



ЭКОЛОГИЯ, ЭКОНОМИКА И ПРАВО

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ANALYSIS OF THE TRANSFER OF INDUSTRIAL PRODUCTION AND POLLUTION BETWEEN REGIONS IN CHINA

As economy and society develop and international trade relations intensify, industrial enterprises are faced with many factors influencing the choice of their geographical location. The relocation of industrial production may result in concomitant transfer of pollution between regions. National pollution prevention and control measures no longer focus on individual regions, as this does not allow the problem of transfer to be dealt with comprehensively. In order to better explore the pathways of pollution generation at the current stage of China's development, this paper examines the overall pollution transfer trend associated with the transfer of industrial production between regions in China. As for the transfer of industrial production, it generally underwent changes during the study period from an initial stable cluster towards the southeast coast and central inland of southern China to a terminal cluster towards remote and underdeveloped regions or traditional resource-rich regions. The cluster analysis of individual pollutants showed that throughout the study period, there was a tendency for pollution to aggregate from central regions to less developed or resource-rich regions in the periphery of China.

Keywords: transfer of industrial production; pollution transfer; location choice; environmental regulation; energy reserves.

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Introduction. The world's industrial development has generally undergone a transition from being resources-dependent to being productivity-driven. This transition has manifested itself in industrial upgrading and in industry transfer across geographic regions. As explained in the theory of industrial gradient transfer, the industry transfer generally occurs between regions at different stages

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of economic development, manifesting as some enterprises in developed regions transferring their production to less developed regions, the essence of which is the optimization and reallocation of industry factors in geographic space. During this process, the industry transfer will bring about changes in the structure of regional production factors and will inevitably cause changes in the degree of factor aggregation. Not only does it affect the productivity of enterprises, it may also lead to changes in regional energy consumption and pollution emissions. In this context, this paper aims to study the industry transfer and pollution transfer in China [1; 2].

Methodology. The traditional dynamic shift-share analysis model views the regional industry development as a dynamic process. It takes the industry development of the country to which the region belongs as the reference for the industry development of that region. In the traditional dynamic shift-share analysis model, each regional change is decomposed into three components, the share component, the industry structure component and the competitiveness component. The specific formula can be represented as follows.

$$\Delta X_{ij} = X'_{ij} - X_{ij} = X_{ij}r + X_{ij}(r_i - r) + X_{ij}(r_{ij} - r_i),$$

where $r = \frac{\sum_{i=1}^S \sum_{j=1}^R (X'_{ij} - X_{ij})}{\sum_{i=1}^S \sum_{j=1}^R X_{ij}}$; $r_i = \frac{\sum_{j=1}^R (X'_{ij} - X_{ij})}{\sum_{j=1}^R X_{ij}}$; $r_{ij} = \frac{X'_{ij} - X_{ij}}{X_{ij}}$,

where X_{ij} – values of economic variables for industry i in region j at the beginning; X'_{ij} – value of this variable at the end of the period.

Further deformation from equation 1 gives:

$$X_{ij}(r_{ij} - r_i) = X_{ij}r_{ij} - X_{ij}r_i = X_{ij} \frac{(X'_{ij} - X_{ij})}{X_{ij}} - X_{ij} \frac{(X'_{ij} - X_{ij})}{X_{ij}} = (X'_{ij} - X_{ij}) - (X'_{ij} - X_{ij}) = 0.$$

We redefine regional industrial growth as three components, the national growth component, the structure mix component, the industry transfer component. In the formula, the sum of the transfer components is verified as 0. This indicates that, in addition to the national growth component and structure mix component, a portion of the national industry growth value exists in the form of industry transfer component across the regions of the country. Thus,




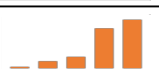

















$$VIT_i = X_{ij}(r_{ij} - r_i),$$

where $r_i = \frac{\sum_{j=1}^R (X'_{ij} - X_{ij})}{\sum_{j=1}^R X_{ij}}$; $r_{ij} = \frac{X'_{ij} - X_{ij}}{X_{ij}}$;

VIT_i – volume of industry transfer in region i ; X_{ij} – values of economic variables for industry i in region j at the beginning; X'_{ij} – value of this variable at the end of the period [3].

