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Spatial-temporal Pattern Evolution of Manufacturing Geographical Agglomeration and Influencing Factors of Old Industrial Base: A Case of Jilin Province, China

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Abstract: The primary object of this paper is to examine the spatial-temporal pattern evolution of manufacturing geographical agglomeration of the old industrial base. Industrial spatial agglomeration index and concentration ratio are used in this paper. Multiple linear regression models are also applied to try to explore the internal driving mechanisms on manufacturing geographical agglomeration. The results show that: 1) the manufacturing agglomeration degree of Jilin Province is increasing gradually. The spatial polarization structure is visible; and the central region is the agglomeration area, in addition, the manufacturing industries of Changchun Proper present a trend of dispersion; 2) the structure of manufacturing industries has changed, and the concentration ratio of labor-intensive manufacturing industry is declining, while the proportions of technology-intensive and capital-intensive manufacturing industry are relatively rising; 3) marketing level, location accessibility, labor resources, capital, science and technology innovation capability, scale economy and the level of globalization affect manufacturing agglomeration with different degree. There are significant differences of the effects about employment, technology, the quality of residents and the export-oriented market on the industrial concentration ratio; 4) in the future, the impact of policy and institution, export-oriented market and quality of resident on manufacturing geographical agglomeration pattern will be more profound.

Keywords: old industrial base; manufacturing geographical agglomeration; industrial spatial agglomeration index; concentration ratio; Jilin Province; China

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1 Introduction

As an important driving force in urban and regional development and spatial restructuring, manufacturing agglomeration and dispersion have been widely concerned as a hot topic. Because of the financial crisis, the Western developed countries have experienced a long period of economic downturn, and also realized the importance of developing real economy to keep national economy sustainable. This provides experiences for China to carry out new path of industrialization, that is, we should both ensure the important position of industrial real economy, and promote the upgrade of the industrial restructuring.

Regional agglomerations of industries or enterprises can produce positive external effects on regional development. The characteristics of manufacturing industrial agglomeration vary from different regions, types, and

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production activities. The impact of agglomeration on labor productivity, business activity and enterprise competitiveness would also be diverse (Porter, 1998; Fan and Scott, 2003; Alonso-Villar *et al*., 2004; Konrad and Kovenock, 2009; Drucker and Feser, 2012; Yang *et al*., 2013). Research on the effect of agglomeration on the enterprise distribution can trace back to industrial location theory, and the reason why enterprise′s agglomerate at a specific location is that the cost savings of production and marketing is higher than the cost increasing of freight and labor by reason of agglomeration (Li, 2006). New Economic Geography believes that scale increasing returns, imperfect competition, path dependence and cumulative effect cause the formation of industrial concentration region (Krugman, 1991; Lall *et al*., 2004).

In recent years, scholars have done many empirical researches in terms of manufacturing agglomeration patterns, location evolution, and the influence mechanism, including the research of the relationship between industrial structure, enterprise development and urban spatial expansion (Yang *et al.*, 2004; Fan *et al*., 2009; Liu and Li, 2009; Qi *et al*., 2010); the analysis of different types of spatial pattern and the manufacturing location change from the view of capital, scale and element density (Meng and Shi, 2003; Wen, 2004; Zhang and He, 2007; Wu and Ning, 2010); the research of the relationship between manufacturing development and urban space reconstruction in micro view (Lu and Chen, 2009; Rijkers *et al*., 2010; Yuan *et al*., 2012a), the manufacturing agglomeration effects on production (Zhu and Ding, 2006; Zhang *et al.*, 2012) or provincial scale manufacturing location evolutions (Qiu *et al*., 2013); and the discussion about the influence mechanism of industrial location change (Qi *et al*., 2006; Ng and Tuan, 2006; Chu and Liang, 2007; Ge, 2008). Due to the limited data access, there is less study on provincial manufacturing agglomeration features (Pan *et al*., 2011), but it is more significant to carry out the provincial level research considering administration and regional coordination. Especially under the new international background, what should be concerned is the manufacturing agglomeration features, the cause of recession and location refactoring of old industrial base.

Manufacturing industries hold vital position in the national economy, which are important forces to promote regional industrialization and urbanization level. There are vast numbers of categories of the industries, so the research on manufacturing geographical agglomeration should contain two aspects: the spatial agglomeration pattern and the industrial concentration pattern. As an important old industrial base in Northeast China, Jilin Province has formed an integrated industrial system on the base of automobile industry and petrochemical industry at the period of first five-year plan (1953–1957). Meanwhile, the industrial structure has experienced a process of ′resources industry, dominant of heavy industry, and structure adjustment and optimization′ (Li *et al*., 2009). Now the manufacture of transport equipment, processing of food from agricultural products, manufacture of raw chemical materials and chemical products have a good development foundation, and also are the major pillar industries of Jilin Province. In the context of energy conservation and emissions reduction, to take a new path of industrialization, Jilin Province has to adjust the industrial structure and develop recycling economy so as to alleviate the environment pressure of the industrial agglomeration region. It is also a common problem to be solved for old industry bases. When we study the manufacturing geographical agglomeration, we should not only focus on industrial spatial differentiation, but also study the regional industrial structure evolution. This paper tries to study the manufacturing spatial-temporal pattern and explore influencing factors by constructing industrial spatial agglomeration index and concentration ratio.

