Manufacturing Regional division pattern of the Old Industrial Base in Jilin Province

Linshan Li, Lihui Yang*

Tourism college, Shandong Women’s University, Jinan, Shandong Province, 250300, China

*Corresponding author’s e-mail: li.lin.shan@163.com

Abstract. Since the revitalization of Northeast China for many years, it is still facing the task of structural transformation and upgrading for the manufacturing industry of Jilin Province. Industrial center index and regional specialization index was introduced in this paper to study the manufacturing regional division pattern and analyze the driving factors. The results show that there are certain regional differences of the capital-intensive and technology-intensive industries, while the labor-intensive industries are widely distributed. The manufacturing presents a trend of specialization as a whole. However, few counties and cities are dominated by one industry. The manufacturing region are divided into seven categories, namely, labor specialization region, capital specialization region, technical specialization region, labor-capital specialization region, labor-technology specialization region, capital-technology specialized region, and integrated region. Finally, the main driving factors of manufacturing regional division pattern were analyzed from the natural conditions and economic conditions.

1. Introduction
Regional division is the spatial form of social labor division, which is based on certain geographical advantages, and the mature region will generate new geographical advantages [1]. Industrial regional division refers to the division of human economic activities according to inter-regional differences. Each region focuses on favorable industries according to their own conditions and advantages, and exchanges the products with external regions [2]. With the development of modern commodity economy, China's industrial regional division makes a big difference, which is gradually getting rid of the embarrassment of planning, and undergoing a process of mode adjustment based on regional production specialization.

Western economists such as Smith, Ricardo, and Olin first elaborated on the theory of industrial geographical division of labor and became the authority of modern international trade and inter-regional division of labor theory. Former Soviet economic geography scholar Baronsky pointed out that economic interests, transportation and tariffs. Etc. have an important role in the geographical division of labor [3]. In recent years, with the acceleration of the process of globalization and the advancement of science and technology, in China, the division of labor in the industry has developed from the division of labor in the traditional sector to the division of labor within the department, and then began to develop towards the division of the industrial chain [4]. Domestic research on industrial division of labor is concentrated in the theoretical study of industrial division of labor [5], industrial geographical classification [6], mechanism analysis of industrial division of labor in the new context [7-8], research on regional division of industrial chain [9-10] etc. There is less research on the...
industrial geographical division in old industrial bases, and qualitative research is the main one, which provides an opportunity for relevant research in this paper.

Since the implementation of the revitalization strategy of the old industrial bases in Northeast China in 2003, the revitalization of the old industrial bases in Northeast China has achieved remarkable results and staged results. Especially for the manufacturing industry, the competitiveness of state-owned enterprises has increased, major equipment research has made great progress, and the geographical division of labor has become increasingly reasonable. However, there are still many problems, especially as China's economic development enters a new normal, and the downward pressure on the economy in the Northeast region increases, and the development faces many new difficulties and challenges. The more prominent problem is that the industry structure and product structure of partial resources, traditional and heavy chemical industries do not adapt to market changes, and the development of emerging industries is slow. Resource depletion, industrial recession, and structural single-region (city) transformation are facing more difficulties. Etc [11].

As a representative of the old industrial base in Northeast China, Jilin Province is facing a difficult situation of industrial restructuring and upgrading, and the division of labor and cooperation is in urgent need of strengthening. Therefore, it is necessary to analyze the current situation and existing problems in the industrial division of labor in Jilin Province, and analyze the reasons to propose adjustment strategies. To this end, this paper introduces industrial centrality index, regional specialization index and other methods, quantitatively studies the geographical division of manufacturing in Jilin Province from the perspective of manufacturing level functions and departmental division of labor, and analyzes the driving factors that generate regional division of labor, trying to develop regional advantages and characteristic industries and providing a reference for the characteristic industry, the establishment of a characteristic industrial system that helps the old industrial base to adjust and revitalize and a reasonable geographical division of labor.

2. Methodology and data

2.1. Industrial centrality index
The industrial centrality index means the dominant position of the industrial layout center [3, 12]. In this paper, it is used to evaluate the industrial relative importance of a region to other places. The industrial centrality index $C_{ij}$ of industry $j$ in region $i$ is as follows:

$$
C_{ij} = X_j \sqrt{\frac{1}{n} \sum_{j=1}^{n} X_j}
$$

The higher the value of $C_{ij}$, the more obvious the dominant position of the region $i$.

