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Analysis of Influence Factors of the Old Industrial Area Industrial Structure Optimization and Model Building

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Abstract

The old industrial area in the years of development remain some problems to be solved at the same time, combined with years of accumulation of environmental problems is very outstanding, leading to the sustainable development ability is weak, etc. Therefore, optimize the industrial structure of the old industrial area is necessary. This chapter through the analysis of the influencing factors of the old industrial area industrial structure optimization, so as to refine out key factors, and Shangjie District industrial structure optimization as an example to expand research on the optimization of the industrial structure, and construct industrial structure optimization model by stochastic programming method, in order to provide guidance for choosing the subsequent path of the industrial structure, it has important practical significance for promoting industrial structure of Shangjie District become more rational.

Keywords*: structure optimization, key factors, stochastic plan, path choice*

1. Introduction

The industrial structure optimization is a necessary process of economic development of each country or region, domestic and foreign scholars also have developed a number of achievements for the industrial structure optimization method research, these results provide directly index to measure the level of industrial structure and a solid theoretical foundation and optimization model for China's industrial structure optimization. However, the industrial structure optimization problem emphasis on qualitative analysis, quantitative evaluation method on industrial structure optimization is unilateral, cannot comprehensive measure of the overall quality of the industrial structure [1]. In addition, the industrial structure with randomness and uncertainty in the long-term evolution by natural resources, changes in demand, investment decision-making, scientific and technological progress and ecological environment [2]. In this paper, the actual situation on the development of the industrial structure of Shangjie District, considering the economic development, full employment, less polluting development goals and constraints, stochastic programming to build industrial structure optimization model, provide science theory basis and technical support on the industrial structure optimization decision-making of Shangjie District. [3-8]

2. Analysis of Influence Factors of the Old Industrial Area Industrial Structure Optimization

The combination of old industrial areas industrial structure characteristics, in addition to the factors outlined above that the impact of the old industrial area industrial structure optimization, and by summarizing and analyzing extract the key factors affecting the old industrial area optimization of industrial structure, namely natural resources, consumption structure, investment structure, scientific and technological progress, environmental factors, international trade, and human resource supply. Following detailed analysis is focused on the above key factors affecting. [9-12]

2.1. Natural Resources

The natural conditions have a very important impact on the formation and adjust and optimize the industrial structure of the old industrial area. If the obvious advantages of natural

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resources of a country or region, the development of the industrial structure of the region will be biased in favor of the formation of resource-oriented, coupled with the correct guidance of the government to rely on the resource advantages, the region will gradually form a set of resource development, utilization and deep processing as one the industrial structure, so as to promote the economic development of the region; contrast, the development of the industrial structure of the resource-poor areas can only biased in favor of resource processing.

2.2. Consumption Structure

Consumer demand mainly includes production needs and personal consumption demand. Changes in the demand for the type and number directly determine the size and structure of the industry. With the rapid growth of economy, consumer spending structure converts from the low levels of consumer demand to high levels of demand, promote production resources transform from survival data production areas to the areas of industrial production, thereby enabling the service industry to become independent of a specific industry, further promote optimal adjustment of industrial structure, and promote changes in other related industries structure, thus contributing to the sophistication of the direction of development.

2.3. Investment Structure

Enterprises to expand production, industrial upgrading, in which investment is one of the essential conditions. If there is no investment, expand production and industrial expansion will be out of the question. Therefore, changes in the investment structure can cause changes in the existing industrial structure. Investment with new demand will be the formation of a new industry, you can change the type and quantity of existing industry [13]. The tendency to invest in industry and the proportion of different causes the ample investment industry development is more rapid, the speed and scale of investment in the development of small industries will decrease as time progresses, the final change of industrial structure

2.4. Scientific and Technological Progresses

Scientific and technological progress is essential for the adjustment of industrial structure and changing the mode of growth of the national economy. The progress of science and technology can transform traditional industries, eliminate backward industries and form new industries. No matter what industry, technology is the core strength of industrial development. The progress of science and technology can change the industrial structure by changing the structure of demand and supply, industry productivity and trade structure.