2 Materials and Methods

2.1 Study area and data source

The research of industrial spatial agglomeration index is based on eight prefecture-level cities and one autonomous prefecture of Jilin Province, i.e., Changchun City, Jilin City, Siping City, Liaoyuan City, Tonghua City, Baishan City, Songyuan City, Baicheng City and Korean Autonomous Prefecture of Yanbian (Fig. 1). The research of industrial concentration ratio is based on the 28 manufacturing industries. The original data are collected from: 1) *China City Statistical Yearbook* (National Bureau of Statistics of China, 2001–2012); 2) *China Industry Economy Statistical Yearbook* (National Bureau of Statistics of China, 2001–2012). 3) *Jilin Statistical Yearbook* (Jilin Statistical Bureau, 2001–2013).

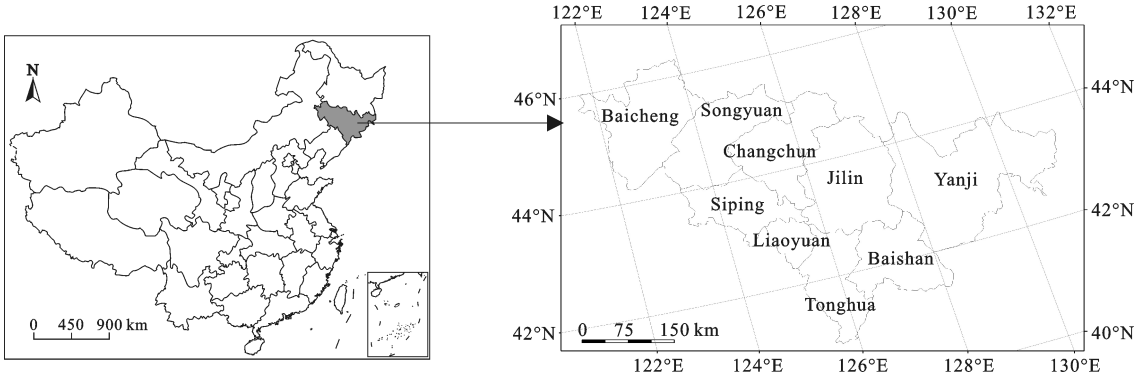

Fig. 1 Division of Jilin Province

The analysis of the industrial distribution is based on the 48 county-level units (nine municipal districts and 39 counties/county-level cities/autonomous counties) of Jilin Province, and the original data are collected from *First National Economic Census of Jilin Province* (People's Government of Jilin Province, 2004) and *Second National Economic Census of Jilin Province* (People's Government of Jilin Province, 2008).

The manufacturing industries are classified into 31 sectors according to national industries classification standard (GB/4754-2002). Because there are some changes about the classification between different years, this paper makes some adjustment to ensure the consistency. The 28 industries are divided into three types according to the contribution of labor, capital, and technology elements (Xu, 2008; Huang and Tan, 2011; Yuan *et al*., 2012b), and the result can be seen from Table 1.

2.2 Methods

Gini coefficient is generally widely used to evaluate industrial spatial layout and agglomeration features (Shi, 2010), and the equation is:

$$G = \frac{1}{2n^2 \overline{s}_k} \sum_{i=1}^{n} \sum_{j=1}^{n} \left| s_i^k - s_j^k \right| \tag{1}$$

where G means the level of industrial agglomeration; S_i^k and S_j^k are the employment of industry k in region i and region j; $\overline{s}_k$ means industrial average share of all regions. The higher the value of G is, the more obviously the industries agglomerate. *Gini* coefficient ranges from 0 to 1. The value of zero indicates that the industries are distributed equally, while the value of one indicates that the industries agglomerate completely in a certain region.

Location quotient is used to evaluate the advantage degree of some industry compared with national average level (Li, 2006), and the equation is:

$$L_i = \frac{a_i / A}{b_i / B} \tag{2}$$

Table 1 Manufacturing industrial classification according to contribution of different factors

