

# *The Industrial Structure Upgrading—A Knowledge-Accumulation Approach*

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**Abstract**—As China's economy steps into the new normal phase, industrial structure upgrading plays a critical role in improving the international competitiveness of the Chinese industries and enterprises. It is also the key factor to decide whether China can transit from a manufacturing country to a leading manufacturing power. Knowledge accumulation, which takes knowledge development, knowledge absorption, knowledge integration and knowledge creation as the core, is an important resource determining the product distribution, economic complexity and internal upgrading of the industry. In the new round of industrial restructuring and upgrading, the establishment of knowledge-based industrial upgrading mechanism should be paid attention to. On the basis of increasing the diversity of the product, the ability of producing complex products will be improved, so as to enhance the product competitiveness with knowledge accumulation advantages.

**Keywords**—*industrial structure; restructuring and upgrading; knowledge accumulation*

## I. INTRODUCTION

Industrial structure determines a country or a region's efficiency of resource allocation and the speed of economic development, and it also impacts the optimization of the economic structure. Under the circumstances of Economic New Normal, China is experiencing the three superimposed periods of growth phase shifting, structural adjustment pains and pre-stimulus digestion. As resources and environment being overwhelmed, the original industry development model which focuses on high capital investment, high resource consumption, high pollution and emission, low cost competition and low efficiency has become difficult to continue. The driving force of Chinese economy growth has been changing from the allocation efficiency of 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> industrial structure to the dynamic efficiency [1]. Industrial transformation and upgrading has an impact on whether China can move forward from a manufacturing country to a leading manufacturing power, and it is also an important approach to enhance the international competitiveness of Chinese enterprises and industries.

The difference of a country's endowment will lead to its different status of international labor division, thus affecting its level of development. The division position is affected not only by its innate endowment, but also the comparative

advantage of acquired endowment upgrading. The endogenous comparative advantage, which is based on 'learning by doing' and knowledge accumulation, has an important impact on upgrading factor endowment, so as to achieve the goal of improving middle and high-end value chain and industrial upgrading [2]. Industrial transformation and upgrading is not longer decided by the distribution and structure of the three industries, but lies in the knowledge accumulation, the upgrading of product space and the complexity of economy [3]. As abilities and knowledge are accumulated to a certain level and the product diversity and complexity are improved, a long run and gradual industrial upgrading process will break through. In the critical stage of China's economy entering the middle and high-speed growth period, the knowledge ability, which integrates and interacts the cycle of knowledge division, knowledge accumulation, knowledge diffusion and knowledge creation, is the key to upgrade the industrial structure [4]. Therefore, this paper tries to demonstrate the role of knowledge accumulation in promoting industrial upgrading from the perspective of knowledge, and explores the dynamic mechanism of knowledge accumulation in the evolution of industrial structure.

## II. LITERATURE REVIEW

What is knowledge? Polanyi [5] and OECD defined the knowledge from the aspects of the explicit and implicit, specialty and non-specialty and the function of knowledge. The endogenous growth model, proposed by Romer [6], affirmed the economic endogenous growth caused by knowledge accumulation for the first time. It also pointed out a virtuous circle between investment and knowledge accumulation, that is, investment promotes knowledge accumulation and knowledge accumulation stimulates investment. Knowledge is the mutual transformation and in the shape of spiral [7]. At the same time, it is also a dynamic incremental process, which represents the acquisition and transformation of knowledge, thus forming the knowledge stock [8]. Knowledge selection, knowledge absorption and knowledge innovation [9] affects the ability of knowledge accumulation. In the era of knowledge economy, the key of industrial transformation and upgrading is the competition of knowledge accumulation.

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From the perspective of knowledge, Hausmann and Hidalgo [3] pointed out that knowledge accumulation is the key factor determining the product distribution, economic complexity and industry upgrading. Industrial upgrading is the process of improving the complexity of production on the basis of improving the product diversity, and enhancing the ability of product upgrading requires the level of knowledge accumulation. The establishment of a virtuous and interactive evolution model between knowledge flow and industrial structure upgrading will contribute to promote the rationalization and feasibility of China's industrial structure.

### III. INDUSTRIAL UPGRADING BASED ON KNOWLEDGE ACCUMULATION

In Richard's trade theory and neo classical trade theory, the gradual process various endowment is regarded as the cornerstone of economic development process. For the specific endowment, knowledge, its accumulation contributes to incremental returns to scale. The more knowledge accumulated in the industry, the greater the incentive to receive innovation and technology. The more products produced, the higher the complexity is. The long-term accumulation of knowledge has promoted the investment of new technology and in return, new technology stimulates investment. Therefore, the competitive advantage has accumulated continuously. The diversity and technology of the product stimulates the innovative incentives, then industrial upgrading is the process of improving complexity and non-imitated of products.