2.5. Other Influence Factors

First, the environmental factors include the development of the industrial structure mode, international environmental institutions and political systems and other factors besides the above factors studied; in addition, international trade is one of the important factors affecting the industrial structure optimization; Finally, the supply of human resources has a certain degree of impact to the process of the industrial structure optimization.

3. Industrial Structure Stochastic Optimization Model of Old Industrial Areas

3.1. Stochastic Programming Basic Principle

Stochastic programming is a mathematical programming method to deal with random data, compared with deterministic mathematical programming, the most difference is that the introduction of the random variable coefficient, which makes stochastic programming with more practical value to solve practical problems.

Model in a random environment contains random variables such function is handled by the following three ways:

(1) Establish expectations model: the original objective function and constraints contain uncertain functions, which can instead by expectations.

(2) The establishment of chance constrained programming model: when constraints contain uncertain variables, and before the variables in observation need to be judged decision-making.

(3) To establish related stochastic programming model: measure maximization from the measure of necessity, credibility, trust and so on.

3.2. Model Assumptions and Decision Variables

3.2.1. Model Assumptions

The paper builds the model of the optimization of the industrial structure of Shangjie District, based on the combination of input-output analysis and random multi-objective programming, now establish the basic assumptions of the input-output model.

Assumption 1: The number of inputs of each departments has proportional relationship with its total output, means the number of inputs is a linear function of the amount of output;

Assumption 2: Each department has the only consumption structure, that's each product can only use one type of technology to produce, and different product alternatives do not exist;

Assumption 3: The scientific and technological level constant, is investment coefficient and direct consumption coefficient is relatively stable in a certain period of time;

Assumption 4: The model only assume that pollution is a random variable, including air pollution, water pollution and solid waste pollution;

Assumption 5: The random variables follow a normal distribution, and the confidence level is set to 95%.

3.2.2. Model Assumptions

The development of Shangjie District includes agriculture, aluminum, machinery manufacturing, the green new materials industry, the general aviation industry, the service sector and other industries. Therefore, the article identified a total of 10 decision variables by the leading industry of Shangjie District, and define Xj as the output value of industry (j=1,2,…,10), the 10 decision variables are as follows:

X_1: Agriculture
X_2: Non-ferrous metal metallurgy
X_3: Ordinary Machinery Manufacturing
X_4: Non-metallic mineral manufacturing
X_5: Non-ferrous metals mining and dressing
X_6: Transportation and warehousing
X_7: Real estate
X_8: Wholesale and retail trade
X_9: Accommodation and catering services
X_{10}: Culture, Sports and Entertainment

3.3. Target Function

This paper selected three target functions of Shang Jie District industrial structure optimization, are full employment, economic growth and environmental friendly.

3.3.1. The Determination of the Economic Growth Target

Under the premise of national economy and social development, industrial structure optimization is to achieve maximization of the overall effectiveness and maximum growth, and it's also the basis and premise of the harmonious development of society [15]. Economic growth target is calculated according to equation (1)

$$\max \frac{e^T(X - AX)}{e^T(X_0 - AX_0)} \tag{1}$$

Among them,

$X=(X_1,X_2,\ldots\ldots,X_n)^T$ is the total output column vector of the industry department (decision variable) during the reporting period;

X_j is the output of the j-th sector,j=(1,2,……n)

X_0 is the total output column vector of the industry department (decision variable) during the base period;

$A=(a_{jk})(j,k=1,2,\ldots\ldots,10)$represents input-output consumption coefficient matrix;

E^T represents unit column vector transpose, is sum matrix;

In the economic growth target, select a given year as the base period, the ratio of GDP during the reporting period and GDP during the base period is the rate of economic growth.

3.3.2. The Determination of the Full Employment Target

Employment is an important issue that Shang Jie District faces during the development of economy, another goal of the industrial structure optimization is to make employment as large as possible, and to achieve full employment. The goal of full employment the paper selects is represented by the lowest unemployment rate.

$$\min 1-\frac{\sum_{j=1}^{n} X_j / l_j}{L} \tag{2}$$

Among them,

L represents the total labor supply;

l_j represents industry labor productivity accounting by social output value;

$\frac{\sum_{j=1}^{n} X_j / l_j}{L}$ represents the rate of employment, is the number of labor that the current economic development needs divided by the number of total labor.