Classification due to factor intensive	Manufacturing industries (C)
Labor-intensive industry	Processing of food from agricultural products (C_{13}), manufacture of food (C_{14}), manufacture of beverage (C_{15}), manufacture of textile (C_{17}), manufacture of textile and apparel (C_{18}), manufacture of leather, furs, feathers and related products (C_{19}), processing of timber. manufacture of wood, bamboo, rattan, palm and straw products (C_{20}), manufacture of furniture (C_{21}), manufacture of paper and paper products (C_{22}), printing, reproducing of recording media (C_{23}), manufacture of articles for culture, education and sport activities (C_{24}), manufacture of metal products (C_{34})
Capital-intensive industry	Manufacture of tobacco (C_{16}), processing of petroleum, coking, and nuclear fuel (C_{25}), manufacture of chemical fibers (C_{28}), manufacture of rubber (C_{29}), manufacture of plastic (C_{30}), manufacture of non-metallic mineral products (C_{31}), smelting and pressing of ferrous metals (C_{32}), smelting and pressing of non-ferrous metals (C_{33})
Technology-intensive industry	Manufacture of raw chemical materials and chemical products (C_{26}), manufacture of medicines (C_{27}), manufacture of general purpose machinery (C_{35}), manufacture of special purpose machinery (C_{36}), manufacture of transport equipment (C_{37}), manufacture of electrical machinery and equipment (C_{39}), manufacture of computers and communications equipment (C_{40}), manufacture of instruments (C_{41})

Notes: 1. Manufacture of rubber and manufacture of plastic are calculated as two types, and auto industry is incorporated into manufacture of transport equipment. 2. The number of the industries are according to national economic industrial classification code, and so they are in the table or figure in other parts of this paper. 3. This article classifies various industries by use of the method of factor contribution measurement refer to existing standards

where L_i means the advantage degree of industry i; a_i and b_i are the employment of industry i in region a and region b (national scale); A and B are the total manufacturing employment of region a and region b. When the value of L_i is greater than 1, the industry has comparative advantage in production scale; on the contrary, which means there are not advantages in production scale.

To evaluate the concentration characterization of different manufacturing industries, and to compare industrial development trend, this article defines the industry concentration ratio, and the equation is:

$$IG_i = \frac{X_i / T}{H}, H = \sum_{i=1}^{n} (X_i / T)^2 \quad (3)$$

where T is the total employment; X_i is the employment of industry i; n is number of manufacturing industries. H is the Herfindahl Index, which is used to measure industry share in the market. IG_i is industrial concentration ratio of industry i. The larger the value of IG_i is, the better industry i develops, and the more probably it would be a regional pillar industry. Instead, industry i with low value of IG_i indicates the industry holds a small proportion.

2.3 Model

Industrial location theory has been deepening the understanding of location factors influencing the layout of the industrial enterprises. In addition to the factors such as freight, labor, agglomeration, resources, land costs, capital, and market (Qi *et al*., 2010), there are also some factors such as technology, industrial chain, international market, environmental influencing enterprise layout which have been widely noticed. For the old industrial base, the institution transformation and the government behavior are important factors influencing manufacturing geographical agglomeration. One important policy is adjusting the ownership structure. At the same time, the government spares no effort to strive for all kinds of national or provincial development zones and industrial parks to attract outside capital and enterprise. Combined with the current development situation of the manufacturing industry in Jilin Province, this paper formulates concrete explanatory variables (Table 2), and the multiple regression model is used to investigate the factors′ influence on manufacturing industry agglomeration and industrial concentration (He and Xie, 2006).

Table 2 Influencing factors on manufacturing agglomeration and explanatory variables

Influencing factors of spatial agglomeration	Explanatory variable	Unit	Variable representation
Market	Total retail sales of consumer goods	10^4 persons	Sales
Scale	Total enterprise employment scale	/	ln(scale)
Freight	Comprehensive freight capacity	10^4 t	Traffic
Labor	Labor population at right age (age of 18–60)	10^4 persons	Labor
Technology	Proportion of science and technology personnel	%	S&T
	Internal expenditure of R&D	10^4 yuan (RMB)	R&D
Capital	Total investment in fixed assets	10^8 yuan	Investment
Globalization	Value of imports and exports	10^4 yuan	I&E
	Foreign direct investment	10^4 dollars (USD)	FDI
Policy and institution	Number of development zone		Development
	Proportion of output of state-owned enterprises on total output value of industrial enterprises	%	State
Environment	Green areas covered	Ha	Greening
Influencing factors of industrial concentration ratio	**Explanatory variable**	**Unit**	**Variable representation**
Employment structure	Proportion of the manufacturing employment on the working-age population	%	LS
Technology	Proportion of personal engaged in S&T activities	%	S&T
Policy and institution	Number of development zone		Development
	Proportion of output of state-owned enterprises on total output value of industrial enterprises	%	State
Quality of resident	Literacy rate of population beyond 15 years	%	Literate
Investment structure	Proportion of investment in manufacturing on total investment in fixed assets	%	IS
Market extraversion	Proportion of value of import on total retail sales of consumer goods	%	Globalization

3 Results and Analyses

3.1 Temporal evolution of manufacturing agglomeration

The trends of regional manufacturing agglomeration of Jilin Province since 2000 are shown in Fig. 2. The results show that the overall trends of manufacturing employment are downward, and the population decreases from 892 600 in 2000 to 648 000 in 2012. The reasons are that the manufacturing labor productivity has been increasing, the state-owned enterprises have been transforming, the industrial structure has been changing and so on. It can also be seen from the trend of *Gini* coefficient that there exists agglomeration phenomenon of manufacturing industry. The *Gini* coefficient has been increasing subject to some fluctuation. It has exceeded 0.5 since 2005, and then remains at 0.53, which indicates that the manufacturing industrial agglomeration in Jilin Province has been improving. Especially since 2003, the nation has determined to implement the strategy of rejuvenating old industrial base in Northeast, and owing to a series of supporting policies, some manufacturing industries in Jilin Province present new trend of growth and agglomeration.