Knowledge is accumulated through a continuous process of knowledge integration, which is, absorption, discussion and improvement. The mechanism of knowledge accumulation is an organic combination of knowledge integration, knowledge absorption and knowledge diffusion [10]. It is indicated that the connotation of industrial upgrading is to improve the diversity, complexity, sustainability and non-imitation of the products, so as to promote the low value added industries to the high value added sectors. This paper will study the role of knowledge accumulation in industrial upgrading from the following four aspects: knowledge development, knowledge absorption, knowledge integration and knowledge creation.

#### A. Knowledge Development

Knowledge development involves knowledge extraction and capture and its essence is to improve and extend the existing competitive. Knowledge extraction means pushing the current performance of industrial technology and focuses on the internal capabilities of the company and the incremental value that technologies brought. Technology is one of the carriers of knowledge accumulation and it is obtained and improved during the extraction process. The labor force in the industry takes the improvement of technology as primary task, in order to transfer the knowledge and accumulate into the innovation process of different products. At the same time, the knowledge has been explicit and experiences are exchanged among different innovation process and projects. In knowledge capture, it focuses on how human capital abstract knowledge from experience and experiment, and further generalizes for the application of new processes. Individuals

make knowledge available to others by incorporating it with carriers such as database, application standards that can be disseminated and retained over time. Through knowledge development, industrial product technology is improved, human capital knowledge base is reinforced and productivity efficiency is increased.

#### B. Knowledge Absorption

The key to enterprise and product innovation ability is to absorb external knowledge, and absorbing external knowledge will contribute to the application and innovation of enterprise knowledge. Products are the main vehicles of knowledge accumulation. Only when enterprises realize the value of knowledge, absorb and apply it to the commercial products, the product complexity is improved and not easy to be imitated by competitors. The scarcity and competitive advantage are enhanced and therefore the overall strength of the industry.

#### C. Knowledge Integration

Knowledge integration within an enterprise is an organic combination of existing knowledge integration and the ability to acquire new knowledge. This ability is not just a tool, but more important is the exchange and coordination between the workforce, so that basic knowledge can be developed among employees. In the process of knowledge integration, new learning occurs when external knowledge is integrated within the company. Learning has shifted to a more comprehensive role in the entire industry.

By learning, people have extra spare time resources to invest in the process, which will help to develop knowledge and product richness and complexity. Companies with managerial and culture awareness of knowledge transfer and integration, are able to transform innovation into optimize commercial opportunities. The implementation and mastery of more complex and uncertain technologies requires the integration and cooperation of knowledge with outside parties, in order to improve the degree of accumulation of technology and knowledge in enterprises and industries. Through the integration of knowledge, internal and external resources can be integrated and shared to achieve scale effect, and ultimately to promote the optimization and upgrading of industrial structure.

#### D. Knowledge Creation

Knowledge creation is the essence of innovation and it acts as a catalyzer in promoting industrial transform and evolution. There are two ways of knowledge creation. One is the reintegration of the original knowledge accumulation and the formation of new knowledge, the other is the leap from quantitative change to qualitative change in the accumulation of knowledge. The first kind of knowledge creation means the diversification of the knowledge subject and the way of production organization needs to expand from division of labor in the value chain to the larger scale inter-organization cooperation based on knowledge creation, which makes the products technology and complexity integrate from low value-added to high value-added. Eventually, an innovative ecosystem is formed. The latter kind of knowledge creation is the process of qualitative change of knowledge, whose aim is

to emphasize the mutual friction, symbiosis and competition between knowledge and a variety of different technologies, thus contributing to achieve radical innovation. The competitiveness, which embedded with heterogeneity and frontier, can be improved and the efficiency of knowledge community and innovation ecosystem will be maximized.

However, there are risks associated with knowledge creation. When radical innovation fails to establish a market that meets consumer expectations, it will pose risks to the industries involved, thereby endangering the incentives for industrial innovation.

