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Industrial Growth Path under the Restriction of Water Resources in China

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Abstract

Resources and environmental constraints are important problems need to be solved in the process of industrial development, especially in the critical period of industrial transformation and upgrading in China. So the perspective of the restriction of water resources was selected to analyze the industrial growth path. The water constraint for industrial growth model was constructed based on the theory of Lucas economic growth, and then the industrial growth path under different water resource constraints was analyzed by the Cobb - Douglas production function. The results show that it is possible to realize stable industrial development, but the ratio of water resources growth rate and the human capital growth rate should be less than the ratio of human capital output flexibility and water output flexibility. Meanwhile, water resources elasticity coefficient should be further increased to improve the contribution of unit water consumption for industrial growth, so the industrial water use efficiency be improved was one of the most important aspects. The above results could provide theory and method for related department to set up industrial development and water resources utilization plans.

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1. Introduction

In the past, the industrial development mode in China was the "high input, high consumption and high emissions", causing the resource dependence in the process of industrialization was higher. However, water is used as one of the important resources to support industrial development, and its effect on industrial development can be summarized as: (1) the industry layout, scale and development rate are also affected by the water resources endowment

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conditions. This is because water can be directly used in industrial production process, and even is as an important part of the production in the related industries, so it will play a more crucial influence to the industrial production costs with the expansion of water right transaction; (2) the technical route of industrial development can be affected by the water. Because the reversed transmission mechanism will be formed under the restrictions of industrial water quota, etc., the match level between the industrial water saving technology and industrial development can be improved, and then the industrial development mode will be optimized constantly. Hao analyzed the process of industrial development and industrial water changes in China, and proposed water resources could support the development of industrialization [1]. Bingbing believed that the industrial development was restricted by water shortages, but industrial structure adjustment would be significant impact on industrial water [2]. Weidong proposed that thermal power industry had a large demand for water, but it was the basic industry in the country, so the industrial water-saving industry system should be constructed [3]. Changfu believed that R&D and water price adjustment were also important way to promote industrial development [4]. Many new viewpoints were proposed in these studies, but few relationships between industrial development and water resource constraints were discussed, especially the mathematical derivation model was used to analyze it. So the industrial growth path under the restriction of water was to be analyzed in this paper from the perspective of relationship between input and output of labor, capital and resources.

2. Industrial Growth Model Under the Restriction of Water Resources

A stock of industrial water dynamics model is to be constructed in this section and neoclassical economic growth model that water resources is as the endogenous variable factors will be proposed to analyze industrial growth under the restriction of water resources.

2.1. Modeling Assumptions

Assuming 1: the growth rate of per capita water resources inventory P_w is not negative affected by the technical level T_e, it means the per capita water resources come into use at time t can not more than the water cycle generation ϑP_w. While the change rate of water resources stock should be complied with the following equation:

$$\vec{P}_w = \vartheta \cdot P_w - P_i \tag{1}$$

In the above formula, $\vec{P}_w$ is the change rate of per capita water resources inventory, and ϑ is the cycle generation rate of water resource stock affected by the technical level T_e. Considering the per capita water P_i using for production, and the study on the relationship between water resources and industrial growth is aimed at the water resource constraints, so water resources is added to the output production function and assuming that water resource is the basic elements are allowed. When $P_i = 0, Y = 0$, and when $Y > 0, E > 0$. On the above basis, a dynamic system can be constructed by the water resources investment P_i, water resources stock, and technical level T_e, and then the water variable biochemical process is finished.

Assuming 2: Y is P_i's function, and follows the straw conditions of diminishing marginal productivity: the marginal contribution rate close to zero, when the water factors level is large enough, then $\lim_{P_i \to \infty} Q_{P_i} = 0$; but when the water factors level is little enough, then $\lim_{P_i \to 0} Q_{P_i} = \infty$.

Assuming 3: total Labor supply is not flexible and it is a constant. Y, S^{pzb}, S^{psy} and S^{pos} is per capita output, stock of capital stock per capita, per capita water resources, per capita consumption respectively. A certain amount of water resources need to be put into industrial production process and its per capita water resources is P_i.

Assuming 4: human capital stock at time t is S^{pgr}, and each producer is engaged in the production by a certain percentage of the time.

2.2. Modeling

Water resources is introduced into the Lucas growth model [5], and assuming that scale reward is constant, so the per capita output function can be expressed as: