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Study on the coordinated development of economy, environment and resource in coal-based areas in Shanxi Province in China: Based on the multi-objective optimization model

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ABSTRACT

Coal-based areas face resource depletion, environmental pollution, ecological damage, and other coordinated economic and social pressures. Based on the theory of policy network and the interest interaction in the policy network of the stakeholders, the paper puts forward the development goals of economic growth maximization, environmental pollution minimization and coal resource consumption minimization. Utilizing the data of the input-output table in Shanxi in 2007 and the China Environment Statistics Yearbook in 2008 and the multi-objective optimization model, this paper designs and assesses the green development policies effects, taking Shanxi province as the case. The results are that: (1) Three stakeholders of coordinated development in coal-based regions are the government, coal enterprises and the residents of the mine area. (2) The common goals of the three stakeholders are the maximization of industry output value, the minimization of pollutant discharge, and the minimization of coal consumption. (3) The research shows the coal industry will still be the main industry in Shanxi in 2015–2020. According to the conclusions, the paper puts forward to pay attention to the government interests, coal enterprises and residents of the mining area. Furthermore, coal exploitation and utilization should be planned scientifically, the trend of the coal market and price fluctuations should be analyzed, and the appropriate tax rate should be formulated.

1. Introduction

1.1. Background

China's economy has been maintaining at a high speed since its reform and opening. However, China's economy has entered a shift from high-speed growth to intermediate-speed growth in the schedule change, namely the economy has entered a new normal. The average annual growth rate from 2012 to 2015 was much lower than that from former years (National Bureau of Statistics of China, 2016). At the same time, the huge pressure of resource depletion and environmental damage which China faces are unprecedented. Contradictions among the environment, resource, ecology, human health, and social and economic development have become severe situations in China's current economic and social development. In the process of economic and social environment coordinated development, environment was deteriorated and then has been improved. Not all countries or regions have to go through the process of the treatment after pollution. Some countries control pollution emissions and resource utilization in the economic take-off phase. Since environmental degradation is irreversible, it is important to focus on the environment in coordinated development. Meanwhile, with the economic development, a certain degree of deterioration of the ecological environment is inevitable. However, economic growth, social and environment-friendly simultaneous development should be achieved under the premise of coordinated development.

Coal has been regarded as the most reliable and abundant resource in China's strategy, which occupies an important position in the energy industry and national economy. However, China's coal industry has changed since 2011 and coal-based regions are under pressure now. Coal-based regions face various problems, such as excessive rapid consumption of resources, serious ecological destruction, low-level environmental governance, unreasonable industrial structure, insufficient coordinated development power and so on. Shanxi province is the first biggest in coal production and typical coal-based province in China. Under the guidance of “only paying attention on the GDP growth

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rate", Shanxi province had extensive development, where many serious waste problems existed. Coal mining in Shanxi province has made great contributions to economic and social development, but it has also brought about ecological damage, environmental damage and geological disasters. Thus, taking Shanxi province as an example, the paper studies the coordinated development of coal resources. Studying on the policies of the coordinated development for Shanxi province can give advice on the coordinated economic growth, environment and resources for China's coal-based regions.

According to the data of Shanxi statistical yearbooks, it can be seen the total GDP growth rate in Shanxi province was far bigger after entering the twenty-first century. During the period between 2008 and 2009, the GDP growth rate appeared to be a relatively smooth trend, which was due to the transient stagnation caused by the financial crisis in 2008. In recent years, due to the terrible coal market and China's New Normal, the GDP growth rate has been gradually slowing down.

The output of raw coal in Shanxi province had been showing an increasing trend from 1978 to 1998. However, it showed a substantial decline in 2000 and 2001, which was due to the adjustment and rectification of the coal industrial structure. Similarly, due to the financial crisis in 2008, the output of raw coal decreased in 2009, while it increased during the following years.

1.2. Literature review

1.2.1. Research on the coordinated development of economy, environment and resource in the resource-based regions

Research on the resource-based regions has mainly concentrated on coordinated development, but the focuses are different. Former research generally constructed the development index to evaluate the coordinated development degree (Huang et al., 2008; Zhang et al., 2010; Guo, 2012; Yan et al., 2012; Zheng and Zhang, 2017). Foreign research paid more attention to the environmental protection, ecological restoration and other aspects, while domestic research tended to pay more attention to the mode choice of the development.