2.2. Regional specialization index
The regional specialization index is used to measure the specialization level of an industry in a particular region [14-15]. In this paper, $FR_i$ is used to indicate the specialization coefficient of region $i$. The higher the value, the higher the degree of industrial specialization. The formula is as follows:

$$
FR_i = \frac{1}{2} \sum_{j} |S_{ij} - S_j|
$$

$S_{ij}$ means the manufacturing employment of the industry $j$ accounted for the total industries in the region $i$, and $S_j$ means the manufacturing employment of the industry $j$ accounted for the total industries in the province.

2.3. Gravity model
The gravity model is an indicator of economic linkage strength between regions [13]. Its formula is:
In which, $E_{ij}$ indicates the economic linkage strength between two counties (cities); $P_i$ and $P_j$ are the populations of the two counties (cities); $G_i$ and $G_j$ are the total manufacturing output of the two counties (cities); $d_{ij}$ is the distance between two counties (cities).

2.4. Boston matrix (BCG Matrix) method

Boston matrix method is also known as the four-quadrant analysis method, which is used to classify and evaluate the enterprise strategic business units by "market growth rate-- relative market share matrix"[16]. It was gradually introduced into the industrial analysis as one of the metrics for regional industrial planning [17]. In this paper, the regional specialization index is taken as the X-axis and the industrial centrality index is taken as the Y-axis. The Boston matrix is applied to construct a matrix diagram of the degree of influence and specialization of the county manufacturing industry. The significance of each quadrant is shown in Fig. 1. The comprehensive dominant type indicates that the manufacturing share of the region is dominant in the province and the development is relatively balanced; the professional dominant type indicates that the manufacturing share of the region is dominant, and concentrates in several industries; The balanced appurtenant type indicates that the manufacturing industries in the region are balanced, but the proportion in the province's share is low; the specialized appurtenant type indicates that the proportion of manufacturing in the region is also low in the province, and there is a certain degree of specialization in a certain industry.

2.5. Data

The research region of this paper is 9 prefecture-level urban regions and 39 county-level units (county-level cities and autonomous counties) in Jilin Province. The manufacturing enterprises employment scale data are from “First National Economic Census Yearbook in Jilin Province (2004)” and “Second National Economic Census Yearbook in Jilin Province (2008)”. The manufacturing sectors were organized according to the National Economic Industry Classification and Code (GB/4754-2011), and divided according to the attributes of labor, capital, and technology input factors in the production process of each department [18-20], which is shown in Tab. 1.

| Classification  | Manufacturing industries                                                                 |
|-----------------|-----------------------------------------------------------------------------------------|
| Labor-intensive | Agricultural and sideline food processing industry, food manufacturing, beverage manufacturing, textile industry, clothing and other fiber manufacturing, leather fur down and its products, wood processing and wood bamboo and rattan brown grass products, furniture manufacturing, paper making and the paper |
products industry, the replication of the printing industry and the recording media, the cultural and educational sporting goods manufacturing industry, the metal products industry

Capital-intensive
- tobacco products industry, petroleum processing, coking and nuclear fuel processing industry, chemical fiber manufacturing, rubber products, plastic products, non-metallic mineral products, ferrous metal smelting and rolling processing, non-ferrous metal smelting and rolling processing

Technology-intensive
- chemical raw materials and chemicals, pharmaceutical manufacturing, general equipment manufacturing, special equipment manufacturing, transportation equipment manufacturing, electrical machinery and equipment manufacturing, electronics and communication equipment manufacturing, instrumentation and cultural office Machinery manufacturing

Note: The classification methods of industries according to the degree of intensive use of elements include visual judgment method and factor contribution measurement method [20]. The author refers to the factor contribution measurement method to classify various industries.

3. Evaluation of manufacturing grades of counties and cities in Jilin Province

3.1. Manufacturing industrial centrality index evaluation in counties and cities of Jilin Province

Based on the manufacturing employment data of all counties and cities in Jilin Province in 2008, the industrial centrality index of the overall manufacturing and different factor classifications were calculated by formula (1). As shown in Fig.1, there is an obvious polarization phenomenon of centrality index in Jilin Province, the highest is Changchun and Jilin, both above 6; followed by Siping, Tonghua, Liaoyuan, Songyuan; The proportion of manufacturing in other counties or cities is generally low.

