Influence of OFDI on Low-Carbon Transformation of Equipment Manufacturing Industry Based on Grey Correlation Method

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Abstract

With increasing emphasis of national government bodies on equipment manufacturing industry, remarkable achievements have been made. In recent years, as advocated, low carbon and environmental development are necessary in all walks of life. As an industry with tremendous energy consumption, it’s urgently necessary to adjust the structure of equipment manufacturing industry and transform and upgrade it to be a low-carbon one. Therefore, by taking productive service industry as an example, this paper uses grey correlation theory and related data in 2006-2016 in China to study the influence of OFDI on low-carbon transformation and upgrading of the equipment manufacturing industry and promote its sustainable green development.

Keywords: Productive Service Industry, Equipment Manufacturing Industry, OFDI, Low-Carbon Transformation and Upgrading, Influence.

1. RESEARCH BACKGROUND

1.1 Literature review

In recent years, the equipment manufacturing industry in China has been developed more quickly, which is paid high attention to by the scholars in China. So, they start to research it in all aspects. There have been lots of researches in China on equipment manufacturing industry over the years. Products about 1/2 of amounts of export commodities in the equipment manufacturing industry in China are upgrading. Especially, improvements in telecommunications and shipping are of greatest concern. Degrading products in the equipment manufacturing industry are little and only accounts for less than 7% of total export amounts of this industry, which is far more than the United States, Japan and Germany. Afterwards, by taking equipment manufacturing industry in China as an example, Wang and Zeng researched the factors affecting innovation subject structure, innovative cooperation space scale, spatial structure and its evolution of cooperation networks of equipment manufacturing industry in China. (Wang and Zeng, 2016). In addition, Si Linbo analyzed the problems in technology synergy innovation of equipment manufacturing industry in China and established the framework for operation mechanism of technology synergy innovation in the equipment manufacturing industry, which is composed of driving force mechanism, dual synergy mechanism, resource supply mechanism and cooperation incentive mechanism (Si, 2017). In OFDI, Wang and Zhao also researched the location choice of OFDI from the aspect of micro enterprise. Research shows that OFDI enterprises have a higher productivity and it has different roles in different locations (Wang and Zhao, 2013). Afterwards, Chen and Huang believe that OFDI is the main accelerator for the transformation and upgrading of foreign trade structure in China (Chen and Huang, 2014). Mo and Li deeply analyzed the complexity of export technologies and believe that measure of complexity index of export technologies and constructing of mathematical model and others are used to show forward correlation between OFDI and complexity of export technologies (Mo and Li, 2015; Zhang and Li, 2015). For the relationship between OFDI and equipment manufacturing industry, Ge Shunqi analyzed the relationship in competitive advantages between OFDI of micro equipment manufacturing enterprises and parent companies in the equipment manufacturing industry, and found that OFDI is promoted by competitive advantages and hampered by competitive disadvantages (Ge, 2013). Later, Liu and Zhang built a game model to prove that OFDI is an endogenous factor for upgrading international competitive advantages of equipment manufacturing industry (Liu and Zhang, 2017). Chen Yan believes that foreign direct investment (FDI) has a larger technology spillover effect than competitive effect on the equipment manufacturing industry in China, which shows that foreign technologies
are followed in the equipment manufacturing industry in China to increase the competitiveness. Market concentration level is decreased due to entry of foreign capital. For OFDI of productive service industry, Meng Pingli and other scholars put forward the research method based on grey correlation theory to research the influence of FDI and OFDI in the productive service industry on upgrading of an industrial structure in the manufacturing industry (Meng and Dong, 2017). Above all, there are little researches on using OFDI as low-carbon transformation and upgrading, and few analyses from the perspective of productive service industry. Meanwhile, there are little researches from the perspective of equipment manufacturing industry, which lays a theoretical basis for the research herein.

