Research Article

Research on Spatial Distribution and Trends of China's Forestry Industry Development

Tingting Li[1], Liangzhen Zang[2*], Danyun Xu[2]

[1]College of Economics and Management, China Agricultural University, Beijing, China.

[2]College of Economics and Management, Beijing Forestry University, Beijing, China.

*****Corresponding author:** Liangzhen Zang, No. 654 mailbox, Beijing Forestry University, 35 Qinghua East Road, Beijing 100083, China. Tel: 086-187-1023-0752; E-mail: zangliangzhen@hotmail.com.

Abstract:

Based on the data of China's forestry industry output from 2007 to 2013, the spatial distribution of China's forestry industry after the Collective Forest Tenure Reform was analyzed by using the methods of Global Spatial Analysis and Hot Spot Analysis. We found that China's forestry industry presented aobvious and stable state of spatial agglomeration before and after the Collective Forest Tenure Reform; The distribution of China's forestry industry exhibited a stepped spatial distribution. Hot Spot Zone of forestry industry development, namely the better development areas, were mainly concentrated in eastern China, while Cold Spot Zone of forestry industry development, namely the less developing areas of forestry industry, were mainly concentrated in western China; The spatial pattern of China's forestry industry development showed a large change before and after the full implementation of the Collective Forest Tenure Reform, while it showed a stable state after the Collective Forest Tenure Reform; The distribution pattern of forestry industry development in different area of China showed a trend to a higher level.

Introduction

At present, China's forestry industry development of has been the concern of a lot of researchers. In particular, with the issue of the Policy on Promoting the Collective Forest Tenure Reform by China's State Councilin 2008, individual forestry property becamemoreclear such that this reform directly impacted the development of China's upstream forestry industry. To no surprise, the whole spatial distribution pattern of China's forestry industry development have been gradually changing from then on. Therefore, it is important to study the spatial distribution of China's forestry industry development before and after the Collective Forest Tenure Reform in order to predict the future trend and distribution of China's forestry industry development.

From the existing literature, a lot of researchers have been focusing on the spatial distribution of China's forestry industry development. Recent studies pointed out that China's forestry industry generally presented a state of spatial agglomeration in 2002, 2007 and 2012, and showed a positive spatial autocorrelation in most provinces of China (Wu, 2015). However, in terms of under-forest economic development in China, it presented a discrete spatial distribution and the high-value agglomeration area was mainly concentrated in northeastern and northern China (Zang, 2014). Further, the spatial disparities of the competitiveness of China's forestry industry was also studied (Tian, 2012). The result showed that the top three provinces with strong forestry industry competitiveness were Heilongjiang, Yunnan and Tibet provinces, oppositely, the last three provinces were Ningxia, Tianjin and Qinghai. In terms of specific forestry industry, forestry industry with high industrial agglomeration in China mainly included wooden handicrafts and woodcut, educating and sporting goods manufacturing, wood and bamboo furniture manufacturing, wood and bamboo paper producing, forest chemical products manufacturing, forestry ecological services and forestry professional technical services, compared to the low industrial agglomeration industry, including forest products processing and manufacturing, forestry tourism and leisure service (Zhao, 2015). The regional comparative advantages of forestry industry in China was also studied and results showed that the distribution of forestry primary industry and tertiary industry did not exhibit a discrete distribution across 31 provinces of China, in contrast, the development of forestry

secondary industry were unbalanced (Ding, 2011). Studies on the determinants of forestry industry development demonstrated that labor resources limitation and low forestry technology had an important impact on distribution of forestry industry development, including the forestry investment, types of forestry resources, and so on (Li, 2012).

In general, studies on distribution of China's forestry industry development focused more on the certain year, and less on comparison research of different years and its evolutionary trend, especially the changes before and after the implementation of China's Collective Forest Tenure Reform. Therefore, this study takes the development of China's forestry industry as the starting point, and uses the spatial data analysis to study the spatial forestry industry development after the implementation of China's Collective Forest Tenure Reform.

Methods

Indicator Selection and Data Resource

The Forestry Industry Gross Output, an indicator to assess the forestry industry development, includes the total value of final products and services produced by China or different provinces in the process of forestry production during a certain period. Because it can fully explain China's or different provinces' forestry industry development, this article takes Forestry Industry Gross Output as the indicator to assess the forestry industry development.