From different industries, the centrality index of various industries in Changchun and Jilin are higher, but the development advantage of technology-intensive industries is the most obvious, due to its advantages in infrastructure, information, talents, transportation and industrial base, and formed a manufacturing base led by automobile, petrochemical, equipment manufacturing, and optoelectronic machinery. The capital-intensive industries central index of Siping and Yanji is relatively high. The reason is that Siping is an important transportation hub city in Northeast China. The manufacturing industry has a good industrial base. So the proportion of machinery, fine chemicals, special vehicles and auto parts industry is high. As for Yanji, tobacco products and non-metallic mineral products account for 30% of the total manufacturing industry. For Jilin Province as a whole, there is a certain geographical division of labor capital-intensive industries and technology-intensive industries, while labor-intensive industries are relatively ubiquitous, but there are still certain regional differences in their internal industries. In the western part of Jilin Province, the textile industry, leather and fur products are the main industries; in the central region, the main industries are food processing industries and textile and garment industries; in the eastern mountainous regions, the main industries are engaged in wood processing, furniture manufacturing, paper making and paper products.
3.2. Evaluation of Manufacturing Specialization Characteristics in Counties and Cities of Jilin Province

The formula (2) was used to calculate the manufacturing specialization index of various regions in Jilin Province in 2008, and combined with the previous central index, the Boston matrix map of the county manufacturing industry was constructed.

Referring to the labor-intensive, capital-intensive, technology-intensive manufacturing matrix map, the regions with highest professional index and centrality index were selected, and identified seven manufacturing type zones (Fig. 3), namely labor-based specialized regions, capital-based specialized regions, tech-based specialized regions, labor-capitalized specialized regions, labor-technical specialized regions, capital-technical specialized regions and integrated regions. Among them, Changchun is located in the first quadrant of the technology-intensive manufacturing matrix, which means a tech-based specialized city, actually the advanced equipment manufacturing industries in Jilin Province are mainly concentrated in Changchun; a group of innovative enterprises such as photoelectric information, bio-medicine and new materials are also distributed in Changchun.

Taking Jilin as the representative, most industries of the counties and cities around Changchun develops balanced. It can be seen from Fig. 3 that the investment in technical elements in Jilin City is significantly higher than that in labor and capital, and the city belongs to a relatively tech-based specialized city. It is worth noting that the specialization of manufacturing in the eastern and western regions of Jilin Province is obvious. Tonghua in the southeast and Dunhua in the northeast are important pharmaceutical manufacturing regions in Jilin Province; Baicheng and Songyuan in the west of Jilin Province are the main agricultural and pastoral planting regions. It has developed special...
industries such as cotton and linen textiles, leather fur and feather products and products, and deep processing of corn.

The specific specialized partitions are as follows:
- Labor-based specialized regions: Dehui, Fuyu, Taonan, Tumen, Hunchun, Longjing, and Helong.
- Capital-based specialized regions: Jiaohe, Panshi, Siping, Yitong, Songyuan, Zhenlai, Yanji, Antu.
- Tech-based specialized regions: Changchun, Tonghua County, Jilin, Jingyu, Linjiang.
- Labor-capital specialized region: Baishan.
- Labor-technical specialized regions: Fusong, Changbai, Qiangguo, Tongyu, Dunhua, Wangqing.
- Capital-technical specialization region: Tonghua.
- Integrated regions: Nong'an, Jiutai, Yushu, Jilin, Yongji, Huadian, Shulan, Lishu, Gongzhuling, Shuangliao, Liaojuan, Dongfeng, Dongliao, Huinan, Liuhe, Meihekou, Changling, Qian'an, Baicheng, Da'an.

![Fig 3. Manufacturing professional classification of Jilin Province](image)

4. Analysis of the manufacturing geographical division pattern and driving factors

4.1. The manufacturing geographical division of Jilin Province

According to ArcMap10.1 platform, based on the centrality index to determine the city level, with the formula (3) gravity model, manufacturing functional region is divided according to the population of the county (city), the total production value and the distance between the two places. The centrality index of Changchun and Jilin is obviously higher than other cities, and they are the provincial center. Siping, Songyuan, Tonghua and Liaojuan are the provincial sub-centers. The other nodes were determined the attribution according to the gravitational size with the upper center. The geographical functional regions are: the central comprehensive manufacturing region, the southeast tech-intensive manufacturing region, the northeast labor-tech manufacturing region, and the western labor-capital manufacturing region. Among them, the central comprehensive manufacturing area mainly develops automobile, petrochemical, food processing and other industries. The southeast tech-intensive manufacturing area mainly develops forestry, building materials, pharmaceutical manufacturing and other industries. The northeast labor-tech manufacturing area mainly develops medicine, tobacco, wood processing, non-metallic minerals and other industries. The western labor-capital manufacturing area mainly develops agricultural and sideline food processing industries, auto parts, textile and garment industries.
4.2. Driving factors analysis