3.2 Spatial pattern evolution of manufacturing agglomeration

The manufacturing employment distribution presents characteristics of spatial polarization, and the main agglomeration region is located in the central part of Jilin Province. The trend of agglomeration gradually increases (Fig. 3). Changchun Proper and Jilin Proper have always been the regions with higher levels of manufacturing employment, and employment population proportion of the two cities increase from 40.9% in 2004 to 46.9% in 2008. In 2004, manufacturing present characteristics of geographical agglomeration, and employment in city proper is generally higher than that in counties. In 2008, there are still polarization patterns in Jilin Proper, Baicheng Proper and Liaoyuan Proper. The manufacturing in Changchun Proper has showed a trend of dispersion because of industrial chain extension. One important impetus is the manufacture of transport equipment, the traditional dominant industry of Changchun Proper, has presented many new features, for example, the outsourcing parts production promoting industrial spatial expansion, the construction of the automobile industry development zone, and the continuous participation in the global production networks (Kelly, 2013). These features improve the employment of Jiutai (Changchun City), Nong′an (Changchun City), Dehui (Changchun City), and Gongzhuling (Siping City), and promote the region forming automotive industrial agglomeration area. In the eastern region, such as Yongji (Jilin City), Yitong (Siping City), and Dongliao (Liaoyuan City), there are fewer manufacturing enterprises. The abilities of manufacturing industrial agglomeration in Tonghua Proper, Baishan Proper and Yanji City (the capital of Korean Autonomous Prefecture of Yanbian) are enhanced. In the western region, such as Baicheng Proper, the development speed and agglomeration level of manufacturing industry lag relatively behind.

Fig. 2 Dynamics of manufacturing industrial employment and *Gini* coefficient

It can be found some geographic agglomeration characteristics by comparing the employment spatial distribution in the two periods of Jilin Province. Firstly, the employment is mainly distributed in the central region of Jilin Province, especially in Changchun Proper and Jilin Proper. Secondly, the manufacturing agglomeration pattern presents obvious characteristics of dual structure. Thirdly, the driving abilities for manufacturing employment in different central cities on periphery zones are different. In 2008, manufacturing in Changchun Proper have experienced the stage of dispersion. While in some regions of Jilin Province, manufacturing still presents state of single center agglomeration, such as Tonghua Proper, Baishan Proper, and so on.

According to Fig. 4, we can find that employment distribution of processing of food from agricultural products is relatively dispersed, and is mainly located in the midwest, forming a industrial agglomeration region.

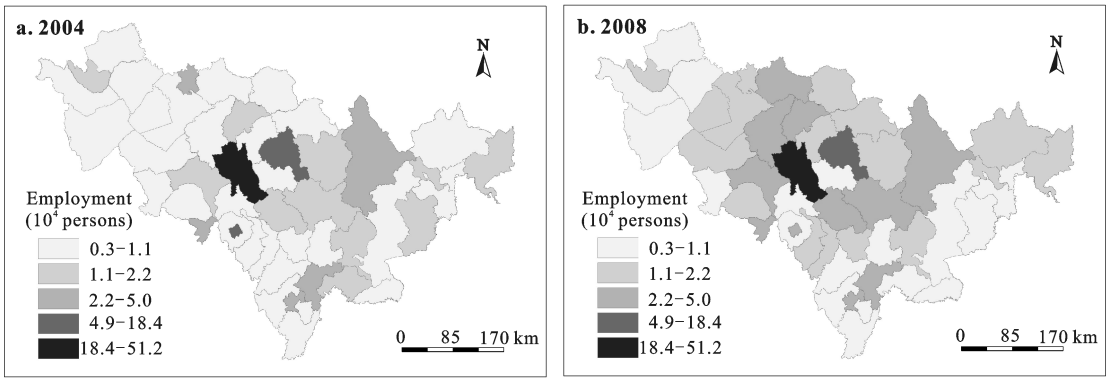

Fig. 3 Spatial patterns evolution of manufacturing industrial employment in Jinlin Province, China

While in the eastern region, the industrial scale is generally relatively small. The reason is that as a typical resource-intensive industry, this industry is affected by raw material, and the midwest is exactly the main production region with grain and animal husbandry. Manufacture of raw chemical materials and chemical products are mainly located in Changchun Proper and Jilin Proper. As the old industrial base of petrochemical industry, Jilin Proper has established the basis of the chemical industrial system during the first five-year plan (1953–1957), so the manufacturing base and scale were larger than that in Changchun Proper. Manufacture of transport equipment is also located in Changchun Proper and Jilin Proper. Widely due to its industrial chain extension features, it forms a related industry agglomeration region in the west of Changchun. Apart from Changchun Proper and Jilin Proper, the distribution regions about manufacturing of medicine can also be found in the southeastern places of Jilin Province. These places have adequate resources to develop the industry because they are all near the Changbai Mountains Region which is rich in medicinal herbs.