Industry transfer across regions in China. In order to quantitatively measure the volume of industry transfer by region, the added value of industry in 30 regions in China from 2014 to 2019 is selected for the shift-share analysis [4]. The analysis results are shown in the table.

Industry transfer by region from 2014 to 2019

100 million yuan	2014–2015	2015–2016	2016–2017	2017–2018	2018–2019	Cumulative Volume
1	2	3	4	5	6	7
Anhui	-114,79	473,89	256,97	-214,62	239,33	
Beijing	-5,82	180,33	14,60	-109,87	-122,81	
Chongqing	423,25	423,39	45,89	-281,63	49,45	
Fujian	477,18	483,13	300,42	2 177,97	589,65	
Gansu	-466,94	-85,49	-95,66	499,95	-55,58	
Guangdong	1 349,20	1 286,72	753,89	2 559,35	-289,94	
Guangxi	343,15	224,64	-1 387,68	-688,02	-100,39	
Guizhou	199,90	279,02	330,10	-70,83	155,08	
Hainan	-24,42	-21,09	17,89	56,72	-24,78	
Hebei	-597,52	300,35	-403,35	-2 749,54	-18,71	
Heilongjiang	-691,72	-554,62	-525,33	-47,00	-152,41	
Henan	141,10	641,73	424,36	-1 024,05	152,44	
Hubei	627,79	583,01	-200,85	1 863,56	434,22	
Hunan	282,19	-8,13	-112,58	-1 026,99	261,34	
Inner Mongolia	-101,79	-788,72	-2 542,03	24,17	133,95	
Jiangsu	1 249,82	1 436,66	1 798,29	2 292,44	-241,96	
Jiangxi	124,33	48,56	153,25	518,77	254,44	
Jilin	-261,28	-265,11	-363,60	-2 735,75	-117,25	
Liaoning	-1 284,45	-4 863,96	90,03	467,69	17,65	
Ningxia	14,00	38,85	-18,98	100,92	14,58	
Qinghai	-52,74	-24,83	-176,23	4,35	-2,08	

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1	2	3	4	5	6	7
Shaanxi	-584,63	-14,75	654,66	445,59	29,84	
Shandong	773,23	732,04	-477,50	-5 929,94	-851,46	
Shanghai	-141,43	131,54	400,84	1 418,24	-621,12	
Shanxi	-1 067,51	-369,85	1 382,52	521,70	-29,43	
Sichuan	-717,81	-383,29	-121,77	849,57	336,76	
Tianjin	-39,64	-432,44	-334,45	-2 548,17	-114,05	
Xinjiang	-413,38	-163,13	421,80	522,77	-100,21	
Yunnan	-19,42	-97,55	-26,72	845,51	124,04	
Zhejiang	580,15	809,09	-258,81	2 257,13	49,41	

According to the table above, we can learn that there is a wide variation in the annual industry transfer by region in China during the study period. Only a small number of regions across the country show consistent inward or outward industry transfer over the six-year period. Among them, Fujian and Jiangxi show some inward industry transfer in each year of the study period. Heilongjiang, Jilin and Tianjin, on the other hand, show some outward industry transfer in all years.