At the beginning of the 1950s or 1960s, resource-based regions began to appear with the phenomenon of Dutch disease and the resource curse, and the development of some resource-based regions began to slow down. Since then, experts have begun to explore how to transform and develop the resource-based regions. Sachs and Warner (1995, 1997, 1999, 2001) studied the relationship between economic development and the resources of mining countries and introduced the concept of the "Resource Curse". Its means were that the countries with great natural resource wealth tended to grow more slowly than resource-poor countries. Ross (1999) reviewed a wide range of attempts in both economics and political science to explain the "resource curse". The results indicated that less was known about their political problems. The disparity between strong findings on economic matters and weak findings on political ones partly reflected the failure of political scientists to carefully test their own theories. Mehlum et al. (2006) claimed that countries rich in natural resources constituted both growth and growth loss, which differed according to the quality of the institutions. The paper tested this theory based on the hypothesis that the institutions were decisive for the resource curse, which was confirmed. The results claimed that the institutions did play a role for the countries rich in natural resources. Boyce and Emery (2011) demonstrated that resource abundance was negatively correlated with growth rates but positively correlated with income levels using panel data for the USA from 1970 to 2001. Morrison (2012) examined the purported causal mechanisms underlying this "curse" and showed that they all focused on the revenue that these resources generated for the government. Zaman et al. (2016) recognized that environmental conservation and human activities should be paid more close attention to in the coordinated development. Gonzálezet al. (2017) deemed that coordinated development except the economics, society and environment depended on policy and culture. Now, coordinated development in the abroad is increasingly concerned with the development and utilization of renewable resources or renewable energy, which is conducive to the reduction of environmental pollution.

Domestic research on the development of resource-based regions was conducted later than abroad research. China began to attach importance to the problem and the transformation of resource-based regional development after 1990s, and the resource-based regions were dominated by coal-based regions or cities, which mainly focused on the development modes, industrial restructuring, the development stage and related policies. Fan (1993) recognized that the industrial structure should be adjusted urgently to develop resource-based regions. Based on the law of the urban pyramid, Shen and Wan (2003) proposed that there were few middle- and small-scale cities of resource-based cities in China and that the development should be accelerated. Based on the review of the resource curse, Shi and Huang (2009) constructed a dynamic model of three sectors, including resources, manufacturing and service sectors, from the economic perspective. The results showed that resource-based regions must make a strict mining plan, prevent excessive exploitation to maintain coordinated development, and plan to continue to afford strengthening support and assistance for the manufacturing industry. Jing and Zhang (2006) recognized that the differences in resource exploitation and urbanization disrupted the power and transformation mechanism between industrialization and urbanization during development. According to the characteristics of the resource economy, this paper suggested the idea of integrating industrialization and urbanization. Zhang (2001), Wang and Li (2005), Zang et al. (2006), Duo et al. (2007) conducted research on the industrial transformation of resource-based cities from different angles. Liu and Li (2009) recognized that resource-based cities could be divided into four layers, involving resources endowment layer, industry pattern layer, the logistics industry layer and the policy system layer. Industry expanded development pattern also needed the support of science and technology, talent and market. Zhou (2014) established the evaluation index system of the coordinated development level of coal industry in Shanxi, and made a comprehensive evaluation for the coordinated development level of coal industry in Shanxi. According to the analysis, environment and resource efficiency were the main negative factors affecting the coordinated development of Shanxi's coal industry. Chen (2017) argued that in recent years, the single management pattern of coal enterprises in Anhui province couldn't satisfy the requirement of coordinated development with the influence of the excess capacity, the falling coal prices and other factors.

From the research on the development of resource-based regions, it can be seen that the focus of this study mainly concentrates on the adjustment of the industry structure and economic transformation. Studies on the interaction of stakeholders are rare, and fewer studies have been conducted on quantitative research policy.

1.2.2. Research on policy network theory

Since the beginning of the late 1970s, policy network theory has become an important subject in the public policy field in the western countries. When the states promote public policies, they must coordinate the interests of the relevant groups, integrate of various resources to promote public governance capacity. The policy network is the interactive form of this stability and sustained relationship. It has formed different genres in its development process.

From the micro level, scholars in the USA mainly study the relationships among the interest group, bureaucracy and government individuals in the process of policy formulation. Wright (1988) explored the ways in which the relationship between the 'government' and 'industry' in the formation and implementation of policy could be compared cross-sectorally and cross-nationally. Thatcher (1998) considered that determining the appropriate scope and ambitions for network approaches depended on the choice of their fundamental purpose and role, together with their relationship with substantive hypotheses and models.