The Mechanism and Measures of Adjustment of Industrial Organization Structure: the Perspective of Energy Saving and Emission Reduction

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Abstract

Based on the theory of scale economies, this paper probes the mechanism and measures of adjusting industrial organization structure to promote energy saving and emission reduction. The structural factors and efficiency factors influencing energy consumption per unit of GDP interact with each other. Among which, the interaction between economies of scale and industrial organization structure constitutes the implementation mechanism that industrial organization structure is adjusted to promote energy saving and emission reduction. The empirical study of energy efficiency of some enterprises in the steel industry in China demonstrates the close relationship between energy efficiency and the scale of enterprises. In the end, measures of adjusting the industrial organization structure are put forward to promote energy saving and emission reduction.

Key Words: Energy saving and emission reduction, Industrial organization structure, Economies of scale, Mechanism, Measures

1. Introduction

With problems of energy wastage and environmental pollution that are becoming increasingly serious, how to reduce energy intensity in China is becoming the hot topic of academic research. Energy efficiency improvement and adjustment of industrial structure were studied to reduce the energy intensity. But in the research industrial structures were limited to industrial composition and efficiency factors limited to technological progress. Some scholars also studied measures of adjustment of industrial

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organization structure, Lu Zhengnan[1], Jiang Jinhe[2], Qi Jianguo[3] suggested measures of eliminating backward production capacities and adjusting the scale of enterprises. Wei Chu[4] argued that trans-regional annexation and reorganization of enterprises within industries should be encouraged to increase industry concentration and produce economies of scale. Cheng Yan et al.[5] suggested the energy consumption standards should be set for every enterprise in various industries, enterprises whose energy consumption were higher than the maximum standard or whose declining rate of energy consumption were lower than the minimum standard should be gradually eliminated in order to improve energy efficiency. Even so, seldom research has been done in regard to the mechanism of adjusting industrial organization structure to promote energy saving and emission reduction, and measures were limited to eliminating backward production capacities in the research.

2. Influencing factors of energy consumption per unit of GDP and their relationships

We begin with ascertaining the factors influencing energy consumption per unit of GDP in the study. Taking former research as reference, we can divide the factors influencing energy consumption per unit of GDP into two categories——direct factors relating to the process of energy consumption and indirect factors acting through affecting the process of energy consumption. Direct factors include energy intensity of sectors (efficiency factors), the proportion of added value of industries (structural factors), household energy consumption. Efficiency improvement comes from technological progress, economies of scale and other causes. Economies of Scale (including Economies of Scale and Agglomeration Economies) refer to benefits coming from the decrease of average cost of product with the increasing output, which means that enterprises can reduce production costs and energy consumption through expanding their production scale. Industrial structures include not only the industrial composition, but also the industrial organization structure and the industrial spatial structure. Indirect factors include the economic development, natural conditions, and so forth. Natural conditions include the macroscopic environment such as the geographical position, the land area, climate, resource endowment of a country, and environmental capacity affecting the location of industries and enterprises from the microcosmic aspect.

The factors which affect energy consumption per unit of GDP are not functioning alone, but interacting with each other, which constitutes the mechanism of energy saving and emission reduction in industries. Indirect factors take effect through direct factors, therefore, we conclude that efficiency factors and structural factors and their interactions determine the energy consumption per unit of GDP. There are three aspects among the relationships between efficiency factors and structural factors.

(1) Relationship between technological progress and change of industrial composition. Technological progress promotes and also benefits from the upgrade of the industrial composition.

(2) Relationship between economies of scale and change of industrial organization structure. Economies of scale, deriving from the expansion of production scale of enterprises, become the motivation and condition for enterprises to expand their production scale and achieve competitive advantages.

(3) Relationship among agglomeration economies, environmental capacity and change of industrial spatial structure. Industries should be located in the areas where environmental capacity and agglomeration economies are appropriate for the development of the industries.

3. Energy saving and emission reduction, economies of scale and adjustment of Industrial organization structure

3.1 Sources of economies of scale
Economies of scale refer to benefits coming from the decrease of average cost of product with the expanding of production scale of enterprises under certain condition (with the best combination of production factors) [6]. Scholars investigated sources of economies of scale from the perspective of indivisibility of fixed assets, transaction cost, division of labor, storage cost, and so on. In this paper, we use system theory to study sources of economies of scale: when an enterprise is regarded as a system, economies of scale derive from the scale and structure of the agglomeration of production factors. The scale of agglomeration of production factors is the prerequisite for enterprises to obtain economies of scale: enterprises cannot take full use of the productive capacity of fixed assets, save transaction costs and storage costs and obtain economies of scope until their production reach certain scales. The essence of a system is the structure, the expansion of the scale leads to crucial changes of relationships among production factors in enterprises, especially relationships among labors, which means the development and deepening of the division of labor and specialization, and technological progress and development of production mode.