It can be found that the four pillar industries (Fig. 4) tend to be agglomerated in the central city (mainly in Changchun Proper and Jilin Proper), because there are sufficient accumulation of capital, labor force, and infrastructure in the central cities. The impact of resource elements on the space layout of the raw materials industries can not be ignored either.

3.3 Evolution characteristics of manufacturing industrial structure

It can be seen from Table 3 that the manufacturing employment in Jilin Province increases after reducing at first, and the proportion about the employment in the three provinces in Northeast China is basically on the rise. It indicates that the old industrial bases of three provinces in Northeast China generally experience a process from recession to revitalization, and also indicates that the status of manufacturing industry of Jilin Province has increased. In 2011, the manufacturing employment number is 1 072 800, which accounts for 36.49% in the three provinces.

The employment scale of C_{13} in Jilin Province is increasing. The proportion and the location quotient are on the rise, indicating that the proportion of light industry, represented by C_{13}, is increasing. It also confirms the trend of diversification about manufacturing structure.

The employment scale of C_{26} decreases significantly. The proportion in Northeast China shows a trend of fluctuations. The location quotient is only 0.72 in 2011, no longer has comparative advantage. It manifests the impact of industrial structure adjustment on weakening of the heavy chemical industry.

The employment scale of C_{27} increases year by year, slightly higher than the average proportion in Northeast China. The value and the proportion respectively growth to 107 200 and 52.24% in 2011.The location quotient is 2.27, indicating high development advantage of this industry.

Manufacture of C_{37} is not only a pillar industry, but also the leading industry of Jilin Province. It has always been the industry with advantage in Northeast China, because the proportion always stays above 40%. However, location quotient is on the decline from 2.49 to 1.64, showing that the competitive challenges from the same industry in other places (Beijing, Shanghai, and Guangzhou) become more obvious, despite C_{37} of Jilin Province still has strength foundation.

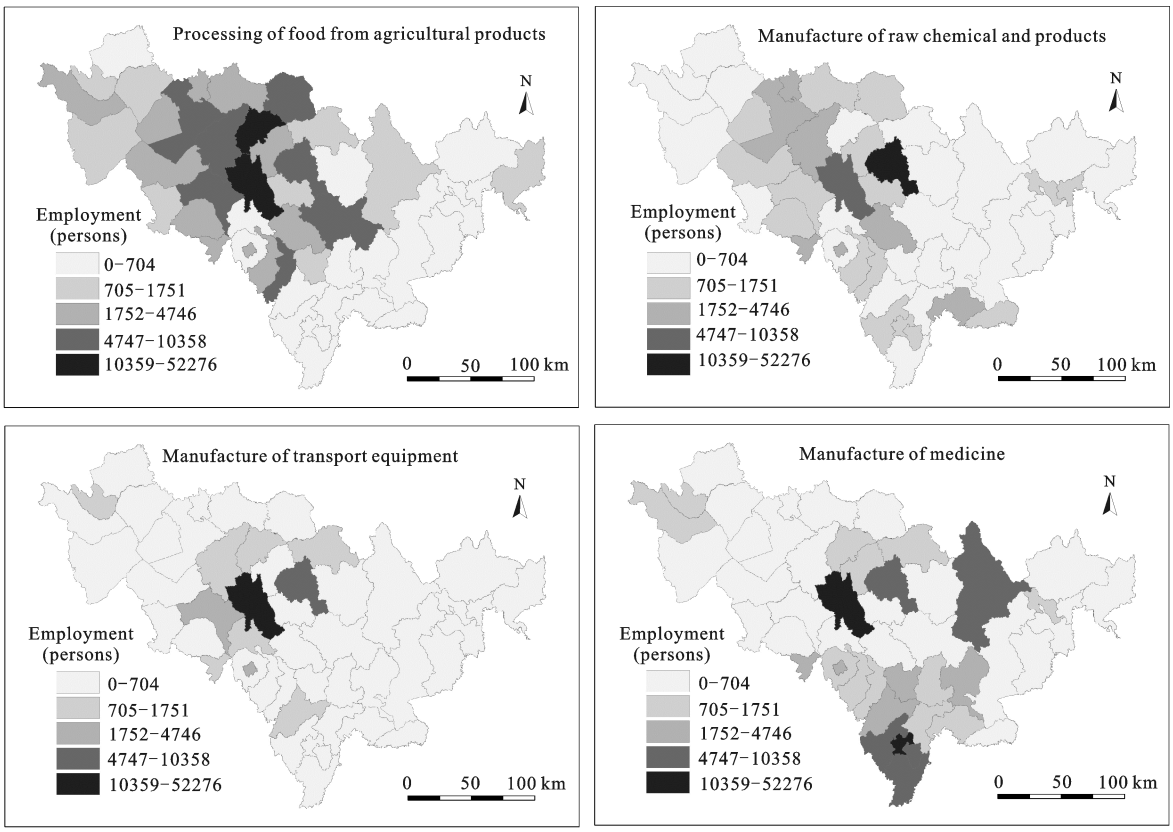

Fig. 4 Distribution of pillar manufacturing industrial employment in Jilin Province, China in 2008