Because the Collective Forest Tenure Reform in China was implemented in 2008, this research takes the state of forestry industry in 2007 as the reference year and analyzes the spatial state from 2007 to 2013 in order to note gradual changes before and after the reform from the perspective of economic geography. All the data used in this study come from the Yearbook of China Forestry Statistics 2007 to 2013.

Global Spatial Autocorrelation

This article aims to analyze the spatial distribution and discover the evolution of China's forestry industry development using the global spatial autocorrelation and hot spot analysis. Global spatial autocorrelation can reveal the spatial correlation state of Chinese forestry industry as a whole. It is helpful to analyze the interrelated state of the whole spatial system through the analysis of the global space, so as to note the distribution of forestry industry development in different provinces of China. In general, the global Moran's I is used to represent the global spatial autocorrelation, which is calculated by:

$$Moran's\ I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}(x_i - \overline{x})(x_j - \overline{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}\sum_{i=1}^{n}(x_i - \overline{x})^2}$$

where Moran's I is global spatial autocorrelation index of forestry industry development; n is the number of provinces; the subscripts i and j refer to province i and j, respectively; x is the Forestry Industry Gross Output; is the average Forestry Industry Gross Output of China's 31 provinces; w is the weight matrix.

Hot Spot Analysis

However, the global spatial autocorrelation analysis just makes an overall analysis about distribution of China's forestry industry development from a global perspective. Therefore, in order to study agglomeration and dispersion effects of different provinces, the hot analysis method is also conducted to make a further analysis. In this research, specific calculation is performed using the Getis-OrdGi* index:

$$G_i^* = \frac{\sum_{i=1}^{n} w_{ij} x_j}{\sum_{i=1}^{n} x_j}$$

whereGi* is the hot-spot value; i, j, x and w are the same as index in Global Moran's I formula. Likewise, Gi* is also tested with the normalized statistic Z:

$$Z(G_i^*) = \frac{G_i^* - E(G_i^*)}{\sqrt{var(G_i^*)}}$$

The research province is in Hot Spot Zone, where the province and its neighbors have high Forestry Industry Gross Output, if Z (Gi*) is positive; oppositely, the research province is in Cold Spot Zone, where the province and its neighbors have low Forestry Industry Gross Output, if Z (Gi*) is negative.

Estimation and Results

By taking advantage of Forestry Industry Gross Output data from 2007 to 2013 across 31 provinces of China, results from a global spatial autocorrelation analysis are showed in Table 1. As seen in Table 1, G-Moran's I is always positive from 2007 to 2013 that fully indicates that China's forestry industry development presents a positive correlation in the overall space before and after the Collective Forest Tenure Reform, namely the forestry industry development in China exhibited a spatially concentrated state before and after the Collective Forest Tenure Reform. The provinces with higher Forestry Industry Gross Output were concentrated in certain zones, while the provinces with low Forestry Industry Gross Output were concentrated in some other zones.

Year	Moran's I	Z-value	p-value
2007	0.160	2.527	0.012
2008	0.183	2.803	0.005
2009	0.177	2.789	0.006

2010	0.172	2.717	0.007
2011	0.185	2.838	0.005
2012	0.137	2.234	0.025
2013	0.135	2.213	0.027

Table 1: Moran's I of China's Forestry Industry Development

As seen from Z value and p value in Table 1, the absolute value of Z statistic from 2007 to 2013 is greater than critical value of confident level of 5%, and the p value is less than 0.05. Therefore, it means that spatial agglomeration effect of forestry industry development in China is extremely obvious. Furthermore, results also showed that distribution of forestry industry development in China presented a stable state because the volatility of G-Moran's Iis not obvious, although it is different in each research year.

Based on overall analysis above, this research continues to make an analysis about China's forestry industry development focusing on different provinces taking advantage of Hot Spot Analysis. After calculating the Getis-OrdGi* value by using Hot Spot Analysis formula, the Jerks natural fracture method is used to classify the calculated values, which are divided into four categories: Hot Spot Zone, Sub-hot Spot Zone, Sub-cold Spot Zone Spot Zone and Cold Spot Zone. In this study, only the specific distribution map of 2009, 2011 and 2013 are shown (Figure 1, 2, 3, 4).