3.2 Economies of scale and change of industrial organization structure

The production scale of an enterprise in an industry should be expanded to obtain economies of scale, so, for the industry, the amount of enterprises should be reduced. For some industries, especially heavy industry, it is conducive to rational resource allocation and maximization of consumer welfare that few large-scale enterprises occupy the majority of industrial production. Nevertheless, the obtainment of economies of scale would not be unlimited, and excess monopoly within an industry would lead to low efficiency of resource allocation. On the other hand, under the fierce market competition, the obtainment of economies of scale is of significant importance for the survival and development of enterprises, and economies of scale thus become the intrinsic motivation for enterprises to expand production scale. It is clear that economies of scale and the change of industrial organization structure interact with each other.

The expansion of production scale is the premise of division of labor in an enterprise, on the other hand, the development of division of labor can promote the expansion of production scale of the enterprise. From a historical and logical standpoint, the social division of labor was the premise of division of labor in enterprises, and the development of division of labor in enterprises would promote the development of social division of labor. It is not necessary to place every step of the whole production process into an enterprise. The appropriate scale and reasonable boundary of an enterprise should be defined after characteristics such as asset specificity and management ability of the enterprise being considered.

3.3 Adjustment of Industrial organizational structure based on the targets of energy saving and emission reduction

Through production scales of enterprises being expanded and concentration of industries being increased, enterprises and industries would obtain economies of scale, which means that their production costs would be decreased, at the same time the efficiency of inputs including energy of enterprises would be improved: the improvement of labor productivity, full use of equipments, improvement of management efficiency etc. would promote energy saving and energy wastage reduction. In addition, scales is the premise for enterprises to use more advanced technology, because knowledge intensive equipments are always large-scale, especially for heavy industry; and according to Schumpeter’s study, large-scale enterprises have advantages in R&D and technological progress; therefore, to some extent, at least for heavy industry, economies of scale are the premise of energy saving from technological progress.
4. Empirical Study of the relationship between enterprise's scale and energy efficiency—a case study of steel industry

Steel industry is the largest industry in energy consumption in China. According to “Guidelines on energy saving and emission reduction in steel industry of Ministry of Industry and Information Technology” issued in 2010, China's output of crude steel exceeded 560 million tons in 2009, the energy consumption of steel industry accounted for about 16.1% of the total energy consumption of the country, and 23% of total energy consumption of industries in China. There appears a very complex situation in industrial organization structure in China's steel industry: on the one hand, the concentration of China's steel industry is relatively low, and the average scale of production is small, according to "Steel industry restructuring and revitalization plan" issued by the State Council in 2009, the average production scale of China's crude steel enterprises is less than 100 million tons; on the other hand, production scales of a small number of steel enterprises are huge. In the ranking of global companies concerning crude steel production, published by the well-known British industry media "Metal Bulletin" in 2009, there are 5 and 3 Chinese companies in the top 10 and top 5 respectively.

An overwhelming majority of steel enterprises are small or medium enterprises, they use outmoded equipments characterized by small capacity, low efficiency and heavy pollution, whose energy consumption per unit is usually 10% - 15% higher than large equipments[7], which makes the comprehensive consumption of energy per tonnage of steel in China's steel industry very high; on the other hand, the comprehensive consumption of energy per tonnage of steel in few large enterprises has exceeded the international advanced level of 610 kg of standard coal per ton[8] (Table 1 shows outputs of crude steel and the comprehensive consumption of energy per tonnage of steel of the five largest steel enterprises, key enterprises and enterprises of the whole country).

Table 1: Outputs of crude steel and the comprehensive consumption of energy per tonnage of steel of some enterprises

<table>
<thead>
<tr>
<th></th>
<th>National Key steel enterprises</th>
<th>Hebei steel group</th>
<th>Baoshan steel group</th>
<th>Wuhan steel group</th>
<th>Shagang group</th>
<th>Shandong steel group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outputs of crude steel (ten thousand)</td>
<td>56 784</td>
<td>46 593</td>
<td>4 024</td>
<td>3 887</td>
<td>3 035</td>
<td>2 639</td>
</tr>
<tr>
<td>Comprehensive consumption of energy per tonnage of steel (kg)</td>
<td>730</td>
<td>619</td>
<td>599</td>
<td>599</td>
<td>708</td>
<td>588</td>
</tr>
</tbody>
</table>

Note: Among the data of comprehensive consumption of energy per tonnage of steel, we use the data of Baoshan Steel Ltd. standing for the data of Baoshan Steel Group, use the data of Jinan Steel Ltd. standing for the data of Shandong Steel Group; the data of Shagang Group is the data from January to May in 2009.