Table 3 Status of pillar manufacturing industrial employment of Jilin Province in Northeast China in different years

Type	2000			2004		
	Jilin Province (10^4 persons)	Proportion in Northeast China (%)	L_i	Jilin Province (10^4 persons)	Proportion in Northeast China (%)	L_i
C	93.47	22.87		77.44	22.79	
C_{13}	4.22	25.03	0.95	4.48	19.08	0.79
C_{26}	11.21	27.88	1.23	8.18	34.57	0.95
C_{27}	4.47	37.57	1.70	4.58	36.01	1.46
C_{37}	20.10	40.16	2.49	18.43	40.97	2.06
Type	2008			2011		
	Jilin Province (10^4 persons)	Proportion in Northeast China (%)	L_i	Jilin Province (10^4 persons)	Proportion in Northeast China (%)	L_i
C	89.65	31.41		107.28	36.49	
C_{13}	9.15	21.83	1.11	12.03	24.23	1.26
C_{26}	7.95	26.40	0.71	8.66	30.30	0.72
C_{27}	5.20	31.89	1.32	10.72	52.24	2.27
C_{37}	21.54	42.49	1.74	25.08	43.05	1.64

Note: C means the total manufacturing industries; C_{13} means processing of food from agricultural products; C_{26} means manufacture of raw chemical materials and chemical products; C_{27} means manufacture of medicines; C_{37} means manufacture of transport equipment; L_i means location quotient (Equation 2)

We also use the Equation 3 to calculate the data of manufacturing industries employment of Jilin Province, and find the dynamic rule of manufacturing industry concentration ratio (Fig. 5).

The proportion of labor-intensive manufactures declines basically after 2009, showing that the dependence

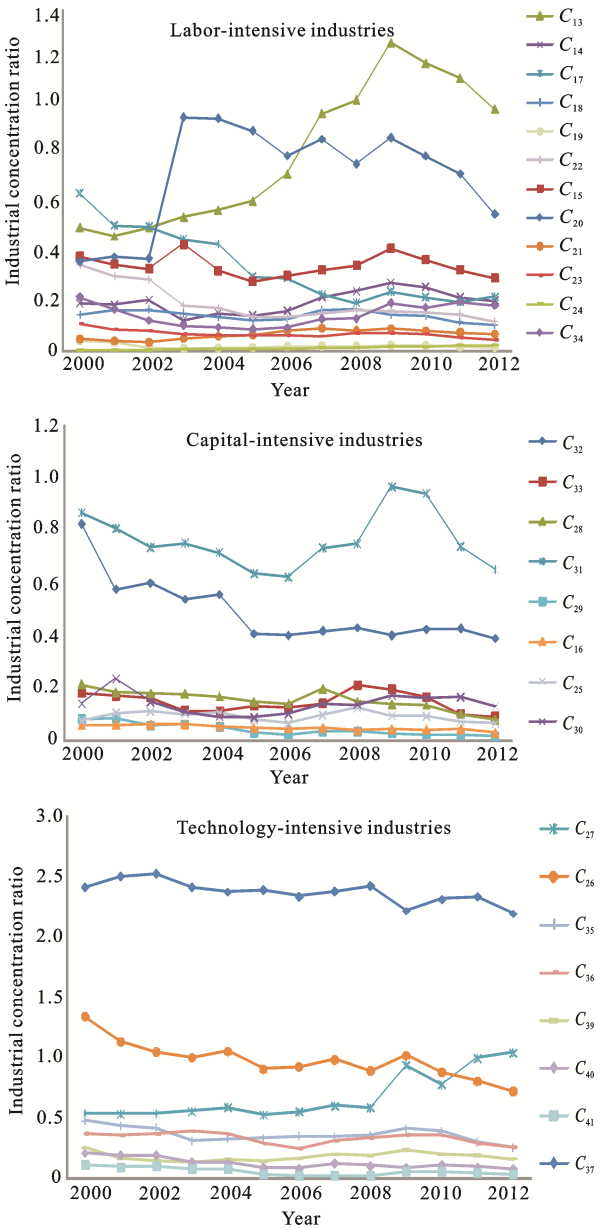

Fig. 5 Industrial concentration ratio of different factor-intensive manufacturing industries

of manufacturing on labor has declined in recent years. The concentration ratio of C_{13} has been rising from 2000 to 2009, and fall after 2009; the proportion of C_{20} has presented a downward trend since 2003. The concentration ratios of technology-intensive and capital-intensive industry show trends of polarization. The proportions of most manufacturing have more or less dropped, although there are some industries such as C_{26}, C_{31}, C_{37}, C_{27} with an index more than 0.5.