3.3.3. The Determination of the Resource Consumption Target

Economic development of Shang Jie District has a problem of resources wasting and excessive consumption, high energy consumption economic growth mode and high-carbon industrial structure brought serious environmental pollution problems, in order to achieve the industrial structure optimization of Shang Jie District, and to build a resource-saving and environment-friendly modern city, the paper selected minimize resource consumption as industrial structure optimization goals

$$\min \frac{\sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij} X_j}{\sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij} X_0} \tag{3}$$

Among them,

C_{ij} represents the rate of the j-th industrial sector of the i-th resource consumption.

3.4. Analysis of the Constraints

For the analysis of influencing factors on the Shangjie industrial structure optimization, combined its own characteristics, the key factors which are able to bind not just impact the Shangjie industrial structure optimization can be refined from the influencing factors of industrial structure optimization of these old industrial areas [8]. Therefore, through the analysis, the conditions which can make up the constraint on Shangjie industrial structure optimization are seven aspects of the consumer demand, the capital formation, the net exports, the supply of labor, sector's output balance, and the state of the environment, specifically described as follows:

3.4.1. Consumer Demand Constraints

The gross output of the production of various departments must meet the needs of all consumers.

$$(1-s)[e^T(X-AX)] \geq e^T Y_c \tag{4}$$

In which, s is the domestic savings rate, Y_C is the column vector for the end consumer. $e^T(X-AX)$ represents the final output of the various departments available to consumers and is equal to GNP minus the output consumed by the various departments. It can be used for not only the consumers' final consumption, but also household savings to facilitate future investment.

3.4.2. Capital Formation Constraints

Investment behavior in the production process is used for capital formation. Therefore, the requirement of the invested capital is greater than capital formation.

$$(s+s_f)[e^T(X-AX)] \geq e^T Y_I \quad (5)$$

In which, s_f is the foreign capital inflows to GDP ratio, Y_I is the column vector for capital formation.

3.4.3. Net Export Constraints

The sum of the foreign industry needs of a country or region should be less than the output of foreign investment, and should meet the consumer level of the nation or region.

$$s_f[e^T(X-AX)] \geq e^T(-Y_n) \quad (6)$$

In which, Y_n is the column vector for net exports.

3.4.4. Labor Supply Constraints

Labor as a crucial factor of production, its meaning is self-evident on Shangjie economic development, so we should as far as possible provide sufficient jobs to meet the employment needs of the population to be employment, and promote economic growth while maintaining social stability.

$$0 < \frac{\sum_{j=1}^{n} X_j / l_j}{L} < 1 \quad (7)$$

3.4.5. Sector Output Balance Constraints

In economic activity, demand for the product is equal to supply, but to maintain a balance between the two is often more difficult, so industry supply should be greater than the sum of the consumption, the capital formation and the net exports.

$$X-AX \geq Y_C+Y_I+Y_n \quad (8)$$

3.4.6. Environmental Constraints

Protection of the ecological environment and control of the pollution is a serious problem faced by Shangjie long-term economic development. The paper selected pollution as a random variable, and applied probability constraint programming, that is when the inequality satisfied probability of random variables contained by environmental constraints can be greater than a selected constant, and we say it satisfies the constraints [9].

$$P(a_g x+\varepsilon_g \leq G) \geq \beta_g \quad (9)$$

$$P(a_s x+\varepsilon_s \leq S) \geq \beta_s \quad (10)$$

$$P(a_w x+\varepsilon_w \leq W) \geq \beta_w \quad (11)$$

In which, G represents the maximum emissions allowed in a given period by economic development in the region, S represents the maximum waste emissions allowed in a given period by economic development in the region, W represents the upper limit of the liquid waste emissions allowed in a given period by economic development in the region, ε_g, ε_s, ε_w are randomized emissions of waste gas, waste, liquid waste, β_g, β_s, β_w are the inequality probability meeted, this requires various regions according to their own development to determine specifically(the paper selected 95%).

