Empirical Study on the Trend of Interregional Industrial Transfer since the Financial Crisis: Based on Electricity Consumption Data

Wang Xiang *, Tan Xiandong, Zhang Jiaying
State Grid Energy Research Institute Co., Ltd, Beijing 102209, China
* Corresponding author's e-mail: wanghsiang2012@163.com

Abstract. Since the international financial crisis, the issue of industrial transfer has received increasing attention. This paper makes full use of the data advantages of the industry's electricity consumption, builds an industrial transfer index, and measures and analyzes the industrial transfer trends of various provinces. The study found that the industrial transfer in Hebei Province in the eastern region is more obvious. There are more industries that are transferring in the central and western provinces, and the industrial transferring in the northeast region is less obvious. The number of provinces in which industries has transferred out relatively is small, and there is relatively large number of industries that transferring out of the coastal provinces.

1. Introduction
Since the international financial crisis in 2008, with the tremendous changes in the domestic and international environment, the Chinese economy has gradually entered a new normal. In order to achieve steady economic growth, the government attaches great importance to inter-regional industrial transfer. In 2010, the State Council promulgated the "Guiding Opinions on Undertaking Industrial Transfer in the Central and Western Regions", and then set up six national level of industrial transfer demonstration such as Guangxi Guidong, Chongqing Riverside, Anhui Minjiang River, Hubei Jingzhou, Shanxi-Shanxi-Yu Border Yellow River Golden Triangle, and Hunan Xiangnan. However, the current situation of industrial transfer in various regions has not been fully studied.

So far, the theoretical research of industrial transfer has been mature, mainly divided into industrial transfer theory based on comparative advantage and new economic geography theory based on increasing income and imperfect competition. There are relatively few empirical studies. Due to the limited statistical data, domestic understanding of the trend of industrial transfer is still controversial.

The outstanding problem of empirical research is that the data of open, continuous and sub-industry are not fully used, and the trend of industrial transfer in various industries cannot be analyzed continuously and comprehensively. Power data has many advantages to be used such as immediate production, wide coverage, convenient statistics, high accuracy, and no price interference. It can provide more accurate measurement and analysis for inter-regional transfer, with important research value and practical significance.

2. Relationship between electricity and macroeconomic variables
According to the data from 1978 to 2018, the GDP in China is highly correlated with the electricity consumption. The goodness of fit for the one-way regression is above 0.99, and the goodness of the
industrial added value and its electricity consumption is also above 0.98. Since 1978, the trend of the growth rate of electricity consumption in the whole country and the growth rate of GDP have been basically the same. However, the volatility of electricity consumption growth is even stronger. In comparison, the industrial value-added electricity consumption growth rate is more synchronous with its value-added growth rate.

From the perspective of the sub-sectors, the correlation between the growth rate of the above-scale growth of the manufacturing industry and the growth rate of its electricity consumption is relatively high. After comparing, unifying and analyzing the various industries by referring to the national standards of the National Economic Industry Classification in 2002 and 2011, the correlation coefficient between the growth rate of the added value and the growth rate of electricity consumption in 20 out of 25 industries is above 0.5.

3. The analysis of regional industry growth trend

According to the technical classification standards of OECD manufacturing products, the capital labor ratio of various industries in the manufacturing industry, the 20 major industries in China's manufacturing industry are divided into three categories: Labor-intensive, capital-intensive, and Capital-technically intensive. Specific industry categories are divided as shown in Table 1.

| Production factor intensive types | Industry categories |
|----------------------------------|---------------------|
| Labor intensive                  | Food, Beverage and Tobacco Manufacturing, Textiles, Apparel, Footwear/Leather and Down Products, Wood Processing and Products and Furniture Manufacturing, Paper and Paper Products, Printing and Recording Media Reproduction, Sports Goods Manufacturing |
| Capital-intensive                | Petroleum processing, coking and nuclear fuel processing industries, chemical raw materials and chemical products manufacturing, pharmaceutical manufacturing, chemical fiber manufacturing, rubber and plastic products, non-metallic mineral products, ferrous metal smelting and rolling processing, Non-ferrous metal smelting and rolling processing industry, metal products industry |
| Capital-technically intensive    | General and special equipment manufacturing, transportation / electrical / electronic equipment manufacturing, transportation equipment manufacturing, handicrafts and other manufacturing |

Note: Although the transportation equipment manufacturing industry is a transportation/electrical/electronic equipment manufacturing sub-sector, listed separately here.