It can be seen that manufacturing industry structure presents a phenomenon of adjustment after 2009, the proportion of labor-intensive manufacturing declined. However, the proportion of technology-intensive and capital-intensive manufacturing growth are not significant except C_{27}, showing that the manufacturing industry structure optimization and upgrading effect will not be remarkable in a short period of time for the capital and technology constraints. What's more, the manufacturing industry structure development tends to be diversified, which can be indicated from the fact that the industries with higher concentration ratio such as C_{37}, C_{26}, C_{13} are on the decline, and the proportion of C_{20}, C_{21}, C_{24}, C_{27} are increasing to some degree.

3.4 Influencing factors analysis of manufacturing agglomeration

Taking *Gini* coefficient and industrial concentration ratio of manufacturing as the dependent variable respectively, this article applies multiple linear regressions to analyze the influencing factors, and take the weighted average of concentration ratio of each industry as the dependent variable of labor-intensive, technology-intensive and capital-intensive industry. Because there is a linear correlation between some variables in the model, the interpretation of the correlation between variables are discussed separately. Model regression results are shown in Table 4 and Table 5.

In general, there is significant positive correlation between manufacturing agglomeration degree and most of the variables, while the correlation between the one with the urban environment is negative. The region with developed market, convenient location, abundant labor resources, active investment and better ability in S&T is prone to agglomerate in manufacturing. This coincide with the truth that manufacturing agglomeration is higher in Changchun-Jilin region. In addition, economy of scale is also an important factor to attract manufacturing agglomeration by declining the cost of enterprises and improving the level of profits. The impact of the capability of integrating into the global market on industry development becomes more and more important, as globalization process is accelerated. Some high technology-intensive industries are more sensitive to the global market and tend to agglomerate in the region with higher level of opening.

Statistical results also show that the policy and institution are important factors affecting the manufacturing agglomeration. Especially for the old industrial base, the

Table 4 Regression results of influencing factors of industrial agglomeration degree

Variable	*Gini* coefficient of manufacturing industry									
Constant	0.19***	–0.28***	–0.03*	–0.22***	0.42***	0.2***	0.15	–0.5*	0.1***	–0.32***
Sales	0.67***									0.01*
ln(scale)		0.99***								1.0***
Traffic			0.78***							0.04**
Labor				0.84***						0.01*
S&T					0.46***					0.02**
R&D					1.00***					0.01*
Investment						0.49***				0.002*
I&E							0.32***			0.007*
FDI							0.44***			0.006*
Development								0.55***		0.5***
State								0.04*		0.01***
Greening									0.76***	–0.04***
R^2	0.45	0.99	0.61	0.70	0.664	0.24	0.48	0.31	0.59	0.99
F	85***	43907***	167***	251***	95***	33***	35***	24***	150***	5387***

Notes: * means P <0.1, ** means P <0.5, *** means P <0.01.

Table 5 Regression results of influencing factors of industrial concentration ratio

Variable	Industrial concentration ratio of labor-intensive manufacturing					
Constant	0.32***	0.30***	0.30***	0.29	0.55	0.73*
LS	0.22*				0.73*	1.20*
S&T		–0.10			–0.49	–0.25
Development			0.09*		–0.13	0.14*
State			–0.03			0.08
Literate				0.002	–0.10	0.22
IS	0.11	0.17	0.10	0.14	0.17	0.18
Globalization	–0.48*	–0.50*	–0.46*	–0.48*	–0.65*	–0.48*
R^2	0.37	0.32	0.33	0.32	0.50	0.55
F	2.29*	1.92*	1.33*	1.84*	1.52*	1.38*
Variable	Industrial concentration ratio of capital-intensive manufacturing					
Constant	0.26***	0.45***	0.32***	1.63***	0.59	0.33
LS	0.75***				0.86	0.53
S&T		–0.61**			0.05	0.03**
Development			0.38*		0.33	0.12*
State			0.58***			0.41**
Literate				0.67***	0.20	0.06*
IS	0.34**	0.31*	0.03	0.60***	0.47*	0.16**
Globalization	0.47***	–0.61	0.49***	0.77***	0.52***	0.45**
R^2	0.77	0.53	0.79	0.60	0.78	0.82
F	13.32***	4.49**	10.47***	6.03***	5.37***	5.07***
Variable	Industrial concentration ratio of technology-intensive manufacturing					
Constant	0.47***	0.86***	0.76***	3.26***	1.20*	1.24*
LS	0.90***				0.43	0.46
S&T		0.88***			0.30***	0.30**
Development			0.92*		0.33	0.21*
State			0.15			0.11**
Literate				0. 89***	0.20**	0.21*
IS	0.02	0.10	0.28*	0.31*	0.03*	0.01**
Globalization	0.23**	0.43***	0.37***	0.63***	0.40***	0.40**
R^2	0.85	0.69	0.89	0.71	0.91	0.91
F	22.34***	8.87**	21.52***	9.98***	15.17***	11.60***

