ISSN : 0974 - 7435 Volume 10 Issue 16

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(16), 2014 [9002-9006]

Analysis on energy saving and emission reduction of industrial structure optimization under resource and environment constraints

Huang Zhiqi

School of Management and Economics, North China University of Water Resources and Electric Power, Zhengzhou, P.R.C

E-mail : zhiqih@sohu.com

ABSTRACT

With the adjustment of the industrial structure and the acceleration of the industrialization and urbanization process in China, the resource consumption and the ecological environment stress are intensified continuously, so that the resource and environment constraint degrees are increasingly deepened. Quickening the optimization and upgrading of the industrial structure will be conducive to reducing the dependency on the resources and the influence on the environment, and relieving the resource and environment constraints. Through building the objective programming model involving three objective functions such as economic growth, resource saving and pollution control, this paper regards small industrial resource consumption and reduction of the industrial pollution discharge as the constraint condition, to break through the resource and environment constraints by the adjustment and optimization of the industrial structure, and achieve the sustainable development of the industry in China.

KEYWORDS

Resource and environment constraints; Industrial adjustment; Energy saving and emission reduction.

PREFACE

The industrial structure is an important bond of economic activities and ecological environment, and the industrial structure is closely related to the economic growth, resource utilization, and environmental pollution. Therefore, the industrial structure optimization refers to the quality and sustainability of the economic growth. During the process of the economic growth, the contradiction between the limitation of the natural resource supply and the ever-increasing demands, between the limited bearing capacity of the environment and the increasing pollutant discharge are sharpening day by day. For example, at present the structural contradictions of the industry in China is acute, and the high energy-consuming industry has relatively large energy consumption. The comprehensive energy consumption of the industry above designated size has rapid growth, and the energy use efficiency is low, and the outdated capacity exit mechanism is unsound, resulting in the unsustainability of the energy resource consumption. Especially under the multiple stresses and restrictions of the scarce resources, energy shortage, and environmental pollution, exploring the industrial structure optimization problems under the dual constraints of the resource and environment possesses the major theoretical and practical significance, so as to provide the favorable development opportunity for the industrial structure optimization under the dual constraints of the resource and environment.

MODEL DESIGN OF INDUSTRIAL STRUCTURE OPTIMIZATION UNDER RESOURCE AND ENVIRONMENT CONSTRAINTS

Building objective functions

In combination with the special national conditions, this paper designs the objective functions in three aspects, involving economic growth, resource consumption and pollution control. The ultimate goal of the industrial structure optimization is to achieve the growth of the gross national product and adopt GDP maximum as one of the optimization objectives. Under the resource and environment constraints, the industrial water consumption and industrial energy consumption per ten thousand yuan of GDP is the major indicator of investigating the industrial water efficiency and energy consumption efficiency.[1] Thus, the minimum total water consumption and high energy consumption efficiency is another major indicator of optimization. The discharge of three wastes is also the major indicator of measuring the pollutant discharge of the industrial department. Reducing the total discharge of three wastes is of great significance for relieving the ecological environment stress.

The objective functions of the model are built as follows:

(1) Economic growth objective

$$\max F(x_t)=\sum a_i * x_i(t)$$

It regards achieving the economic growth maximum as the objective. a_i is the value-added rate of the industry, and $x_i(t)$ is the total output value of the i industry at t phase.

(2) Resource consumption control objective

$$\min G(x_t)=\sum c_i(t) * x_i(t);\ \min H(x_t)=\sum d_i(t) * x_i(t)$$

It regards the resource consumption minimum as the objective, to achieve the minimum industrial energy consumption per ten thousand yuan of GDP and minimum industrial water consumption. $c_i(t)$ is the gross output energy consumption coefficient of each establishment at t phase. $d_i(t)$ is the gross output water consumption coefficient of each establishment at t phase.[2]

(3) Pollution control objective

$$\min K(x_t)=\sum e_i(t) * x_i(t)+\sum f_i(t) * x_i(t)$$

It regards the pollution minimum as the objective, to represent by the minimum chemical oxygen demand and sulfur dioxide emission in reference to the relevant literatures. In the formula, $e_i(t)$ is the chemical oxygen demand emission coefficient of the i industry in t year. $f_i(t)$ is the sulfur dioxide emission coefficient of the i industry in t year.[3]

Determination of constraint conditions

(1) Constraint of industrial scale

Control the scale of the industrial development in accordance with the industrial development planning and industrial growth laws.