Since the revitalization of the old industrial base, the manufacturing geographical division in Jilin Province has been adjusted. And the level of industrial upgrading and specialization has improved. Specifically, the main driving factors that lead to the manufacturing geographical division adjustment in various counties and cities are as follows:

Natural conditions are the material basis for industry sector selection and development. The geographical space of Jilin Province is vast. And the natural conditions have obvious differences in east-west direction, which have important influences and constraints on the formation of economic and social geographical space [21]. The eastern part of Jilin Province is abundant with forest resources, wildlife resources, water resources and mineral resources. Wood processing, steel, cement, Chinese herbal medicine and other products occupy an important position in the province. The central platform plain is flat, the soil is fertile, and agricultural production conditions are favourable, the level of specialization is high and the human resources are abundant, which is conducive to the comprehensive development of various sectors of the manufacturing industry. The western plain belongs to the agro-pastoral zone, with rich cultivated land resources and pasture resources, and is an important agricultural and livestock product processing in the province. Simultaneously the fragility of the ecological environment also limits the large-scale development of the manufacturing industry, especially the development of some industrial sectors with obvious environmental impacts.

Economic conditions are the economic basis for the formation and development of economic regions, which is particularly important under market conditions [2]. The impact of economic conditions is reflected in the industrialization stage, the original economic base, market conditions, and regional internal linkages.

First of all, the industrialization process of Jilin Province has gradually spread from the central region to the east and the west. With the acceleration of the industrialization process in the central region, the manufacturing industry has accumulated a comprehensive cluster of core circles, and the peripheral hinterland is mainly characterized by agricultural and mining-leading industrial division. The degree of difference in the regional economic development is growing.

Secondly, the original economic base has far-reaching influence on the development of industrial division of labor. Once the distribution of industrial enterprises is formed, it is difficult to change at will. The manufacturing geographical division in Jilin Province was generally formed under the support of several major projects in the early days of New China. For example, Changchun First Automobile Manufacturing Plant built the dominant position of the automobile in Changchun, Jilin Chemical Industry Company, Jilin Dyestuff Factory, and Jilin Fertilizer Plant built the dominant position of the petrochemical industry in Jilin.

![Fig 4. Manufacturing regional division pattern of Jilin Province](image)
Thirdly, the pull of export-oriented market. During the ten years of revitalization of the old industrial base, the openness of the manufacturing industry in Jilin Province began to increase. With the improvement of traffic conditions in the central and southern regions, the development and opening up of the central and eastern regions of Jilin Province led to the upgrading of the local manufacturing industry.

Fourth, the promotion of internal relations. The increase in the strength of the link will facilitate the free transfer of capital, industry and technology within the province. With the advancement of convenience such as roads, communications, and finance, the intensity of internal relations in Jilin Province has been increasing, which in turn has promoted the more efficient allocation of resources and the progressive division of industrial specialization.

5. Conclusion
At present, the understanding of the geographical division of manufacturing in Jilin Province is based on qualitative research. Based on the economic census data, this paper introduced the industrial centrality index to evaluate the functional characteristics of Jilin Province manufacturing. And regional specialization index was used to evaluate the professional characteristics in manufacturing industry of each county. With the combination of the two index to build a Boston matrix map of manufacturing impact and specialization, and then analyze the manufacturing division of labor and the main drivers.

The study draws the following conclusions:

- In the various manufacturing sectors of Jilin Province, capital-intensive and tech-intensive industries have a certain geographical division, while labor-intensive industries are relatively ubiquitous.
- The overall manufacturing industry in Jilin Province presents a trend of specialization, but there are not many counties and cities that rely solely on a certain production factor to develop into a specialized county. Seven types of zones have been identified. Among them, Changchun belongs to a technical specialization city and has a diffusion effect on the knowledge elements of manufacturing development in surrounding counties and cities. Jilin is a relatively technical specialized city. And the investment in technical element is significantly higher than the labor and capital elements.
- Jilin Province is divided into four manufacturing regional functional areas: the central comprehensive manufacturing area, the southeast tech-intensive manufacturing area, the northeast labor-tech manufacturing area, and the western labor-capital manufacturing area.
- Natural conditions are the material basis for the selection and development of manufacturing sectors in counties and cities in Jilin Province. Economic conditions have affected the final formation of the geographical division of labor in manufacturing, and its impact is mainly reflected in the industrialization stage, the original economic base, market conditions, and regional linkages etc.

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