In terms of the industry transfer by region in each year, the 30 Chinese regions studied from 2014 to 2015 include 17 regions with outward industry transfer, which are relatively large in number. Most of these regions are located in the northern part of China's territory or at the periphery. As for the volume of industry transfer, the remote border regions had a relatively larger volume of outward industry transfer in that year. The regions with inward industry transfer, which account for a small proportion, are mostly belonging to southeast coastal regions or in the central inland areas of southern China. Although these regions account for a relatively small proportion in terms of both number and geographical acreage, they have a huge capacity to absorb industry clusters. By virtue of their outstanding advantages, these regions attract industries from all regions of the country to cluster in a small geographical area. It can be seen that during the year, the main trend of industry transfer in China continued to cluster towards the southeast coast of China. From 2015 to 2016, the migration of industries from most regions of the country to the southeast coast has moderated. In this year, the trend of industry transfer in China was mainly characterised by an increase in outward industry transfer from some remote and peripheral regions, while the outward industry transfer from some regions located in the central north slowed down or reversed. In the period from 2015 to 2016, the number of regions that fell

into the category of outward industry transfer has shrunk to 14, which has brought a relative balance with the number of regions with inward industry transfer. There are four regions where the industry transfer has changed from outward to outward: Anhui, Beijing, Hebei and Shanghai. They are all located in the centre of China and have relatively developed economies. At this point, the advantages of other regions are no longer attractive to them. However, the southeast coastal regions of China still have a greater advantage in the location choice of industries and continue to attract industries to cluster there. From 2016 to 2017, the situation of industry transfer began to change. Areas that were once popular in the choice of industry location, such as the southeast coastal regions and those located in the heart of the south, are gradually becoming regions with outward industry transfer, such as Shandong and Zhejiang. While the regions that were previously the main regions with outward industry transfer, such as Liaoning, Shaanxi, Shanxi and Xinjiang, are beginning to attract clusters of industries. Most of these regions are located in the border areas of China or are traditional resource-based regions of China, which possess the advantages of high potential resource endowments and relatively low labour costs. The main reasons for industries to converge on these regions during this period may be the abundant and accessible energy and low labour costs. In addition, a restricted level of social development and the lack of well-established environmental regulations may also be an attraction for industries to migrate to these regions. From 2017 to 2018, this year witnessed a significant change in the inter-regional industry transfer in China. In comparison to the previous year, some regions changed from inward industry transfer regions to outward industry transfer regions in this year. These regions include Anhui, Beijing, Chongqing, Guizhou and Henan. Although these regions do not have a large volume of industry transfer, it is evident that there is a clear preference for geographical choice of industry location. The attractiveness of most regions to industries is not outstanding. The phenomenon of industry clustering is beginning to be seen in a few regions where there are noticeable advantages. Some other regions have changed from outward industry transfer to inward industry transfer. These regions are Gansu, Hubei, Inner Mongolia, Ningxia, Qinghai, Sichuan and Yunnan, some of which are remote or economically and socially underdeveloped, and some of which are traditional resource-based regions of China. It is also noteworthy that regions characterised by geographical remoteness, economic and social underdevelopment or resource endowment have continued and increased their attraction to industry clustering within the regions compared to the previous year's data. Such variations demonstrate that resource endowments and environmental regulations are increasingly influencing the choice of industry location. However, some of the southeast coastal regions and the central regions of southern China remained as the predominant regions with large inward industry transfer during the period. In general, between 2017 and 2018, the location choice of Chinese industries began to have clear preferences. With outward industry transfer, most of China's regions are not attractive for industry relocation. In China, the industry transfer has been influenced by resource factors, production factors and environmental regulations, with a general trend towards the southeast coastal or central southern regions and remote resource-based regions. From 2018 to 2019, the advantages of the southeast coastal regions in attracting industry clusters further diminished.

It is particularly notable that Guangdong, Jiangsu and Shanghai, which are located along the southeast coast and have long been favoured in terms of industry location choice, became outward industry transfer regions during the year. In addition, Zhejiang, which has always attracted a significant number of enterprises to settle, did not attract as much inward transfer in the year. At the same time, the attractiveness of remote resource-based regions for inward industry transfer showed a certain tendency to decline. Evidently, environmental regulations and resource endowments have not yet led to a stable preference for the geographical location choice of industry at this stage. Nevertheless, it can be seen that as the economy and society develop, the location advantages of the southeast coastal regions and the southern centre of China, where there was a considerable location advantage in the early years of the study, are weakening. Under the influence of production factors, resource factors, environmental regulations, and globalisation, China's industry is forming a completely new landscape.