1.2 Research objective

Equipment manufacturing industry is a key industry for rapid development of China industrial economy and plays an important role in the national defence construction. What’s more, it also has an industrial driving effect with high technology, high knowledge and high additional value of commodities. At the present stage, under the complicated conditions in the global economy, China is mainly aimed at adjusting the industrial structure and listing the advanced and high-end equipment manufacturing industry in the national “12th Five-Year Plan” and “13th Five-Year Plan”. The equipment manufacturing industry has become a strategic new industry in China. In addition, with slowing growth in China’s economy, equipment manufacturing industry is continuously restrained by serious environmental pollution, excessive resource consumption and increasing labour costs. At the same time, in order to reconstruct the information industry and give play to the international advantages of equipment manufacturing industry in all aspects, most developed countries continuously put forward multiple strategies, such as “re-industrialization” and “advanced equipment manufacturing industry plan”. Emerging economic entities in the foreign countries are continuously trying to enter the middle and low equipment manufacturing industry, so as to attract other investment countries and occupy the world market.

In view of this, the equipment manufacturing industry in China and domestic equipment industry have an increasing operation costs and low-carbon transformation and upgrading. Although productive service industry is the main force for promoting smooth development of equipment manufacturing industry in China, it is also greatly affected by backward economy and weak strength in the overall equipment industry. On this basis, optimization and upgrading of equipment manufacturing industry should be urgently used by OFDI of productive service industry in China to improve the international competitiveness, track various changes and trends in the market, and achieve smooth transformation and upgrading of the equipment manufacturing industry. So, there are practical and feasible significance and necessity for researching how to change main advantage of the equipment manufacturing industry from low labour to technology, capital and information, i.e. obtaining the international competitive advantage in the equipment manufacturing industry. As there aren’t obvious effects in the existing research channels, it’s necessary to explore the new economic growth mode, so as to effectively integrate OFDI of productive service industry into equipment manufacturing industry, excavate more potential in the equipment manufacturing industry and promote its low-carbon transformation.

2. ACTION MECHANISM FOR IMPROVING INTERNATIONAL LOW-CARBON COMPETITIVE ADVANTAGES OF EQUIPMENT MANUFACTURING INDUSTRY BY OFDI OF PRODUCTIVE SERVICE INDUSTRY

Currently, equipment manufacturing industry in China is facing the problems and challenges on changing low-end pattern and advantages. International division of labour is very serious and production factors relating to equipment manufacturing industry in the foreign countries are in the process of mass flow around the world. Under this condition, it’s urgently required to master the development opportunity and take the initiative to create competitive advantages of the equipment manufacturing industry, introduce high-end technologies and facilities and equipment in the equipment manufacturing industry from the abroad and grasp related management experience. In addition, reverse spillover effect is used to upgrade the relatively low-carbon advantage of the equipment manufacturing industry to low-carbon competitive advantages of the international equipment manufacturing industry. For this purpose, OFDI should be introduced. Advantages of global low-carbon transformation and upgrading in the equipment manufacturing industry in China can be obtained by improving the production efficiency in the equipment manufacturing industry, demand matching degree at home and abroad, industrial openness, and cooperativeness of the equipment manufacturing industry with related industries. Action mechanism for improving international low-carbon competitive advantages of the equipment manufacturing industry by OFDI of the productive service industry mainly includes promoting production efficiency in the equipment manufacturing industry, improving the industrial openness and relevant industrial cooperativeness, and learning effect and innovation effect.
OOFDI of the productive service industry means investing in other countries in the relative demand model and it can be divided into favourable gradient and adverse gradient according to the flow direction. The former is aimed at obtaining relevant scarce resources or capital interest in the equipment manufacturing industry in the country with low technological level in the equipment manufacturing industry, especially those lagging behind China. The latter is mainly aimed at obtaining strategic assets in the equipment manufacturing industry for the countries with developed technological level in the equipment manufacturing industry, including high-end equipment technology, advanced management experience and powerful international market.

