the decoupling theory and based on the above data, the calculation results are as follows.

The decoupling coefficient between total energy consumption and economic development in Chongqing is shown in Table 4.
Table 4. Decoupling coefficient of total energy consumption and GDP in Chongqing

| Year | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|------|------|------|------|------|------|------|------|------|------|
| decoupling coefficient | 0.693 | 0.628 | 0.403 | 0.412 | 0.554 | 0.523 | 0.472 | 0.214 | 0.216 |

The decoupling status between total energy consumption and economic development in Chongqing is as Table 5

Table 5. The decoupling of total energy consumption and GDP in Chongqing

| Year | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|------|------|------|------|------|------|------|------|------|------|
| decoupling status | WD   | WD   | WD   | WD   | WD   | WD   | WD   | WD   | WD   |

4. Conclusion and Discuss

From the results of the above calculation, we can see that the total energy consumption and economic development in Chongqing are in a good state of development. From the calculation data, we know that Chongqing's total energy consumption and economic development show a weak decoupling state from 2009 to 2017. The total energy consumption in Chongqing was 47.07 million tons of standard coal in 2008 and 84.49 million tons in 2017, an increase of 79.49% over 2008. The total GDP of Chongqing in 2017 was 1950 billion Yuan, an increase of 235% over 583 billion Yuan in 2008. It can be seen that Chongqing's total GDP and total energy consumption have increased, and the growth rate of GDP is obviously faster than that of total energy consumption from 2008 to 2017. It shows that there is a strong correlation between Chongqing's economic development and energy consumption, but it has gradually got rid of the dependence on energy consumption.

In summary, it can be seen that Chongqing's energy consumption and economic development have shown a trend of coordinated development. The reasons for this are mainly the following.

The first reason is the improvement of the quality of the population. The Chongqing Municipal Government attaches great importance to education. After years of hard work, the education level has increased substantially. In 2008, the financial education expenditure of Chongqing was 15.35 billion Yuan, and in 2017, the financial education expenditure of Chongqing was 62.63 billion Yuan, which was 4.08 times that of 2008. A large amount of education expenditures have resulted in a large number of high-quality talents. As can be seen from Table 6 below, the number of college students in Chongqing in 2008 was 485,000. In 2017, the number of college students in Chongqing reached 805,000, which was 1.66 times that of 2008. A large number of high-quality talents provide a steady stream of talent support for Chongqing's economic development, which is one of the main reasons for the high-quality development of Chongqing's economy.

Table 6. Chongqing financial education expenditure, unit: 100 million Yuan

| Year | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|------|------|------|------|------|------|------|------|------|------|------|
| Education expenditure | 153.5 | 190.3 | 240.5 | 318.7 | 399.3 | 437.3 | 469.9 | 536.2 | 575.2 | 626.3 |

The second reason is the enhancement of scientific and technological strength. As can be seen from the table below, Chongqing's financial and technological expenditures have increased year by year. In 2008, Chongqing's fiscal and technological expenditures were 1.51 billion Yuan. By 2017, Chongqing's fiscal and technological expenditures reached 5.93 billion Yuan, 3.93 times that of 2008. Huge financial input will effectively improve the scientific and technological level of Chongqing. Judging from the number of patent applications, according to the data of Chongqing Statistical Yearbook, the number of patent applications in Chongqing in 2008 was 8,324. In 2017, the number of
patent applications in Chongqing was 64,648, which was 7.766 times in 2008. The advancement of science and technology has enabled the use of more advanced technologies in Chongqing's economic development, thereby reducing energy consumption and reducing environmental pollution while economic development.

Table 8. Chongqing finance and technology expenditure unit: 100 million Yuan

| Year | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|------|------|------|------|------|------|------|------|------|------|------|
| Science Technology expenditure | 15.1 | 15.6 | 17.9 | 25.0 | 33.8 | 38.6 | 38.2 | 45.7 | 51.6 | 59.3 |

The third reason is the optimization of the industrial structure. The Chongqing Municipal Government attaches great importance to the role of industrial restructuring. By vigorously adjusting the industrial structure, the secondary industry with high energy consumption and high pollution will be gradually reduced, and the proportion of the tertiary industry will be increased. This can effectively reduce energy consumption and thus effectively reduce environmental pollution. As can be seen from the table below, the proportion of Chongqing's primary industry decreased from 9.9% of GDP in 2008 to 6.9% of GDP in 2017, showing a downward trend. The proportion of the secondary industry dropped from 44.8% of GDP in 2008 to 44.1% of GDP in 2017, and it also showed a downward trend. The proportion of the tertiary industry rose from 45.3% of GDP in 2008 to 49.0% of GDP in 2017, showing an upward trend. Obviously, the tertiary industry is a low-energy, low-pollution industry compared to the primary and secondary industries. Therefore, the increase in the proportion of the tertiary industry is conducive to the coordinated development of energy, environment and economy in Chongqing.

Table 9. Composition of industrial structure in Chongqing Unit: %

| Year | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|------|------|------|------|------|------|------|------|------|------|------|
| First industry | 9.9 | 9.2 | 8.6 | 8.4 | 8.2 | 7.8 | 7.4 | 7.2 | 7.3 | 6.9 |
| Second industry | 44.8 | 45.2 | 44.8 | 44.8 | 45.6 | 45.8 | 46.1 | 45.3 | 44.5 | 44.1 |
| Third industry | 45.3 | 45.6 | 46.6 | 46.8 | 46.2 | 46.4 | 46.5 | 47.5 | 48.2 | 49.0 |

References

[1] Bei H.P. Analysis on the Relationship of Regional Economy Growth and Carbon Emission in Beijing-Tianjin-Hebei Region. Tianjin University of Finance and Economics, 2017
[2] Chen Y.A study on Dynamic Mechanism of Jiangsu Province Energy Structure Optimization. Jiangsu University, 2017
[3] Cheng C, Tong S. Y, Peng H.Y. Analysis of economic development level and resources and environment carrying capacity in the central Yunnan urban agglomeration. Chinese Journal of Agricultural Resources and Regional Planning, 2017, 3:122-131
[4] Cui M. H. Decoupling analysis between economic growth and energy consumption and pollution discharge in Yangtze River Economic Delta. China Development, 2018, 10:1-8
[5] Fan F.Y. Study on the Impact Factors of Carbon Emissions and the Emission Reduction Policy in Beijing. China University of Geosciences (Beijing), 2016
[6] Guo P. J, Liu H.L, Li L. Q, Zhang Y. Decoupling relationship and driving factors between economic growth and the resource environment for Henan province. Journal of Shanxi Normal University (Natural Science Edition), 2019, 3:86-92
[7] Han R. L, Zhang Q. L, Zhu S. H. Environmental response analysis of Tangshan city’s economic development based on decoupling and VEC Model. Hebei Normal University, 2017, 3:29-35
[8] Han W. Y, Chen X. P, Zhang Z.L. Research on relationship between urban water use and economic growth based on decoupling analysis theory. Bulletin of Soil and Water Conservation, 2017, 10:141-146