From the cumulative volume of industry transfer by region for the entire study period from 2014 to 2019, we could notice that industry transfer by region mainly occurred before 2018, and in some regions a large proportion of industry transfer was completed even earlier. Most of the regions have entered a stage of regional industry development after 2018. The increase or decrease of industry transfer is significantly lower compared to previous ones. For some of the southeast coastal regions, such as Fujian, Guangdong, Jiangsu and Zhejiang, we can learn that their predominant industry intake took place between 2017 and 2018, after which the share of industry transferred to these regions began to slow down. These regions have entered a stage of regional industry development. For remote resource-based regions and regions lagging behind in economic development, such as Yunnan, Xinjiang, Shanxi and Shaanxi, they began to reverse the continued loss of industry in 2016 or 2017. They began to attract industry back to gather by virtue of the advantages given by the development over time and the unique energy endowment. In the time since then, the general industry transfer has been less dynamic against the backdrop of regional industry development taking place in most other regions. As a result, the trend in the cumulative volume of industry transfers in these regions has slackened.

Pollution transfer across regions in China. From the above analysis of industry transfer across regions in China, we could understand that industry's preference for geographical location is not static, but as society develops, more and more factors become necessary for industry to consider in their location choice. As industry migrates from one region to another, industrial pollutants, which are by-products of industry, will also be transferred across regions. Nowadays, when we talk about pollution, it would be biased to focus on individual regions or countries. As globalisation deepens, the intensive trade and industry transfer among regions and among countries has made pollutants an issue that should be discussed in the national and even the worldwide context.

In order to learn the pollution transfer across regions in China, the data on the transfer of sulphur dioxide emissions, chemical oxygen demand, and industrial solid waste generated, concerning air pollution, water pollution and solid waste and the data on the transfer of carbon dioxide accompanying the operation of pollution-intensive industries from 2014 to 2019 are selected and processed by cluster analysis [5]. The results are visualised on the map, as shown in the figure.



Pollution transfer by region from 2014 to 2019

From the overall pollution transfer in China, there is a noticeable geographical bias throughout the study period. The regions with inward pollution transfer include major resource-based regions and remote economically underdeveloped regions, as well as parts of the southeast coastal regions. The concentration of pollution in resource-based regions and remote and economically underdeveloped regions could be explained by the fact that increasingly stringent environmental regulations are forcing industries, especially those with high pollution generation and emissions, to pursue pollution havens. A large part of the industries is pollution-intensive and, in an atmosphere of national and global concern for the environment, they are driven to balance regional environmental regulation with economic efficiency in their location choices. In addition, a majority of industries are resource-intensive. Their inevitably high demand for energy makes energy availability and energy costs a primary consideration. Consequently, the phenomenon of pollution aggregation emerges, in accordance with the preferences of industry transfer. Pollution transfer shows spillovers from the central regions of China to the peripheral and underdeveloped regions and resource-based regions. In addition, although some of the regions lying along the southeast coast still show the characteristics of inward pollution transfer during the study period. However, other regions along the southeast coast have already shown outward pollution transfer. The possible reasons for this, in addition to the lack of comparative advantage in environmental regulation and energy supply, could also be related to the increasing labour costs. Nevertheless, the external ports of China are set up particularly in the southeast coastal regions. These regions have frequent commercial intercourse and a unique advantage in information exchange. Therefore, as globalisation continues, for some industries, the southeast coastal regions have an unassailable geographical advantage for international trade. Furthermore, it is obvious from the figure that the central regions of China do not have a competitive advantage in location choice and at this stage they mostly belong to the regions with outward pollution transfer [6].