3.4.7. Nonnegative Constraints

The total output of each sector in the model is greater than zero:

$$X=(X_1, X_2 \ldots X_n)^T \geq 0,\ X_n \geq 0 \quad (n=1,2,\ldots\ldots 10) \tag{12}$$

3.5. Modeling and Solving

Based on the above analysis, the stochastic programming model of the entire multi-objective industrial structure optimization is as follows:

$$\max \quad \frac{e^T(X - AX)}{e^T(X_0 - AX_0)}$$

$$\min \quad 1 - \frac{\sum_{j=1}^{n} X_j / l_j}{L}$$

$$\min \quad \frac{\sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij} X_j}{\sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij} X_0}$$

$$s.t. \begin{cases} (1-s)[e^T(X - AX)] \geq e^T Y_C \\ (s+s_f)[e^T(X - AX)] \geq e^T Y_l \\ s_f[e^T(X - AX)] \geq e^T(-Y_n) \\ 0 < \dfrac{\sum_{j=1}^{n} X_j / l_j}{L} < 1 \\ X - AX \geq Y_C + Y_l + Y_n \\ P(a_g x + \varepsilon_g \leq G) \geq \beta_g \\ P(a_s x + \varepsilon_s \leq S) \geq \beta_s \\ P(a_w x + \varepsilon_w \leq W) \geq \beta_w \\ X = (X_1, X_2, \ldots\ldots, X_n)^T \geq 0 \\ X_n \geq 0 \end{cases}$$

There are several ways of solving multi-objective planning, and you should apply different methods for solving different problems, doing specific conditions, and the general case can be classified into three categories [10]:

The first is the evaluation function method; the second is the hierarchical sequence method; the third is the analytic hierarchy process. Taken in this paper is the introduction of the first solution method, by allocating the right weight to a single target of the multi-objective planning, making multiple goals into a single objective, to solve problem, and simplify the model. Then, inspect the optimization of industrial structure under the circumstances of different target weights and according to the optimal value of the industrial structure in different objective function determine the nature of the industry as well as the development direction.

As ε_g, ε_s, ε_w are random variables, according to the theory of stochastic optimization, the inequality (3-9) (3-10) (3-11) can be transfomed into:

$$G\text{-}a_g^T X \geq \phi(\beta_g) \tag{13}$$

$$S\text{-}a_s^T X \geq \phi(\beta_s) \tag{14}$$

$$W\text{-}a_g^T X \geq \phi(\beta_W) \tag{15}$$

$\phi(\beta_g)$,$\phi(\beta_s)$,$\phi(\beta_W)$ in the upper-inequality are confidence levels under normal distribution, the selected confidence level is 95%, and with the corresponding confidence level is 1.96.

Three objective function weights are setting $\lambda_1, \lambda_2, \lambda_3$, and by processing the objective function and the constraints, the stochastic optimization model of the article can be completely converted to deterministic linear programming model, as the following form:

$$\min \quad \lambda_1 \frac{e^T(X_0 - AX_0)}{e^T(X - AX)} + \lambda_2\left(1 - \frac{\sum_{j=1}^{n} X_j / l_j}{L}\right) + \lambda_3 \frac{\sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij} X_j}{\sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij} X_0}$$

$$s.t. \begin{cases} (1-s)[e^T(X - AX)] \geq e^T Y_C \\ (s + s_f)[e^T(X - AX)] \geq e^T Y_l \\ s_f[e^T(X - AX)] \geq e^T(-Y_n) \\ 0 < \dfrac{\sum_{j=1}^{n} X_j / l_j}{L} < 1 \\ X - AX \geq Y_C + Y_l + Y_n \\ G - a_g^T X \geq \phi(\beta_g) \\ S - a_s^T X \geq \phi(\beta_s) \\ W - a_w^T X \geq \phi(\beta_w) \\ X = (X_1, X_2, \ldots\ldots, X_n)^T \geq 0 \\ X_n \geq 0 \end{cases}$$

4. Empirical Analysis

4.1. Data Selection and Processing

This paper data is from 07-10 years' Shangjie Statistical Yearbook, and pollution emissions coefficient and other relevant parameters of the model are collated by the relevant data of Shangjie Statistics Yearbook. Random variable εs, εg, εw are normal distribution, selected confidence level of 95%.

In order to make this model timeliness, firstly input-output tables should be revised, usually using the RAS method, using this method to obtain the direct consumption coefficient matrix in 2010.