Constraint of energy sources

$$\sum c_i(t) * x_i(t) <= R_1(t)$$

$R_1(t)$ is the constraint of the maximum energy consumption of each industry in t year.

Constraint of water resources

$\sum d_i(t)*x_i(t)<=R_2(t)$

$R_2(t)$ is the constraint of the maximum water consumption of each industry in t year.

(4) Constraint of pollution control

① Constraint of chemical oxygen demand

$\sum f_i(t)*x_i(t) <=R_3(t)$

$R_3(t)$ is the constraint of total chemical oxygen demand emission of waste water discharge represented by each industry in t year.

② Constraint of sulfur dioxide emission

$\sum e_i(t)*x_i(t)<=R_4(t)$

$R_4(t)$ is the constraint of total sulfur dioxide emission of waste water discharge represented by each industry in t year.

Determination of output department

The data as required by the model is mainly calculated on basis of *China Statistical Yearbook* (2012-2013), and *Environmental Statistical Bulletin of China* (2012-2013). Based on the industrial structure optimization model with goal of resource saving and environmental protection built above, it lays extra emphasis on estimating the industrial energy consumption, water consumption, pollution discharge and industrial structure proportional relation from 2014 to 2015 in China. Due to the difference of the data statistical caliber and the difficulty level of the data collection, it finally determines three industries of China as the optimization objective. During the solution process of the model, the determination of the initial data and parameters is the key factor, which will directly influence the estimation result. Thus, it is necessary to firstly determine these parameters.[4]

Determination of parameters

(1) Determination of parameters in plan summary. The production value structure change evaluation of China is mainly in accordance with *The Twelfth Five-year Plan Summary of National Economic and Social Development*. During the period of "the Twelfth Five-year Plan", the average annual increase of the gross domestic product is more than 7%. The industrial structure tends to become more reasonable, and the development quality and level of three industries are improved significantly. The average annual increase of the added value of the service industry is more than 4%. According to the decomposition indicators of the energy saving and emission reduction in *Comprehensive Work Program of Energy Saving and Emission Reduction in The Twelfth Five-year Plan* by the State Council, the energy consumption per ten thousand yuan of GDP is reduced by 16%, for the purpose of determining the dynamic control objective of the energy constraint. The specific parameters are shown in TABLE 1.

TABLE 1 : Determination of optimization model R value

Determination of R Value	2013	Remarks
Energy consumption per ten thousand yuan of GDP (ton standard coal)	[0, 1.926]	The energy consumption per ten thousand yuan of GDP is reduced by 10% in "the Twelfth Five-year Plan".
The water consumption of the primary industry (100 million cubic meters)	[0, 495.95]	The total water consumption ratio of the primary industry is reduced by 4% in "the Twelfth Five-year Plan".
The water consumption of the secondary industry (100 million cubic meters)	[13.6, 14.14]	The water saving of the primary industry is fully used for determining the maximum limit of the secondary industry.
The water consumption of the tertiary industry (100 million cubic meters)	[1.14, 1.19]	The water saving of the primary industry is fully used for determining the maximum limit of the tertiary industry.
Chemical oxygen demand emission (10 thousand tons)	[0, 56.9]	The emission of "the Twelfth Five-year Plan" is controlled within the scope of "the Eleventh Five-year Plan".
Sulfur dioxide emission (10 thousand tons)	[0, 63.1]	The emission of "the Twelfth Five-year Plan" is controlled within the scope of "the Eleventh Five-year Plan".

(2) Grey prediction. It is a system science theory initiated by Professor Julong Deng as the scholar of China in 1980s. It includes five types of the prediction methods, and the foundation of the sequence prediction is based on the GM (1, 1) model of the accumulated generating sequence. The method is used for the prediction of the parameter coefficient.