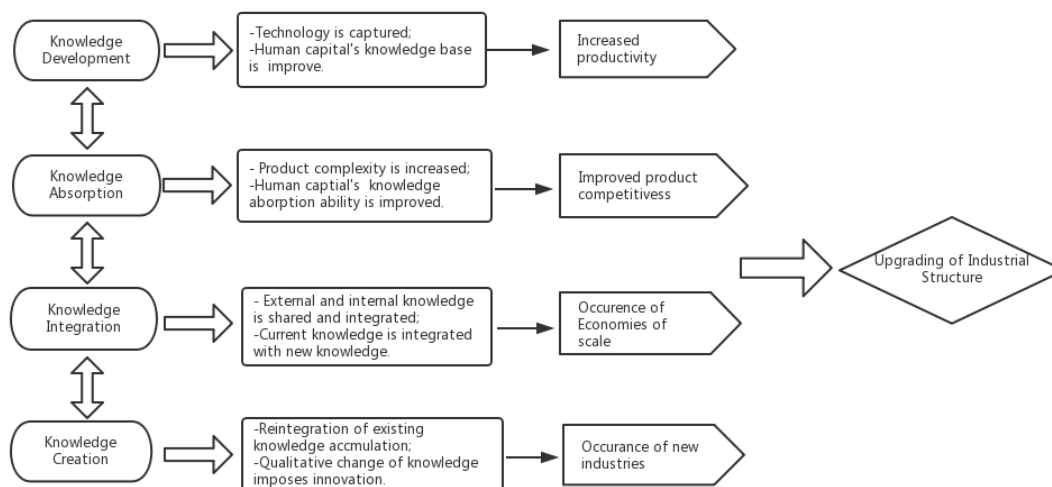


Fig. 1. The industrial upgrading mechanism based on knowledge accumulation

The upgrading of industrial structure is the evolution cycle of knowledge accumulation based on knowledge development, knowledge absorption, knowledge integration and knowledge creation interaction. The concrete manifestation of knowledge accumulation is the progress of technology in factor endowment, the accumulation of human capital and the increasing of final product complexity, which becomes the sustainable source of increasing returns to scale. The accumulation of human capital promotes technological progress, which is reflected in the enhanced complexity of products, and the product complexity improves the economic complexity, which guides the industrial upgrading path to move to more complex region and finally boost the development of enterprise core competitiveness and the growth of social wealth. The growth of wealth shows that the benefits gaining from knowledge accumulation is increased and the incentive of enterprise innovation ability will be fostered, which in return stimulates knowledge creation and accumulation. This virtuous cycle constitutes an upgrading form of industrial structure based on knowledge accumulation.

#### IV. THE ESTABLISHMENT OF KNOWLEDGE ACCUMULATION BASED INDUSTRIAL UPGRADING MECHANISM

Industrial upgrading lies on the accumulation of knowledge and ability. The elevating of ability based on knowledge accumulation can lead the economic development path to the knowledge devemoplent direction, and it is also an effective way to speed up the optimization and upgrading of industrial structure. The optimization and upgrading of the industrial structure is based on the accumulation of knowledge.

Without the accumulation of knowledge, industrial upgrading has become the source of no source, and is unable to support sustained and effective structural optimization and upgrading. In fact, the ranking of China's econmy complexity has increased from 28th in 2008 to 19th in 2015. It can be clearly seen that the upgrading pace of China's manufacturing industry is accompanied by the improvement of product space and economic complexity, that is, the accumulation of knowledge. The upgrading of products and knowledge accumulation is the backbone of the improvement of economy complexity. Therefore, it is necessary to establish indusitrial optimization and upgrading mechanism based on knowledge accumulation in a country or region.

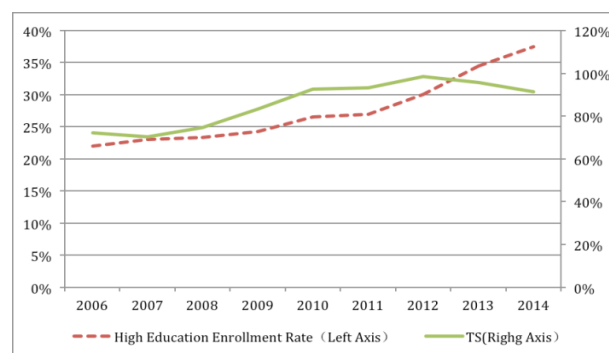


Fig. 2. the industrial sctructe ts index and higher education enrollment rate in china

To begin with, the cultivation of knowledge elements and the allocation efficiency of factor endowments should be emphasized. To realize the optimization and upgrading of industrial structure, its essence is to upgrade the factor endowment, improve the comparative advantage, and increase the factor input of knowledge. Cultivating knowledge is to breed the potential comparative advantage, which leads the product have a competitive advantage in the global high-end value chain. The core of knowledge accumulation lies in human capital, so it is necessary to pay more attention to the training of high-tech labor force. Facilitating the sharing and transmission of experience and knowledge among labor forces, it can promote the transformation of tacit knowledge into explicit knowledge, and accelerate the accumulation of knowledge in enterprise development.

What's more, it is also critical to enhance knowledge learning and absorptive capacity, and establish organizational based learning mechanism. A comprehensive mechanism of external and internal learning can transform the potential absorptive capacity of knowledge into practical knowledge absorptive capacity, thus promoting the accumulation of knowledge and innovative activities of enterprises. Establishing an external learning mechanism which based on technology imitation, skills transferring or peripheral technology seeking, and an internal learning mechanism based on knowledge exchange and sharing, can improve the enterprise's knowledge ability. It will also help the industry to avoid only paying attention to the introduction of technology, ignoring the knowledge absorptive capacity, and prevent enterprises from falling into the trap of "catching up with technology".

Last but not least, to promote the optimization and upgrading of industrial structure requires the improvement of knowledge integration and innovation. Knowledge integration is not only a rearrangement of existing knowledge, but also a process of integrating existing knowledge into new knowledge. When the knowledge integration is improved, the higher the knowledge accumulation ability is, the more new products will be produced, the more income from the integration and accumulation ability, and therefore the higher the incentive of innovation ability. Under the current situation of unclear global demand, the improvement of enterprise technology is facing greater resistance. The cost advantage competition is more fiercer and local differentiation soars. A relaxed growth

environment should be created and insured to encourage local entrepreneurs to explore according to their own reality, and establish local trial and error and innovation system.

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