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Development of Chemical Energy and Sustainable Development of Regional Economy in Shaanxi Province Based on Input - output Theory

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In order to study the development of chemical energy based on input-output theory and the sustainable development of regional economy in Shaanxi, firstly, the concept and theory of energy-related are analyzed, and the sustainable development of economy and input-output theory are elaborated. Taking Shaanxi Province as an example, on the basis of introducing the status quo of Shaanxi chemical energy and economic development, the relationship between Shaanxi chemical energy development and regional economic development is analysed. Then, the quantitative analysis of input-output theory is achieved. Energy development has a certain promotion effect and restriction effect on economic development. Finally, according to the actual situation, some prospects for future energy research are set up.

1. Introduction

Energy is the material basis and guarantee for economic and social development. All activities in human society production and life need to consume energy. The prosperity of economic society depends on the continuous supply of energy. With the rapid economic development, the demand for energy is constantly increasing. There are many energy conservation problems such as the prominent contradiction between supply and demand of energy and the serious waste of energy and resources (Lalumiere et al., 2013). In the energy industry development process, it will inevitably have an adverse impact on the ecological environment. The problems of resource depletion and environmental pollution have drawn widespread public concern. As an energy province in China, how to solve these problems as soon as possible and achieve sustainable development of energy industry has become a major issue that must be considered in the economic development of Shaanxi.

Shaanxi has long belonged to one of China's energy-starved provinces, and energy self-sufficiency rate is not high. However, with the gradual establishment of Longdong energy chemical industry base, Hexi new energy base and Shaanxi energy transportation corridor, the development of new energy sources in Shaanxi will play a decisive role in the development of regional economy and the development of the western region (Zhang and Baranger, 2017). Therefore, according to the resources advantage, the energy industry will be developed, and the economic development of the province is an important breakthrough to promote the economic and social development of Shaanxi. However, the energy industry has obvious polarization effect. The new energy industry has high investment cost in the early stage, and the energy security problem is outstanding. The impetus effect of energy development to the economy has not been fully highlighted (Timmer et al., 2015). Thus, the security work of energy development and the rational planning of the energy industry layout and base construction are the key points of the current research.

Based on the above background, firstly, the energy related concepts and theories are analyzed, especially the input-output theory, the circular economy theory and the low carbon economic development theory. Taking Shaanxi Province as an example, on the basis of introducing the current situation of energy and economic development, the promoting effect and restriction effect of energy development on economic development are analyzed quantitatively by input-output method (Qu et al., 2017).

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2. Method

2.1 Theoretical basis of chemical energy development and economic development

At present, there are about 20 definitions for chemical energy. Chemical energy is a source of energy that has many forms and interchangeable. Chemical energy is also known as energy resources or chemical energy resources (Ohunakin et al., 2014). There are many forms of chemical energy, including chemical energy, biomass energy and coal, crude oil, natural gas, coal bed gas, water energy, nuclear energy (disposable chemical energy) and electricity, heat, product oil (secondary chemical energy). In addition, there are some other new chemical energy and renewable chemical energy. The above chemical energy, which has been recognized by human beings, can be converted into some form of energy that people need under certain conditions (Aslani and Wong, 2014). The development of chemical energy means the whole process of energy resources investigation, exploration, planning, design, construction and mining. It includes the production of various chemical energy products which have been established in the development of various chemical energy resources and its secondary processing (Winkler et al., 2017). Specifically, it refers to the production of coal, oil, natural gas, hydropower and other chemical energy sources, as well as the production of thermal power generation, coking, crude oil processing and thermal production. The development of chemical energy research in this paper mainly refers to the exploitation, processing, transformation and development of the hydropower resources.

2.2 Sustainable development of economy

The sustainable development involves many aspects, such as nature, environment, society, economy, science and technology, politics and so on (Mekhilef et al., 2014). There are many definitions for sustainable development. The most influential is the United Nations Committee on environment and development presided by Mrs. Blue Lent, and she is the former prime minister of Norway. In 1987, the definition proposed in *Our Common Future* was “Sustainable development is an improvement that meets the needs of the present person without compromising the ability of future generations to meet their own needs”. Now, our chemical energy is facing a crisis of shortage. In order to overcome the crisis, we should not only find a new supply of chemical energy resources, but also reduce the use of existing chemical energy. Based on this basic idea, the idea of sustainable development of chemical energy resources in China is put forward (Shen and Luo, 2015).

Sustainable development is an improvement that meets the needs of the present person without compromising the ability of future generations to meet their own needs. It emphasizes that the development of economic and social development must be coordinated with the development and utilization of resources and environmental protection. Paying attention to the internal relations of the economy, resources, environment and social subsystem belongs to a kind of systematic thought. The sustainable development is to study the economic form based on this systematic thought. Sustainable development is an economic and social system. It consists of four subsystems, namely, economy, resources, environment and society. As shown in Figure 1, each subsystem is composed of many elements.