Following is the input-output direct consumption coefficient correction formula:

$$a_{ij}^1 = r_i a_{ij}^0 s_j \tag{16}$$

In which, a_{ij} represents the direct consumption coefficient of the products produced by the industry j to the ones produced by the industry *i*;

a_{ij}^1 represents the direct consumption coefficient fixed;

a_{ij}^0 represents the actual direct consumption coefficient of the base year;

r_i is the alternative multiplier, which reflects the intermediate inputs i substitute other inputs, or the degree of substitution of other inputs;

s_j is the manufacturing multiplier, which reflects the degree of change in the proportion of sector *j* intermediate inputs.

The matrix form of the modified formula is:

$$B=RAS \tag{17}$$

In which, *A* represents the 2007 input-output matrix, whose element is a_{ij}^0;

B is the 2010 input-output matrix estimate, whose element is a_{ij}^1.

Assuming the existence of the diagonal matrix $R=diag(r_1,r_2,\ldots\ldots,r_n)$ and $S=diag(s_1,s_2,\ldots\ldots,s_n)$, if it is known that in the forecast period the total output, the final product, the net output vector of the various departments are X_t, Y_t, N_t, the total of the material consumption and the intermediate products of each sector in the forecast period is:

$$C_t=X_t-N_t, U_t=X_t-Y_t \tag{18}$$

Firstly, calculate the first line multiplier: $r_i^1 = \dfrac{u_i^t}{u_i^1}$, and adjust the flow line multiplier: $x_{ij}^2 = r_i^1 x_{ij}^1$

Then calculate the first column multiplier: $r_i^1 = \frac{u_i^t}{u_i^1}$, and adjust the flow line multiplier: $x_{ij}^3 = s_i^1 x_{ij}^2$

In accordance with the above procedure for the rows and the columns of the direct consumption coefficient matrix ongoing adjustments, it gets the direct consumption coefficient matrix modified.

4.2. Model Description

Using the most simplified form discusses the effectiveness of multi-objective optimization methods and the optimal production value of each industry with the goal weights change movements, and using the weighting method makes multi-objective optimization problem simplify to a single objective optimization problem. The following are four points to discuss weight of three goals function set by Shangjie industrial structure optimization stochastic programming model:

(1) Neutral program: (λ_1,λ_2,λ_3) = (1/3,1/3,1/3), that is as important as the degree of economic growth, full employment and resource conservation.

(2) Economic growth bias: (λ_1,λ_2,λ_3) = (1,0,0), that economic growth is more important than full employment and resource conservation.

(3) Full employment bias: (λ_1,λ_2,λ_3) = (0,1,0), that full employment is more important than economic growth and resource conservation.

(4) Resource conservation bias: (λ_1,λ_2,λ_3) = (0,0,1), that resource conservation is more important than economic growth and full employment.

4.3. Results Discussion

Finishing on Shangjie Statistical Yearbook data, simplifying a multi-objective optimization model built, and inputting 2010 data to model, the above four scenarios are simulated.

(1) Prepare the objective function and the constraint functions, and use MATLAB software simulation.

(2) Use toolbox function of the model for solving.

Table 1 shows the simulation results in different programs, the data showing that simulated index value of the neutral program, economic growth bias program, full employment bias program, resource conservation bias program. At the same time, the paper selected similar economic indicators in Gongyi City, the developed areas of Henan Province in 2010, with which to do the horizontal contrast. Gongyi City is also the part of Zhengzhou City, and has the similar geography, resources, environment and location advantages with Shangjie Area, and both of them are horizontal comparable.

Table 1. Economic growth and industrial structure change analog indicators of Shangjie Area

Index	The year of 2010		The industrial structure change simulation indicators of Shangjie Area in 2015			
	Shangjie Area	Gongyi City	1/3,1/3,1/3	1,0,0	0,1,0	0,0,1
GDP(One hundred million yuan)	89.4	404.7	121.1	127.6	119.4	108.0
The proportion of primary industry(%)	0.6	1.3	0.5	0.6	0.7	0.9
The proportion of secondary industry(%)	79.3	72.1	74.3	76.2	78.7	71.8
The proportion of tertiary industry(%)	20.1	26.6	25.2	23.2	20.6	27.3
Unemployment rate(%)	9.2	7.4	7.9	8.3	7.8	10.8
Sulfur dioxide emissions(Ten thousand tons)	5.7	3.1	4.6	6.9	7.5	3.4
Soot emissions(Ten thousand tons)	0.48	0.13	0.52	0.57	0.54	0.42