3.1. Analysis of relative growth of electricity consumption in the industry

The production of an industry in an area is extremely active, which is an important sign of the transfer of the industry. The relative increase in electricity consumption in various regions can be used as the initial evidence of whether the industry has transferred. The year-on-year growth rate of electricity consumption in the industry and the proportion of electricity consumption in the manufacturing industry can all indicate relative growth (Liu Youjin, Zeng Xiaoming, 2018) Here only use the year-on-year growth rate for analysis. The following is the calculation formula:

$$T_{g}^{i,j} = \frac{(D_{g}^{i,j} - Q_{g}^{i,j})}{|Q_{g}^{i,j}|}$$  \hspace{1cm} (1)

$T_{g}^{i,j}$ refers to the relative growth rate of electricity consumption in a certain period of time (from time $l$ to $L$) of the $j$ industry in a certain area $i$, $D_{g}^{i,j}$ indicates the compound electricity growth rate of the $j$ industry in the region $i$ during a certain period of time (from time $l$ to $L$), $Q_{g}^{i,j}$ represents the
compound growth rate of electricity consumption in the national j industry during a certain period of time (from time l to L). If $\tau_{ji}$ is greater than 0 in two consecutive time periods, it is considered that the j industry has a tendency to shift to the region. According to the electricity consumption data, the two time periods of 2008-2012 and 2012-2016 are selected for calculation and analysis. The data come from the “Compilation of Statistics of Power Industry” and the basic database of “One Library and Three Centers” of State Grid Corporation.

On the relative growth in electricity consumption, there are widespread industrial transfer phenomena in the 20 major manufacturing industries. The average number of provinces in which each industry has transferred is 10, and there are average three industries transferred in the eastern provinces. Six industries have shown signs of industrial transfer, and the central and western provinces have relatively more industrial transfer, prominently in food/beverage and tobacco manufacturing, textiles, petroleum processing/coking and nuclear fuel processing, rubber and plastic products, and non-metals. Mineral products industry, non-ferrous metal smelting and rolling processing industry, metal products industry, transportation/electrical/electronic equipment manufacturing, are distributed in three major industries.

The disadvantage is that it fails to consider the regional advantages and economies of scale. Moreover, there has been an industrial shift, and such an active production space change is not very consistent. In addition, the above relative growth rate method mainly determines the trend of industrial transfer, and cannot identify where the industry is transferred. Therefore, it is necessary to conduct a more in-depth and comprehensive analysis and argumentation.

3.2. Analysis of industry electricity consumption industry transfer index method

3.2.1. Calculation and discrimination criteria. Based on the calculation of the relative quantity change of the industry for a certain period of time, and considering the natural growth impact of the industry brought about by the expansion of the economic scale of a certain region, it may not be the migration of production activities in other regions (Sun Xiaohua et al., 2018). The industry transfer index of electricity is as follows:

$$\tau_{ji} = \frac{e_j}{\sum e_i} \left( \frac{\sum e_{ij}^L - e_j^L}{\sum e_i^L - e_i^L} \right)$$

$\tau_{ji}$ refers to the electricity consumption industry transfer index of the industry $i$ of the region $j$ in a certain period of time (from time l to L), $\tau_{ji}^L, \tau_{ji}^l$ representing the relative amount of $L$ and $l$ year considerations of regional economic scale factors, $e_j$ represents the electricity consumption of industry $j$ in $i$ area of L and $l$ years respectively, $\sum e_i$, $\sum e_i^L$ refers to the national electricity consumption of industry $j$ and the total electricity consumption of all industries in region $i$, $\sum \sum e_i$ is the total electricity consumption of all industries in all regions.