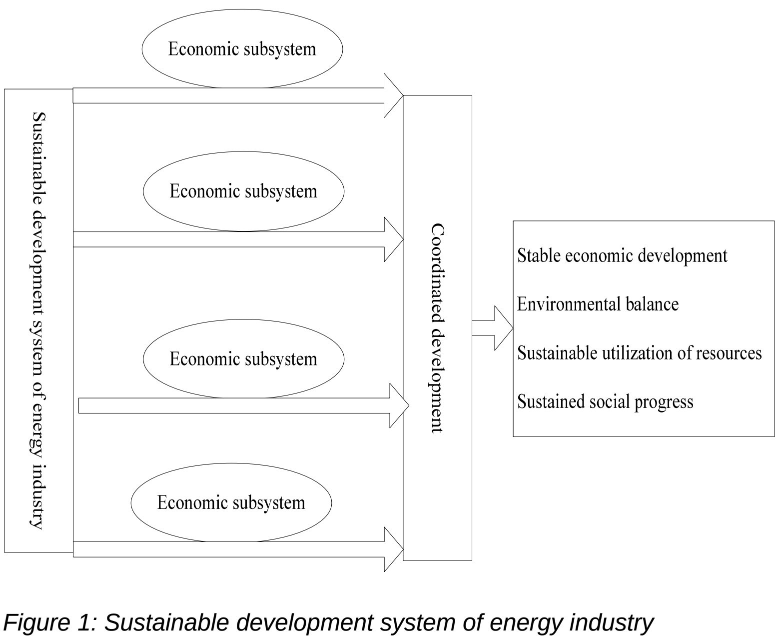


Figure 1: Sustainable development system of energy industry

As shown in Figure 1, the four subsystems of sustainable development are interconnected and interacted with each other. The economic subsystem is the material guarantee for the sustainable development of other subsystems. Resources are the material basis for sustainable development. Environmental protection is the key to sustainable development, and social progress is the strategic goal of sustainable development. Economy, resources, environment and society can be called subsystems. They are an organic whole that consists of multiple factors, multilayers, multi structures and multivariable. The subsystem contains many factors with causality, and the various elements play a role in a certain way. In the role of these elements, the causes and results are constantly changing positions. They interact as causality, and eventually form a cycle of causality. Therefore, the relationship between the four subsystems should be coordinated in the way of sustainable development. On the premise of ensuring the healthy and stable development of the four major subsystems, the long-term stability and sustainable development of the whole social system is maintained (Luo et al., 2015).

2.3 Input-output theory

Input-output analysis is an empty box attempt to combine economic facts and theories to enrich the economic theory. In the study of economic problems, qualitative analysis must be combined. The development of modern productivity, the progress of science and technology and the highly socialization of production also urge us to make a more precise quantitative analysis for the complicated economic connection (Zeng et al., 2013). Based on the input output method, the input-output of chemical energy industry in Shaanxi is analyzed by input-output method, and the input-output coefficient of each chemical energy industry is calculated. Based on the input-output thought, the promoting effect and restriction effect of Shaanxi chemical energy industry on economy are analyzed, and the relationship between energy development and economic development of Shaanxi chemical industry is revealed.

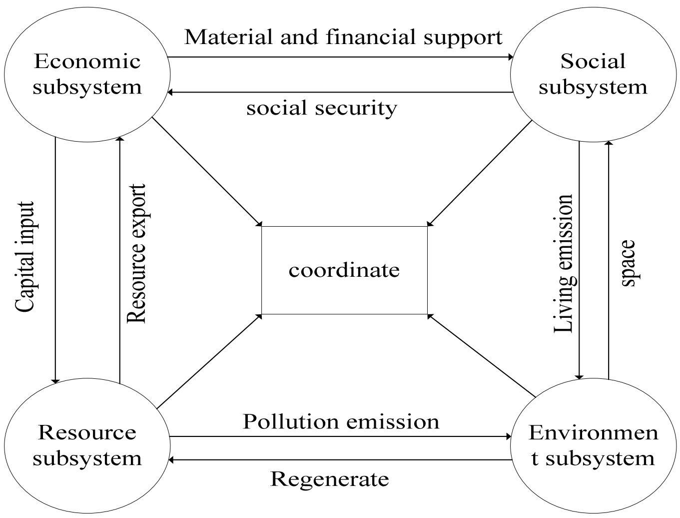


Figure 2: Sustainable development system coordination

3. Result

3.1 Analysis of the relationship between the development of chemical energy and regional economy in Shaanxi

Since the reform and opening up, especially in the past 10 years in the western development, Shaanxi's chemical energy industry has made great progress, and its production capacity and technology level has been greatly improved. Shaanxi chemical energy industry is developing rapidly. Especially the rapid development of clean new chemical energy, it prompts the whole chemical energy consumption structure of Shaanxi to become more reasonable, which basically meets the needs of national economic growth. The "bottleneck" problem which has long restricted the economic and social development of Shaanxi has been solved.