With implementation of adverse gradient OFDI and by virtue of learning and innovation effects in the equipment manufacturing industry, advanced technologies and products in the equipment manufacturing industry are introduced from the overseas to improve the product structure, optimize the production process for equipment in China, reasonably produce the diversified products matched with foreign demands, strengthen the matching degree of domestic demand with foreign demand in the equipment manufacturing industry, and continuously improve the international low-carbon competitive advantages of the equipment manufacturing industry. Adverse gradient OFDI of the productive service industry can be used to improve integration of domestic and foreign markets, attract lots of FDI in the productive service industry, strengthen its openness and promote low-carbon transformation and upgrading. It can also be used to strengthen the relationship between equipment manufacturing industry and the world, deepen the labour division in the global manufacturing industry, actively participate in the global value chain, deepen internal labour division of the products and continuously strengthen the coordination of equipment manufacturing industry with other related industries, so as to improve the international law-carbon competitive advantages of the equipment manufacturing industry.

3. EMPIRICAL ANALYSIS OF OFDI ON LOW-CARBON TRANSFORMATION AND UPGRADEING OF EQUIPMENT MANUFACTURING INDUSTRY

3.1 Data selection and sources

In order to more comprehensively analyze the influence of OFDI in the productive service industry on low-carbon transformation and upgrading of equipment manufacturing industry in China, the time sequence of industrial numeric ratio in four categories of equipment manufacturing industry and industrial ratio of OFDI in the productive service industry are used in this paper for relevant grey correlation analysis. The statistical objects of empirical data include post industry, information transmission, network service and software industry, wholesale-retail industry, financial industry, leasing and business service industry, scientific research, technical service and geological prospecting industry. OFDI data of productive service industry are expressed by the proportion of OFDI stocks in the productive service industry in China for years to total stock of foreign investment. The time range of selected data is 2006-2016. Data are mainly from China Statistical Yearbook and China OFDI Communiqué. Ratio of output values in four categories of manufacturing industries is from China Industry Statistical Yearbook.

3.2 Research methods

Most scholars in China use Granger testing and regression analysis, and there are little researches by using grey correlation analysis. Grey correlation analysis is applicable to research carrying capacity of sample data and its laws. Meanwhile, grey correlation analysis is used to avoid inconformity of quantizing structure and qualitative analysis. On the consideration of relevance of related variables, this paper establishes the model according to the grey correlation analysis, and empirically researches the relationship between OFDI of productive service industry and low-carbon transformation and upgrading of equipment manufacturing industries, so as to explore the correlation effect among them. Firstly, reference and comparison sequence are determined. It’s assumed that reference sequence $Y_i(k) = \langle Y_i(k)/Y(1), X'_i(k) = X_i(k)/X_i(1) \rangle$ represents the time sequence for output ratio of technologies in the low-end equipment manufacturing industry, mid-low end equipment manufacturing industry, mid-high end equipment manufacturing industry, and high-technology equipment manufacturing industry respectively; The comparison sequence is detailed below:

\[ X_i(k) = \langle X_i(1), X_i(2), ..., X_i(m) \rangle, t = 1, 2, ..., 6 \] represent OFDI of six above productive service industries, respectively. Secondly, standardization and correlation coefficient of time sequence are calculated. The common method for standardization of time sequence includes initialization and mean-value methods. For economic sequence, the common method is initialization, which means that data sequence of reference sequence and comparison sequence in different times are used to divide by the first data sequence, i.e. \[ Y_i(k) = \langle Y_i(k)/Y(1), X'_i(k) = X_i(k)/X_i(1) \rangle, \] so as to form a new data sequence, such as mother sequence $Y'_i(k)$ and
subsequence $X'_i(k)$. Following sequence is explained by taking the first data sequence $Y'_i(k)$ of mother sequence as the example. $\Delta_1(k) = |Y'_i(k) - X'_i(k)|$ is used to calculate the absolute sequence difference of corresponding mother sequence and subsequence, and finally calculate the maximum range $\max |\Delta_1(k)|$, the minimum range $\min |\Delta_1(k)|$. 

Then, $y'_i(k) = \frac{\min |y'_1(k) - y'_2(k)| + \rho \max |y'_1(k) - y'_2(k)|}{|y'_1(k) - y'_2(k)| + \rho \max |y'_1(k) - y'_2(k)|}$, $\rho \in [0, 1]$ is used to calculate the grey correlation coefficient of the first data of the subsequence and the mother sequence with the subsequence; among them, $\rho$ is the coefficient of the resolution ratio. This paper mainly uses the most grey correlation analysis and sets $\rho$ to 0.5. Finally, grey correlation of the data in the first row of the subsequence and the mother sequence can be known through calculation according to $y'_i(k) = \frac{1}{m} \sum_{k=1}^{m} y'_i(k)$. If the correlation coefficient is more close to 1, it means the correlation is stronger.