Figure 1: Hot Spot Map in 2007

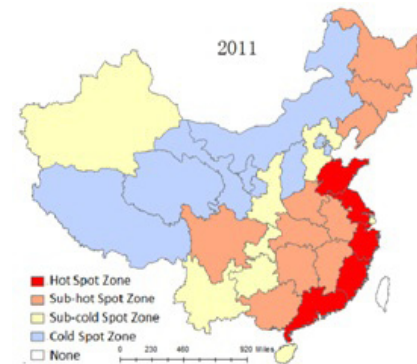
Figure 2: Hota Spot Map in 2009

Figure 3: Hot Spot Map in 2011

Figure 4: Hot Spot Map in 2013

As seen from Figure 1, in 2007 prior to the implementation of Collective Forest Tenure Reform, China's forestry industry development has already presented a state of industrial agglomeration. The figure shows that provinces in Hot Spot Zone mainly include Guangdong, Fujian and Zhejiang. In comparison, the Sub-hot Spot Zone includes Shandong, Jiangsu, Jiangxi, Hunan and Sichuan, while the Sub-cold Spot Zone Spot Zone includes Heilongjiang, Jilin, Liaoning, Hebei, Henan, Anhui, Hubei, Guangxi and Yunnan. All other provinces are in the Cold Spot Zone that constituted the highest proportion by province numbers in all 31 provinces of China. The proportion of province numbers in four different zones are 9.68%, 16.13%, 29.03% and 45.16% respectively. Thus, all these figures showed that most provinces of their forestry industry development are in the Cold Spot Zone along with less proportion in Hot Spot Zone before the overall implementation of China's Collective Forest Tenure Reform. In 2007, forestry industry development in most provinces of China was weak, while only a small group of provinces were at a high level.

From the specific distribution of four different zones, Hot Spot Zone were mainly distributed in southeast coastal areas of China. Comparatively, Sub-hot Spot Zone were mainly distributed in eastern coastal area and central area, such as Jiangxi, Hunan and Sichuan provinces. Sub-cold Spot Zone were mainly distributed in northeastern, northern and southwestern area, while Cold Spot Zone were mainly concentrated in China's northwestern and south-

western area, such as Chongqing and Guizhou. From the analysis above, we can know that regional disparities of China's forestry industry development were already obvious before the overall implementation of China's Collective Forest Tenure Reform, which show a stepped distribution from the Southeast to the Northwest.

Figure 2 shows the distribution of China's forestry industry development in the first year after the implementation of China Collective Forest Tenure Reform, namely the state in 2009.

As seen from the figure, the province numbers in Hot Spot Zone did not change in 2007, with 3 provinces in it. In contrast, the province numbers in Sub-hot Spot Zone increased significantly, while Heilongjiang, Jilin, Liaoning, Hebei, Henan, Hubei and Guangxi provinces entered into this zone based on the ones in 2007, reaching 12 provinces.

The provinces in Sub-cold Spot Zone also had obvious changes from 2007 to 2009. Provinces in the Sub-cold Spot Zone transferred into Sub-hot Spot Zone during that period, while the other provinces transferred from Cold Spot Zone into Cold Spot Zone. Specifically, provinces in Sub-cold Spot Zone in 2009 were Xinjiang, Shaanxi, Anhui, Chongqing, Guizhou, Yunnan and Hainan, reaching 7 provinces. Overall, in 2007, the province numbers in Cold Spot Zone significantly reduced that Tibet, Qinghai, Gansu, Ningxia, Inner Mongolia, Shanxi, Beijing, Tianjin and Shanghai disappeared from that zone. The province numbers in Hot Spot Zone, Sub-hot Spot Zone, Sub-cold Spot Zone and Cold Spot Zone accounted for 9.68%, 38.71%, 22.58% and 29.03% across 31 provinces of China, respectively. From the perspective of geographical distribution, state of distribution of China's forestry industry development in 2009 was similar with the one in 2007, which presented a stepped distribution from the southeast to the northwest in China. This situation indicated that forestry industry development in all areas of China made a big progress, and also showed a strong developing trend as a whole.