Shaanxi province has abundant energy resources such as coal, oil, gas and so on. In 2011, the output of raw coal in Shaanxi reached 286,436,800 tons of standard coal, up 15.24% over the previous year. The output of crude oil is 46,078,300 tons of standard coal, up 6.9% over the previous year. The output of natural gas is 36,204,200 tons of standard coal, up 25.47% over the previous year. Relying on resources and location advantages, Shaanxi has attracted energy companies from all over the country to invest in energy projects in

Shaanxi, laying the foundation for better implementation of sustainable development (Adaramola et al.,2014). In 2011, 21 modern coal mines were newly built in Shaanxi coal, with a new production capacity of 94,320,000 tons. New proven reserve of oil is 580 million tons, and the new capacity is 10 million tons. New proven reserve of natural gas is 230 billion cubic meters, and the new capacity is 4 billion cubic meters. The new power installed capacity is 12.28 million kilowatts, of which West-East electricity transmission project of North Shaanxi is 3.6 million kilowatts. At the same time, Shaanxi province smoothly push forward the energy and people's livelihood project and accelerate the transformation of rural power grid. The total investment of 10 billion yuan was completed, and 14 rural electrified counties in Lantian and Ansai county were built, and the "gasification Shaanxi" project was vigorously implemented.

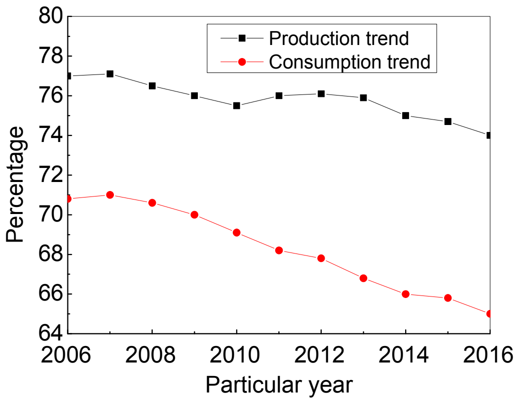
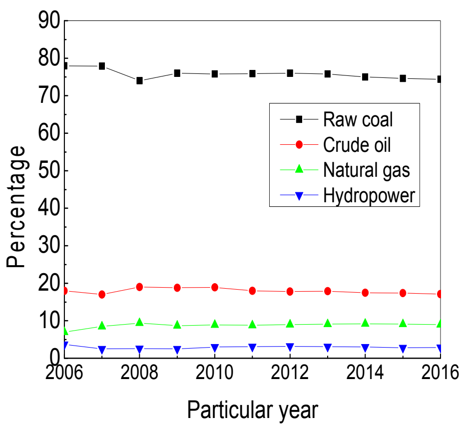


Figure 3: Energy production and consumption in Shaanxi

With the development of the economy, energy consumption in Shaanxi has been increased year by year, and energy production has developed rapidly. The total amount of energy production exceeds the total energy consumption, and the gap between the supply and demand of energy is expanding. Figure 3 shows the situation of energy production and consumption in Shaanxi since 2006.
On the other hand, Shaanxi's energy consumption is dominated by raw coal, and the proportion of raw coal accounts for more than 70% of the energy consumption, which is higher than the national average. Figure 4 reflects the energy consumption structure in Shaanxi.



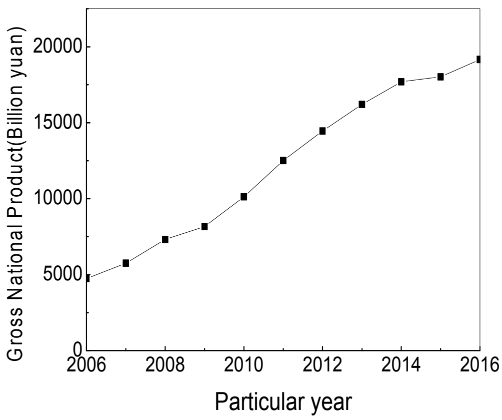


Figure 4: Energy consumption structure in Shaanxi Figure 5: Changes of GNP in Shaanxi in 2006-2016 years

According to the data in Figure 4, the proportion of Shaanxi coal in energy consumption in the 2006-2016 years fluctuates in 70%, and the proportion of natural gas is rising in the fluctuation. However, the proportion of oil and electricity is declining.
As shown in Figure 5, in 2016, the total output of Shaanxi province reached 19165.35 yuan, and the pace of expansion of the economic total was accelerating. According to the comparable price, the average annual growth rate of Shaanxi's GDP has reached 10.7% since the development of the western region. Especially since 2006, the gross domestic product has maintained double digit growth for seven consecutive years, with

an average annual growth of 11.1%. As shown in Figure 6, it shows that the GDP per capita in Shaanxi increased from 15165.12 yuan in 2006 to 51650.35 yuan in 2016, and the average annual growth rate increased by 13.3% based on comparable price.