Notes: * means P <0.1, ** means P <0.5, *** means P <0.01

role of economic system reform and government behavior is more apparent on regional industrial development (Yu, 2004). The regression result of *Gini* coefficient and development zone quantity is more significant than the one with proportion of state-owned industrial production. Development zone can provide a series of support measurements in financial, taxation, land policy, *etc.*, which are extremely important factors promoting manufacturing agglomeration for the old industrial base. The proportion of state-owned enterprises output in the total industrial output value is 21.2%, and still have advantage in economy of scale. However, in some regions dominated by state-owned enterprises, there are inherent rigid mechanism defects of the industrial structure, which is unfavorable to improve the industrial development environment. In the future, with the further perfection of the ownership structure, the influence of state-owned industries on manufacturing agglomeration of Jilin Province will gradually decrease.

The results show that there exist obvious differences of the impact factors of industrial concentration ratio between different types of industries. There is significant positive correlation between employment scale (LS) and labor-intensive manufacturing industry, while S&T and quality of resident (Literate) lack of relevance with this kind of industry. This situation is reverse in capital-intensive industries and technology-intensive industries. The reason is that labor force is still an important factor to promote the development of labor-intensive industries of Jilin Province, but for capital-intensive and technology-intensive manufacturing, high-quality workforce is more significant, which includes scientific research personnel, management personnel, *etc*. The development of the manufacturing industry in the future will rely more on technological progress and S&T innovation. On the new background, on the one hand, labor force will flock to service industry, promoting the adjustment of industrial structure. On the other hand, manufacturing will be further upgraded, for example, labor-intensive industry concentration ratio will fall, or transform into capital-intensive and technology-intensive industry.

Financial capital is one of the largest liquidity elements in production, and financing condition is essential to the industry development (Li, 2006). The regression coefficient of manufacturing investment proportion (IS) with capital-intensive industry is higher than the one with technology-intensive industry. The reason is that there are some features of capital-intensive industries, such as more technology equipment, large investment, and slow capital turnover, so the impact of IS is more important for the technology-intensive manufacturing.

The correlation of market oriented factor (Globalization) with labor-intensive manufacturing is negative, and the correlations of it with the other two types are significantly positive, showing that the three types of industries orient to different markets. The products of labor-intensive manufacturing are mainly for the domestic market, while capital-intensive and technology-intensive manufacturing depend more on the external market, and industrial extroversion degree is higher.

The influences of policy and institution factors also differ between the three types of industries. The impact of state-owned industry output value proportion (State) on capital-intensive industries is more obvious than the one on technology-intensive industry, and it lacks significant correlation with labor-intensive industries. The reason is that capital-intensive industries are more prone to be controlled by state-owned enterprises than technology-intensive industries and labor-intensive industries. The impact of development zone quantity (Development) on the three kinds of manufacturing are all positive, suggesting that the government industrial support policies and regional development measurements promote the development of all the manufacturing industries.

4 Conclusions

In the process of promoting old industrial base transformation, upgrading the structure of manufacturing industries and adjusting the existing unreasonable spatial layout are needed. The manufacturing agglomeration degree of Jilin Province has increased since 2000. Influenced by the old industrial base development history, there are obvious agglomeration characteristics of the central region. Changchun Proper and Jilin Proper are the regions with higher degree in manufacturing agglomeration, although the industrial belt has not yet formed. The auto industry in Changchun shows a trend of spread to the west, driving some counties in Changchun and Siping to form joint agglomeration region of auto industry. The reason why manufacturing agglomeration degree of Changchun-Jilin region is higher is

that there are advantages in market level, location accessibility, labor resources, financing activity, S&T innovation ability, residents' quality, *etc*. In addition, the central region shares the most preferential industrial policies, which is one of the key impetuses developing the old industrial base. For example, regions of Changchun Proper and Jilin Proper have the most national or provincial economic development zones, high-tech development zones, and industrial parks (24 in Changchun Proper, 17 in Jilin Proper).

The manufacturing industries tend to be diversification after 2009, and the proportion of the industries with higher concentration ratios is on the decline; while some industries such as C_{20}, C_{21}, C_{24} and C_{27} have improved. There are significant differences of the influence factors such as the proportion of manufacturing employment, the proportion of investment, S&T personnel and quality of resident, market extraverted ability among the three types of industrial concentration. Development zone industrial policy is a common force promoting the development of manufacturing industries.

The situations of reform and opening of the old industrial bases have been deepening, and the development of education has promoted the progress of S&T and increased the quality of resident. In the future, the regional industrial policy and ownership structure adjustment measures, the ability of integrating into global market, ability of S&T innovation and the quality of resident will become the dominant factors influencing the manufacturing geographical agglomeration pattern evolution of Jilin Province. Especially in the process of industrial dispersion from the central region to eastern and western area and the process of industrial structure upgrade, these factors will generate more profound consequences.

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