The sources of data of Comprehensive consumption of energy per tonnage of steel are as follows: national data is the target of comprehensive consumption of energy per tonnage of steel in 2009 set in "Policies for development of the steel industry " issued by National Development and Reform Commission in 2005(because there are no current statistical data), other data are from "Review of energy consumption of key steel enterprises in China in 2009" ("World Metal Bulletin", March 16, 2010), "Social responsibility report of Hebei Steel Group in 2009", "Social responsibility report of Baoshan Steel Group in 2009", "Speed up transforming the mode of development to promote scientific development of Wuhang Steel Group"(" Hubei Daily ", March 9, 2010), "Comprehensive consumption of energy per tonnage of
steel of Shagang Group decreased by 5.16% on an annual basis "(Zhang Jiagang Daily, June 18, 2009)," Annual report of Jinan Steel Ltd. in 2009".

5. Measures of adjustment of industrial organization structure to promote energy saving and emission reduction

In relationships among energy saving and emission reduction, economies of scale and industrial organization structure, energy saving and emission reduction and economies of scale are results of adjustment of industrial organization structure. Moreover, in China the concentration of industries, especially heavy industry (such as the above-mentioned steel industry) is quite low. Therefore, we conclude that the adjustment of industrial organization structure will play an important role to promote energy saving and emission reduction.

5.1 Ways of adjustment of industrial organization structure

Economies of scale derive from the scale and structure of agglomeration of production factors in enterprises, so, the adjustment of industrial organization structure should be focused on expanding the scale and optimizing the structure of division of labor of enterprises. In order to expand the production scales, we need to provide equipments which are more advanced and larger in production capacity for enterprises, and make full use of them. It is more important to optimize the structure of combination of production factors in enterprises: firstly, rationalize the production structure within enterprises and improve the efficiency of production; secondly, determine which steps of the whole production process should be placed into enterprises to define the appropriate scales and reasonable boundaries of enterprises; thirdly, distribute different parts of enterprises in different regions rationally based on regional advantages and characteristics of industries. To achieve the above objectives, apart from encouraging annexation and reorganization among enterprises, we could learn from Japan's experience to encourage establishing the subcontracting series system with large enterprises in the center, through which the operating costs would be saved and flexibility improved for large enterprises, and small businesses would get more support of capital, technology and marketing from large ones.

5.2 Measures of adjustment of industrial organization structure

The government always adopted administrative measures to adjust industrial organization structure in the past, but the effect was not satisfactory. In view of relationships among energy efficiency, economies of scale and industrial organization structure, we should primarily adopt economic measures to promote the adjustment of industrial organization structure.

5.2.1 Impose higher fees for discharge of pollutant or carbon tax in order to increase the threshold for the access to heavy industry. Imposing fees for discharge of pollutant or carbon tax on enterprises meet the principle that those who cause the pollution should deal with it. Small enterprises in heavy industry cannot undertake the high cost of pollution because they can not obtain economies of scale. So the result is that small enterprises in heavy industry may be annexed by large ones, or become cooperative enterprises of the large ones, or die out in the market competition.

5.2.2 Adopt some preferential measures such as taxation reduction or low-interest loans to encourage the annexation and cooperation of enterprises. An enterprise can obtain economies of scale after the annexation or cooperation has been finished. Therefore, in order to make the annexation or cooperation be carried out, the government should make sure enterprises can undertake costs of annexation or cooperation.
6. Conclusion

Former studies have confirmed the impact of structural factors and efficiency factors on energy consumption, but the studies also had flaws: structural factors were limited to industrial composition, and efficiency factors were limited to technical progress, so it is difficult for them to grasp the significant impact of efficiency factors and structural factors on energy saving and emission reduction completely. Whether enterprises could obtain economies of scale and industrial organization structure could be reasonable are of significant importance for energy saving. Economies of scale are the motivation and base of the adjustment of industrial organization structure, and the adjustment of industrial organization structure is the prerequisite for enterprises to obtain economies of scale. Because economies of scale derive from the scale and structure of agglomeration of production factors, ways of adjusting industrial organization structure to promote energy saving and emission reduction should be to expand the production scales, optimize division of labor in enterprises. The government could take economic measures to promote adjusting industrial organization structure, such as impose higher fees for discharge of pollutant or carbon tax in order to increase the threshold for the access to heavy industry, adopt some preferential measures such as taxation reduction and low-interest loans to encourage the annexation and cooperation of enterprises.

Reference