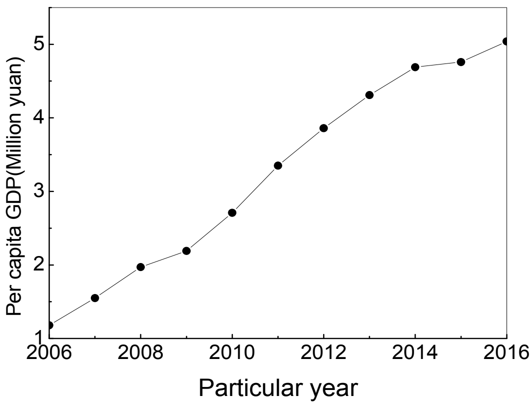


Figure 6: Changes in per capita GNP of Shaanxi Province in 2006-2016 years

3.2 Analysis of input-output effect on the development of chemical energy in Shaanxi

The input-output model is established on the basis of input-output table, and the input-output table is expressed in the form of matrix: AX+Y=X. In the expression, A is a direct consumption coefficient matrix, X is the total product matrix, and Y is the total matrix of the final product. After sorting the expression, it can be obtained: X=(I-A)- 1Y，that is, input-output row model. In the expression, I is a unit matrix. Assuming that B=(I-A) – 1, then B is Leontief Paradox. Based on this matrix, the modified influence coefficient and the induction coefficient are calculated. Using the full supply coefficient D= (I-R) - 1 matrix, the driving coefficient and the driving induction coefficient are calculated. R is the coefficient matrix of the joint distribution and the I is a unit matrix.

The input effect of chemical energy development mainly refers to the direct pulling effect of chemical energy development on Shaanxi investment. The influence factor is greater than 1, indicating that the impact of production on other sectors is more than the average level of social influence. The influence coefficient is less than 1, which indicates that the level of production to other departments is lower than the general level of the society. The size of the influence coefficient reflects the relative strength of the production of the department to the production of other sectors. The specific calculation formula is as follows:

$$\delta_j = \frac{\sum_i bij}{\sum_j (\sum_i bij) aj} \tag{1}$$

In the formula, a_j is a weight. It represents the proportion of the final product at the j sector to the total amount of the final product of the national economy, which is called the coefficient of final output. The output effect of chemical energy resources mainly refers to the direct pulling effect of chemical energy development on the total output of the society and the output value of other industries, which is mainly reflected by the induction coefficient and the driving force coefficient. Obviously, the greater the induction coefficient is, the greater the demand pressure for the department is. The improved induction coefficient is expressed as:

$$\theta_{\mathrm{i}} = \frac{\sum_{\mathrm{j}} bi_{ij} a_j}{\frac{1}{n} \sum_i \sum_j b_{ij} a_j} \tag{2}$$

In the formula, a_j is a weight. The economic meaning of the numerator in the formula is: The national economy produces a comprehensive final product and has a stimulating effect on the i sector of the national economy. The economic meaning of the denominator is: The national economy produces a comprehensive final product and plays an average driving role in the national economy. The induction coefficient calculated in this way indicates the comparison degree between the product influence inducement of the i department and the average influence induction of the national economic sector. The driving coefficient based on the distribution coefficient is the true coefficient of induction. The formula for calculating the driving force coefficient is improved as follows:

$$\tilde{\theta}_i = \frac{\sum_{i} d_{ij}}{\sum_{i}(\sum_{j} d_{ij}) \bullet \eta_i} \tag{3}$$

In the formula, di_j is partition coefficient. It indicates the proportion of initial input of the product in the i sector to the total initial input of the national economy, which is called the constituent coefficient of initial input. The economic meaning of the numerator is to increase the driving force of an initial investment in the i sector to the national economy. The economic meaning of the denominator is to increase the average driving force of a comprehensive initial input to the national economy. The driving force coefficient indicates size of the i sector's driving force relative to the entire national economy.

4. Conclusion

In order to study the input-output theory of chemical energy development and the sustainable development of Shaanxi's regional economy, the pulling effect, output driving effect, industrial linkage effect and income increasing effect of chemical energy development investment in Shaanxi province are analyzed. On the basis of introducing the current situation of Shaanxi chemical energy and the situation of economic development, the relationship between the development of chemical energy and the development of regional economy in Shaanxi is analyzed. Finally, the quantitative analysis of the input-output theory is realized. However, due to the limitation of length, the analysis of the current situation of Shaanxi energy industry and the relevant solutions are not provided.

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