3.3 Empirical results

In conclusion, the followings (see Table 1) can be known by calculating grey correlation degree of OFDI in the productive service industries and four categories of equipment manufacturing industries. OFDI of productive service industry has related different influence on low-carbon transformation and upgrading of equipment manufacturing industry. Table 1 shows the influence of productive service industry on output ratio of low and middle-end technologies in the equipment manufacturing industry and ranks them in descending order, including scientific research>OFDI in the financial industry>OFDI in the technical services and geological prospecting industry>transportation>OFDI in the warehousing and postal industry>OFDI in the wholesale and retail industry>OFDI in the information transmission, computer services and software industry>OFDI in the leasing and business services industry. The influence of productive service industry on output ratio of middle and high-end equipment and technology manufacturing industry are ranked in descending order as that scientific research>OFDI in the technical services and geological prospecting industry>OFDI in the financial industry>OFDI in the wholesale and retail industry>OFDI in the transportation, warehousing and postal industry>OFDI in the information transmission, computer services and software industry> OFDI in the leasing and business services industry; Influence of productive service industry on proportion of the number in the middle and high-end equipment and technology manufacturing industry are ranked as follows according to its degree: scientific research variables>OFDI variables in the wholesale and retail industry>OFDI variables in the technical services and geological prospecting industry>OFDI variables in the transportation, warehousing and postal industry>OFDI variables in the network service and software industry>OFDI variables in the financial industry>OFDI variables in the business service industry. Then, scientific research variables in the productive service industry, OFDI variables in the geological prospecting industry and OFDI variables in the financial industry have significant influence on industrial numerical ratio of four categories of equipment manufacturing industries in China. Among them, it has the largest influence on low and middle-end equipment manufacturing industry in China; OFDI in the wholesale and retail industry has a remarkable influence on proportion of output value in the low-end technology equipment manufacturing industry and middle and low-end technology equipment manufacturing industry; OFDI variables in the postal industry only has an outstanding influence on numerical ratio of high-end technology equipment manufacturing industry in China; OFDI variables in the network software industry and business service industry have no prominent influence on numerical ratio of four categories of equipment manufacturing industries in China, but they have a remarkable influence on numerical ratio of high-end technology equipment manufacturing industry; OFDI in the commercial service industry have no prominent influence on numerical ratio of four categories of equipment manufacturing industries.

| Table 1 Grey Correlation of OFDI in the Productive Service Industry with Low-Carbon Transformation and Upgrading of Equipment Manufacturing Industry |
|-----------------|-------|-------|-------|-------|-------|-------|
|                 | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ |
| Low technology equipment manufacturing industry | 0.6834 | 0.6323 | 0.8274 | 0.8949 | 0.5234 | 0.8573 |
| Middle and high technology manufacturing industry | 0.5618 | 0.5462 | 0.6902 | 0.7786 | 0.5383 | 0.7857 |
| Middle and low technology manufacturing industry | 0.6462 | 0.5843 | 0.7967 | 0.8102 | 0.5052 | 0.8603 |
4. CONCLUSIONS

Through empirical influence analysis on OFDI in the productive service industry on low-carbon transformation and upgrading of the equipment manufacturing industry in China, we can obtain the followings: OFDI has strong relationship with low-carbon transformation and upgrading of equipment manufacturing industry in China. For example, OFDI in the postal industry and network software industry can greatly promote the low-carbon transformation and upgrading of equipment manufacturing industry. But, OFDI in the scientific research, technical service and geological prospecting industry, financial industry and business service industry has non-obvious function on low-carbon transformation and upgrading of equipment manufacturing industry in China, or even restricts it. It can be seen that OFDI in the productive service industry has become an important driving force for promoting transformation and upgrading of the manufacturing industry in China.

REFERENCES