If the value of $\tau_{ji}^L$ in the region $i$ is greater than 0 in both periods, and the year before the study period (ie, the initial period) does not have a development advantage in the industry $j$, it indicates that the area of the surveyed area $i$ has been transferred to the industry at an early stage. The two periods as before are still selected for analysis, and the location entropy of each province in 2005 is used to judge whether the industry has advantages. When $\tau_{ji}^L$ in two periods are greater than 0, if the industry $j$ region entropy of district $i$ in 2005 is greater than 1, then the industry is not considered to have transferred, if the location entropy is less than 1, indicating that The industry has moved in.

If the value of $\tau_{ji}^L$ in the area $i$ is less than 0 in both periods, and the year before the study period (ie, the initial stage) has a development advantage in the industry $j$, it indicates that the area of the surveyed area $i$ has been transferred out from the initial stage. That is, when $\tau_{ji}^L$ in two periods are less than 0, if the location entropy of the industry $j$ in zone $i$ in 2005 is greater than 1, then the industry
is considered to be transferred out. If the location entropy is less than 1, then it is recognized that the industry has not turned out because it does not have a development advantage, and local resources are more invested in other advantageous industries.

3.2.2. Measuring analysis results. (1) Industry “transfer in” situation: The average number of provinces in which industries were transferred was seven, which was three less than the average of the relative growth rate analysis. In the labor-intensive industry, some industries in the eastern provinces of Beijing, Tianjin, Shanghai, Jiangsu, and Hebei have been transferred, which may be a strong industrial agglomeration effect in the eastern region, leading to “viscosity” of industrial transfer, or the remaining production activities belong to High-end links. There is very little industry transfer in Northeast China, which is far from the concept of Jilin Province's vigorous development of light textile industry proposed by Lin Yifu (2017). the central and western provinces are not generally industrial transfer, each industry has an average of less than 5 provinces.

In the capital-intensive industries, there are individual industries in the eastern provinces. Among them, there are many industries in Hebei Province, and they are mainly related to petrochemical manufacturing. In the northeast, there are only petroleum processing/coking and nuclear fuel processing industries, rubber and plastics. The transfer of two industries in the product industry. the transfer of industries to the western provinces is more obvious than that of the central provinces, mainly to facilitate the use of rich mineral resources in the western region.

In terms of capital technology intensive, the industrial transfer of Hebei Province in the eastern region is more prominent. Fujian, Guangdong and Hainan have seen industrial transfer in the general and special equipment manufacturing industries. Beijing, Jiangsu and Zhejiang have more in crafts and other manufacturing industries. Many advantages. there is no sign of industrial transfer in the Northeast, indicating that the region’s competitive advantage in high-end manufacturing has not been significantly cultivated. compared with the western region, the industrial transfer of the central provinces is more obvious, especially in the metal products industry, general and special Equipment manufacturing, transportation / electrical / electronic equipment manufacturing.

From the perspective of industry comparison, the petroleum processing/coking and nuclear fuel processing industries, rubber and plastic products industry, metal products industry, handicrafts and other manufacturing industries have become more obvious, and the number of provinces with industrial transfer has exceeded 10. From the comparison of provinces, there are many industries in Hubei, Henan, Guizhou, Hebei and other industries that have transferred to the industry. The number of industries in five provinces including Jiangxi, Sichuan, Anhui, Liaoning and Qinghai transferred to the industry is more than five. The number of industries with industrial transfer in most eastern provinces is less than five. Conforming to the trend of China's industrial transfer from the east to the central and western regions.

(II) Industry “out” situation: The number of provinces in which industries were transferred out of the industry averaged 3.2, which was significantly smaller than the average number of provinces that were transferred to the province. In the labor-intensive industry, some industries in the eastern provinces of Shandong, Fujian, Guangdong and Hainan were transferred out, among which Fujian has appeared in many industries. Heilongjiang and Jilin in Northeast China are in wood processing and products and furniture manufacturing respectively. There is an industry transfer in the paper and paper products industry. only the central and western provinces have industrial transfer. the western provinces of China, Guangxi, Shaanxi, and Xinjiang have industrial exports in the food/beverage and tobacco manufacturing industries.