ANALYSIS ON ENERGY SAVING AND EMISSION REDUCTION PROGRAM OF INDUSTRIAL STRUCTURE OPTIMIZATION IN CHINA BASED ON ENERGY SAVING AND EMISSION REDUCTION

The industrial structure optimization of China under the resource and environment constraint should achieve the economic growth maximum and also achieve multiple objectives such as the improvement of the resource consumption efficiency and the controlling of the pollution discharge. Moreover, the energy saving and emission reduction program is the optimization program with the energy saving, less environmental pollution, ecological environmental protection, and improvement of self-healing capacity of the environment as the primary objective, giving consideration to the economic growth. Therefore, this paper make the optimization analysis on the industrial structure through designing the single objective of the energy saving and emission reduction. According to the requirements and the constraint conditions of the energy saving and emission reduction in China, in consideration to the threshold value of the industrial energy consumption per ten thousand yuan of GDP and pollution discharge, it utilizes the calculation method set out above. According to the dynamic adjustment of the planning year, the optimization results of three industries are obtained, as shown in TABLE 2.

In the energy saving and emission reduction program, in order to meet the requirements of the energy saving and the total emission reduction of the chemical oxygen demand and the sulfur dioxide, the industries with more energy consumptions involving petroleum processing, coking, chemical industry, steel and electric power in Xinjiang should strengthen the technical innovation, make great efforts to enhance the energy use efficiency. The environmental pollution control of the program sacrifices the economic growth to a certain extent. The total output value in this program can not reach the increase level of total output value in the economic growth program. In the program, total quantity of GDP in 2015 will be RMB 57,740.9 billion, which is lower than the total output value level achieved under the scheme of the economic growth. In addition, from the production value structure, the proportion of the primary industry is relatively small, and the contribution of the secondary industry to the economic growth is declined slightly, which shows that the secondary industry of China plays a larger role in the economic growth. The contribution of the tertiary industry to the economic growth has relatively large ascending range, indicating that the energetic development of the tertiary industry is beneficial to the pollution control. At the same time, only upon considering the increase of the ecological environment cost, the quality of the economic growth can be achieved finally.[5]

TABLE 2 : Industrial structure optimization result of energy saving and emission reduction program from 2014 to 2015

	2014	2015
Energy consumption (10 thousand ton standard coal)	37.9	38.1
Energy saving and water consumption (100 million cubic meters)	121	119
Chemical oxygen demand emission for emission reduction (10 thousand tons)	2326	2238
Sulfur oxide emission (10 thousand tons)	2007	1999
The proportion of the primary industry (%)	9.8	9.7
The proportion of the secondary industry (%)	44.1	44.0
The proportion of the tertiary industry (%)	46.1	46.3
Total output value (100 million yuan)	573111	577409

CONCLUSION

In the 21st century, the pace for the economic globalization and regional economic integration is quickening, and various countries in the world begin to a new round of the industrial structure upgrading and adjustment, and the industrial structure is faced with the tasks of upgrading and seniorization. In the course of the economic development in China, the industrial structure is not completely reasonable, and the energy and resource use efficiency is low, and the ecological environment is weak. Adjusting and optimizing the industrial structure timely and walking on the path of the sustainable development shall be the inevitable course of realizing the transformation of the economic development mode and breaking through the “bottleneck” restraint of the resource and environment. Therefore, it is necessary to implement the sustainable development strategy, and strive to achieve the harmony in two aspects, i.e. on the one hand, it is necessary to seek the balance among promoting the industrial development, saving resources, and protecting the environment. On the other hand, through perfecting the social security system continuously, persist in achieving the harmony between the economic social development and the population resource and environment for the industry, so as to create the favorable conditions for the sustainable, rapid and stable development of the economy constantly.

ACKNOWLEDGEMENTS

The philosophy and social sciences innovation team of Institution of Higher Learning of Henan Province supports the achievement of the plan (2013-CXTD-08).

REFERENCES

[1] Yue Dai Research on Industrial Structure Optimization under Resource and Environment Constraint, Academic Exchange, **2**, 126-129 **(2014)**.

[2] Xian Dong; Multi-objective Dynamic Random Optimization Model of Industrial Structure of China, Dalian University of Technology, **(2008)**.

[3] Qing Chen; Research on Multi-objective Optimization of Industrial Structure Adjustment in Wuhan City under Environment and Resource Constraint, Huazhong University of Science and Technology, **(2011)**.

[4] Fang Li; Multi-objective Model Building and Empirical Research of Industrial Structure Optimization in Xinjiang under Resource and Environment Constraint, Xinjiang Farms Economy, **7**, 39-43 **(2013)**.

[5] Chang Meng; Review of Industrial Structure Research Progress – Orientation of Regional Industrial Structure Research under Resource and Environment Constraint, Modern Finance and Economics, **1**, 97-104 **(2012)**.