Conclusion. As economy and society develop and international trade relations intensify, industries are faced with increasingly multiple factors influencing

their geographical location choices. However, industry transfer under locational choice could bring about a concomitant transfer of pollution across regions. In national pollution prevention and control, the attention to individual regions can no longer cope with the complex transfer situation brought about by the era development.

In terms of industry transfer, throughout the study period, industry transfer has generally undergone a variation from an initial persistent cluster towards the southeast coast and the central inland of south China to a terminal cluster towards remote and underdeveloped regions or traditional resource-based regions. There are also temporal differences in the industry transfer process by region. Industry transfer by region mainly occurred before 2018, and in some regions a large proportion of industry transfer was completed even earlier. Most of the regions have entered a stage of regional industry development after 2018. The predominant industry intake of some southeast coastal regions took place between 2017 and 2018, after which the share of industry transferred to these regions began to slow down. These regions have entered a stage of regional industry development. For remote resource-based regions and regions lagging behind in economic development, they began to reverse the continued loss of industry in 2016 or 2017. They began to attract industry back to gather by virtue of the advantages given by the development over time and the unique energy endowment. In the time since then, the general industry transfer has been less dynamic against the backdrop of regional industry development taking place in most other regions.

In terms of pollution transfer, the results of the cluster analysis for the various pollutants show that there is a clear geographical tendency for pollution transfer in China throughout the study period. The main trend is the cluster of pollution from the central China to the peripheral regions. The regions on the periphery of China include the major traditional resource-based regions and those with lagging socioeconomic development. Rich resources and weak environmental regulations are the primary characteristics of such regions. In addition, some of the regions located along the southeast coast have already shown an outward pollution transfer. However, owing to the outstanding advantages in international trade, it can be predicted that the southeast coastal regions will remain prominent in attracting industries to settle there.

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Т. Г. ЗОРИНА, ЛЮ СЮЭЯО

**АНАЛИЗ ПЕРЕНОСА ПРОМЫШЛЕННОГО
ПРОИЗВОДСТВА И ЗАГРЯЗНЕНИЙ
МЕЖДУ РЕГИОНАМИ В КИТАЕ**

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По мере развития экономики и общества и интенсификации международных торговых отношений промышленные предприятия сталкиваются с множеством факторов, влияющих на выбор их географического местоположения. Перенос промышленного производства может привести к сопутствующему переносу загрязнений между регионами. В рамках национальных мер по предотвращению и контролю загрязнений внимания к отдельным регионам уже недостаточно, так как это не позволяет справиться с проблемой переносов комплексно. Для того чтобы лучше изучить пути возникновения загрязнений на нынешнем этапе развития Китая, в данной статье исследуется общая тенденция переноса загрязнений, связанная с переносом промышленного производства между регионами Китая. Что касается переноса промышленного производства, то в течение исследуемого периода он в целом претерпевал изменения от первоначального устойчивого кластера в направлении юго-восточного побережья и центральной внутренней части южного Китая до конечного кластера в направлении отдаленных и слабо развитых регионов или традиционных ресурсообеспеченных регионов. Кластерный анализ отдельных загрязняющих веществ показал, что на протяжении всего периода исследования наблюдалась тенденция агрегирования загрязнений из центральных районов в менее развитые или ресурсообеспеченные регионы на периферии Китая.

Ключевые слова: перенос промышленного производства; перенос загрязнений; выбор местоположения; экологическое регулирование; энергетические запасы.

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Т. А. СИГАЕВА

**КОНЦЕПТУАЛЬНЫЕ ПОДХОДЫ
К ОТРАСЛЕОБРАЗОВАНИЮ В СИСТЕМЕ ПРАВА**

Статья посвящена анализу теоретических воззрений относительно понятия отрасли права, факторов ее образования и критериев определения в системе права в разные исторические эпохи. В дореволюционный период развивалась идея о предмете регу-

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Веснік Беларускага дзяржаўнага эканамічнага ўніверсітэта