It can be seen from Figure 3, comparing with state of forestry industry development in 2009, only a small part of provinces changed their state, along with the stable situation in most provinces in 2011. During this period, Hot Spot Zone, where Shandong and Jiangsu provinces entered into, had an obvious change and numbers in this zone reached 5 in 2011. Specifically, Anhui replaced of Hebei and entered into Sub-hot Spot Zone, while the other zones did not have any changes. Similarly, in Sub-cold Spot Zone, with the exception of Hebei, Shanghai also entered into this zone and province numbers kept 8. In contrast, province names and province numbers in Cold Spot Zone did not change compared to all other three zones. The proportions of four type zones were 16.13%, 32.26%, 25.81% and 25.81% respectively. From a geographic point of view, Hot Spot Zone of China's forestry industry development in this year was mainly concentrated in the eastern

coastal areas, along with Sub-hot Spot Zone in the periphery of Hot Spot Zone, mainly in the eastern area, central-south area and northeastern area of China, while Sub-cold Spot Zone and Cold Spot Zone were mainly concentrated in the western area of China. Hot Spot Zone, with new entry of Guangxi compared with 2011, was still mainly concentrated in the eastern coastal areas of China. Province numbers in Sub-hot Spot Zone where Yunnan province entered into increased to 11. Comparatively, provinces in Sub-cold Spot Zone and Cold Spot Zone did not change. In terms of proportion, the proportion of provinces in the four types were 19.35%, 35.48%, 22.58% and 22.58% respectively.

Conclusion

Base on the spatial distribution and evolutionary trend of forestry industry in China, the results indicate the following: (1) Forestry industry development in China showed a significant spatial agglomeration effect and demonstrated a stable distribution before and after the Collective Forest Tenure Reform, especially in a 7-yr period from 2007 to 2013. (2) Spatial distribution of China's forestry industry development showed a stepped spatial distribution before and after the Collective Forest Tenure Reform. Specifically, Hot Spot Zone of forestry industry development was mainly in eastern China, while Sub-hot Spot Zone was mostly in southeastern inland areas of China. Sub-cold Spot Zone of forestry industry development was mainly concentrated in southwestern China, and Cold Spot Zone was mainly concentrated in western China. (3) Spatial distribution of forestry industry development in China had great changes before and after the overall implementation of Collective Forest Tenure Reform, especially from 2007 to 2009, however, it exhibited a stable state after the Collective Forest Tenure Reform. From 2007 to 2009, spatial distribution of forestry industry changed significantly, especially in Cold Spot Zone and Sub-cold Spot Zone. Comparatively, from 2009 to 2013, only a small group of provinces in all 31 provinces changed in terms of forestry industry development. (4)The types of spatial distribution of forestry industry development in different area of China showed a trend of development to a higher level as a whole. The proportion of the province numbers in Hot Spot Zone were 9.68%, 9.68%, 16.13% and 19.35%, respectively, and proportion of Sub-hot Spot Zone were 16.13%, 38.71% and 32.26% and 35.48%, respectively. Similarly, the proportion of Sub-cold Spot Zone were 29.03%, 22.58%, 25.81% and 22.58% respectively, and proportion of Cold Spot Zone were 45.16%, 29.03%, 25.81% and 22.58% respectively. As a result, proportion of Hot Spot Zone and Sub-hot Spot Zone of China's forestry industry development has been increasing continuously after China's Collective Forest Tenure Reform, while the proportion of Cold Spot Zone and Sub-cold Spot Zone has been decreasing during that period.

Based on the analysis above, we think that the development

of China's forestry industry should focus on the following aspects: First of all, China's coastal areas should take advantages of highly developed regional economy so as to promote diversification of forestry industry to expand high value agglomeration effect of forestry industry development. Second, provinces in Sub-hot Spot Zone, adjacent to the provinces with high-value agglomeration area, should take advantage of geographical position in order to develop forestry industry with the help of coastal areas. Comparatively, northeastern and southwestern China should take advantage of their plentiful forestry resources rather than the geographical position to promote the forestry industry development focusing on the forestry cultivation and forestry tourism. In northwestern China, where Cold Spot Zone and Sub-cold Spot Zone always existed, the endowment degree of forest resources should focus on forestry cultivation to develop the local forestry industry by accumulating the basic resources.

Acknowledgments

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