It can be found in Table 1 that the three major industrial development structure proportion of Gongyi City is more coordination in 2010. Compared with it, there is a big gap in

terms of quality and the proportion of serious imbalance of the three major industries in Shangjie industrial structure. In resource conservation program, the GDP growth rate is relatively slow, only increased from 8.94 billion yuan to 10.8 billion yuan. Compared with three industries accounted analog value, it can be found that there are excessive consumption of resources during Shangjie economic development, harmonious proportions in secondary and tertiary industries, and other phenomena. The proportion of tertiary industry in the economic development needs to be improved. From the unemployment rate, the unemployment rate of resource conservation program is 10.8% and it is significantly higher than the other three programs. In pollution emissions, the effect of resource conservation program pollutant control is most obvious, the emissions of sulfur dioxide is 3.4 million tons, soot emissions is 4,200 tons, and they are lower than the other three programs.

Table 2. Dominant industrial sector GDP changes comparison between Shangjie and Gongyi

Industrial sectors	The year of 2010		The year of 2015				
	Shangjie Area	Gongyi City	Shangjie Area				Gongyi City
			1/3,1/3,1/3	1,0,0	0,1,0	0,0,1	Existing programs
Non-ferrous metal smelting and delay processing industry	37.6	25.4	35.5	36.9	37.8	35.2	25.4
Agriculture	0.6	1.3	0.5	0.6	0.7	0.9	1.3
General equipment manufacturing	23.5	20.1	22.7	23.3	23.1	22.9	20.1
Non-metallic mineral products industry	15.3	10.4	14.2	14.1	15.0	14.0	10.4
Mining industry	11.2	6.2	11.0	11.0	11.2	10.8	6.2
Transportation and warehousing industry	2.7	10.6	3.8	3.5	2.9	3.2	10.6
Real estate	2.8	6.7	3.1	2.6	2.7	3.3	6.7
Wholesale and retail trade	3.4	6.6	4.7	4.2	3.5	4.9	6.6
Accommodation and catering	2.8	8.7	3.6	3.6	3.0	3.5	8.7
Culture, Sports and Entertainment	0.1	4.0	0.9	0.2	0.1	1.3	4.0

Table 2 shows the changes of the structure of GDP in 10 industry sectors under economic growth bias, full employment bias, resource conservation bias and neutral program in Shangjie, as well as 10 sectors GDP structure changes under the current program of Gongyi City.

The proportion of primary industry is lower in Shangjie Area and there are significant differences in the resource conservation bias program. The proportion of secondary industry in economic growth and the most significant decline in the four scenarios is the resource conservation bias program. The proportion of tertiary industry GDP is gradually increasing, especially in resource conservation bias program reached 27.3%, the growth rate of close to 35.8%, but the proportion of tertiary industry in the economic development is still low.

Therefore, for the primary industry in Shangjie, it is the most important way that Shangjie should be adapted to local conditions, creates specialty agriculture base, and takes the new agricultural roads to improve the efficiency of agricultural production and promote agricultural growth, the second industry should focus on the same in a resource-saving improvements to improve; but compared to the primary and second industries, the development space of the tertiary industry in Shangjie is large, and it is necessary to speed up the development of tertiary industry.

5. Conclusion

Firstly, this chapter analyzes the influencing factors of the industrial structure optimization of the old industrial area , and extracts the key influencing factors that affect the industrial structure optimization of the old industrial area; Secondly, for Shangjie as an example, expanding the study of the industrial structure optimization of the old industrial area, making the development goal of economy growth, full employment, and resource conservation as direction, selecting Shangjie 10 leading industries, using randomized multi-objective planning method to build industrial structure optimization model, analyzing the four scenarios on the simulation analysis of the Shangjie industrial structure in 2015 and horizontally comparing the results with similar economic indicators in developed area of Henan Province Gongyi City in 2010, these provide decision support for future development in Shangjie; finally, the optimization of industrial structure lay the theoretical framework and practical foundation for the subsequent path optimization.

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