In terms of capital-intensive industries, in addition to Jiangsu, the eastern provinces have transferred industries in some industries, of which Tianjin is mainly transferred from the petrochemical industry. Zhejiang is mainly transferred from petroleum processing/coking and nuclear fuel processing industries and pharmaceutical manufacturing. Shandong has been transferred from the chemical and non-metallic mineral manufacturing industries, and Beijing has been transferred to the heavily polluted areas such as cement and steel. The three eastern provinces have transferred out of chemical,
chemical fiber and non-metallic mineral manufacturing. the central and western provinces are in the pharmaceutical manufacturing industry. Non-metallic mineral manufacturing, non-ferrous metals and other industries have turned out relatively more.

In terms of capital technology-intensive, there are fewer provinces in which the industry has been transferred out. Tianjin, Shanghai, Guangdong, Zhejiang, etc. have industries in the metal products industry, transportation/electrical/electronic equipment manufacturing, and transportation equipment manufacturing industries transferred. Heilongjiang and Liaoning respectively have industrial transfer in the general and special equipment manufacturing and transportation equipment manufacturing industries. no industrial transfer in the central region. Shaanxi and Guangxi in the west in general and special equipment manufacturing, handicrafts and other manufacturing industries Industry transfer.

From the industry comparison, food/beverage and tobacco manufacturing, wood processing and products and furniture manufacturing, chemical raw materials and chemical manufacturing, pharmaceutical manufacturing, non-metallic mineral products, non-ferrous metal smelting and rolling processing industry Obviously, there are more than 5 provinces with industrial transfer.

From the comparison of provinces, there are more industries in Fujian, Shandong, Zhejiang, Jiangxi, Guangdong and other industries. the number of industries with industrial transfer in most eastern provinces All of them are below 4, especially in Jiangsu Province, where there is no significant shift in the industry, reflecting the province's strong agglomeration advantages. The overall coastal provinces have more industries.

4. Conclusions
The main conclusions of this paper are as follows: From the perspective of sub-regions, the number of industries transferred to the industry in Hebei Province in the east is large, and the number of industries transferred to Shandong is the least. the number of industries that have transferred to the industry is more in the central and western provinces, which is consistent with the industry from coastal to inland. The trend of gradient transfer. the overall transfer of industries in Northeast China is not significant. The number of provinces in which the industry has transferred out of the industry is small, and the industries in the coastal provinces are more transferred.

From the perspective of sub-sectors, capital- and technology-intensive industries such as petroleum processing/coking and nuclear fuel processing industries, rubber and plastic products, metal products, handicrafts and other manufacturing industries are more obvious, rather than labor-intensive industries. It may have a strong economic advantage with the eastern region. Labor/capital-intensive industries such as food/beverage and tobacco manufacturing, wood processing and products and furniture manufacturing, chemical raw materials and chemical manufacturing, pharmaceutical manufacturing, non-metallic mineral products, non-ferrous metal smelting and rolling processing industries It is more obvious.

Acknowledgments
This paper is supported by the Science and Technology Project of State Grid Corporation of China (Research on the method, model and application of economy and electricity demand forecasting based on supply side structural reform).

References
[1] Gao Yu, Zhang Xuekai. Policy shocks, industrial agglomeration and industrial upgrading - the construction of the Silk Road Economic Belt and the industrial transfer of the western region, Economic issues, 2016(1): 1-7.
[2] Lin Yifu et al. Jilin Province Economic Structure Transformation and Upgrading Research Report (Draft for Comment), Peking University New Structural Economics Research Center, 2017.
[3] Liu Hongguang, Liu Weidong, Liu Zhigao. Quantitative Measurement of Inter-regional Industrial Transfer: Based on Inter-regional Input-Output Table Analysis, China Industrial Economy,
2011(6): 79-88.

[4] Sun Xiaohua, Guo Xu, Wang Wei. Industrial transfer, factor agglomeration and regional economic development, *Management World*, 2018 (5): 47-62.