Research on the Optimization of Agricultural Industrial Structure in Hainan Province Based on Shift-Share Method

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Abstract. This paper conducts an empirical analysis of the agricultural industrial structure in various regions of Hainan Province in China from 2009 to 2017 on the basis of the shift-share method. The results show that the agricultural industries in all areas of Hainan have varying growth rates, which jointly promote the agricultural development of Hainan Province. The planting industry and fishery in coastal areas have stronger structural effects and regional advantages. Through further analysis of the changes in the internal structure of the planting industry and fishery, it is found that the optimization effect of industrial structure is significant, and that high quality and sustainable development are basically realized. Based on the conclusions of the above empirical analysis, the countermeasures and suggestions for the optimization of agricultural industrial structure in Hainan Province are proposed.

1. Introduction

Agriculture refers to the agriculture, forestry, animal husbandry, fishery and agricultural service industry. Among them, planting industry, forestry, animal husbandry and fishery are the values created by the exploitation of land, forests, pastures and water resources. The agricultural service industry is a new type of industry that provides various services for agriculture, forestry, animal husbandry and fishery[1]. Research on the internal structure of agriculture can help to understand the utilization level of resources and the quality of internal structure of agricultural development. The experience of developed agricultural regions shows that the optimization of agricultural industrial structure will enhance the modernization and standardization of agriculture, promote the subdivision of agricultural industry and deepen the industrial chain[2-3]. Under the background of Hainan’s construction of a free trade port, how Hainan optimizes the agricultural industrial structure is an issue worthy of further study.

2. Research Design

Shift-share Method (SSM) was founded in the 1960s and was first proposed by American scientist Dunn and quickly applied to various fields of industrial economics. This method can not only accurately quantify the development of an industry in the region, but also comparatively analyze it with the regional average. The adoption of this analysis approach can provide reference for the focus of agricultural development and industrial structure adjustment in Hainan Province, and provide a
theoretical basis for the establishment of a new model of agricultural development with Hainan characteristics.

Assume the total economic output and structure of region \( i \) in Hainan Province and the whole province have changed from the year \( t_0 \) to \( t \), \( b_{ij,0} \) and \( B_{j,0} \) denote the output of the region \( i \) and the industry \( j \) in Hainan province in the year \( t_0 \) respectively, and in the year \( t \), it is \( b_{ij,t} \) and \( B_{j,t} \), then the rate of change of the industry \( j \) in the region \( i \) in this period can be presented as:

\[ r_{ij} = \frac{b_{ij,t} - b_{ij,0}}{b_{ij,0}}, j = 1, 2, 3, \ldots, n \]

The rate of change of the industry \( j \) in the whole province can be expressed as:

\[ R_j = \frac{B_{j,t} - B_{j,0}}{B_{j,0}}, j = 1, 2, 3, \ldots, n \]

To implement the standard processing of the output of the industry \( j \) in the region \( i \) according to the share of the industry \( j \) in the whole province, the scale can be calculated as:

\[ b_{ij}' = \frac{b_{ij,0}B_{j,0}}{B_0}, j = 1, 2, 3, \ldots, n \]

The total economic increment \( G_{ij} \), the national growth effect \( N_{ij} \), the industrial mix effect \( P_{ij} \) and the local share effect \( D_{ij} \) of the industry \( j \) in the region \( i \) can be respectively denoted as:

- \( N_{ij} = b_{ij}'R_j \)
- \( P_{ij} = (b_{ij,0} - b_{ij}')R_j \)
- \( D_{ij} = b_{ij,0}(r_{ij} - R_j) \)
- \( G_{ij} = N_{ij} + P_{ij} + D_{ij} \)

Where the national growth effect \( N_{ij} \) is about the effects of the development of the industry \( j \) in the whole province on the development of industry \( j \) in the region \( i \); \( P_{ij} \) reflects the effects of the industrial structure of the region \( i \) on the total economic output; \( D_{ij} \) denote the contributions of the competitiveness of the industry \( j \) in the region \( i \).

To further study the regional growth advantages, the calculations are made based on the above calculation results, where \( L \) is the provincial growth rate, the \( W \) represents the economic structural effect index, and \( u \) denotes the competitiveness index, the calculating formulas are listed as follows:

- \( W = \frac{\sum_{j=1}^{n} K_{j,0}B_{j,t}}{\sum_{j=1}^{n} B_{j,0}} \cdot \frac{\sum_{j=1}^{n} B_{j,t}}{\sum_{j=1}^{n} B_{j,0}} \)
- \( u = \frac{\sum_{j=1}^{n} K_{j,t}B_{j,t}}{\sum_{j=1}^{n} K_{j,0}B_{j,t}} \)
- \( L = Wu \)

Where \( K_{j,0} = \frac{b_{0j,0}}{B_{j,0}}, K_{j,t} = \frac{b_{ij,t}}{B_{j,t}} \) represents respectively the proportion of the industry \( j \) in the region \( i \) during the start and end of the period. whether \( L \) is greater than 1 indicates whether the economic growth rate is faster than the country, when \( W \) is greater than 1, the larger \( p \) is, the more reasonable is the industrial structure, when \( u \) is greater than 1, the lager \( D \) is, the industrial competitiveness is stronger.

Based on the data of Hainan Province and its 18 counties and cities (excluding Sansha City), the paper carries out the empirical analysis on the data of the total added value of agriculture in 2009-
2017 and the added value data of planting industry, forestry, animal husbandry, fishery and agricultural service industry. The data come from the 2018 Hainan Statistical Yearbook.

3. Empirical Results and Analysis
The overall changes in the agricultural industrial structure in various regions of Hainan Province are shown in Table 1. In 2009-2017, there's varying degrees of growth in the agricultural added value in 18 counties and cities of the whole province. Among them, the total increment of Lingao and Danzhou are over 7 billion yuan, which are the two largest increments. The total increments of Chengmai, Qionghai, Ledong, Sanya and Wanning are also above 4 billion yuan, which belongs to the second echelon. The total increment of Wuzhishan is less than 400 million yuan, which is the smallest increment and the only one with an increment of less than 1 billion yuan.

Table 1. Agricultural SSM analysis results in various regions of Hainan Province.

| Region       | The total increment $G$ | The national growth effect $N$ | The industrial mix effect $P$ | The local share effect $D$ | The structure effect $W$ | The augmentation effect $u$ | The relative growth rate $L$ |
|--------------|-------------------------|-------------------------------|------------------------------|---------------------------|--------------------------|-----------------------------|----------------------------|
| Haikou       | 34.72                   | 13.07                         | 27.77                        | -6.12                     | 1.00                     | 0.92                        | 0.91                       |
| Sanya        | 43.01                   | 12.87                         | 25.08                        | 5.07                      | 1.08                     | 1.08                        | 1.16                       |
| Wuzhishan    | 3.98                    | 0.88                          | 1.61                         | 1.49                      | 0.91                     | 1.30                        | 1.19                       |
| Wenchang     | 37.47                   | 15.74                         | 35.92                        | -14.19                    | 1.01                     | 0.85                        | 0.85                       |
| Qionghai     | 48.62                   | 14.58                         | 31.19                        | 2.85                      | 1.00                     | 1.03                        | 1.03                       |
| Wanning      | 41.93                   | 9.15                          | 18.66                        | 14.12                     | 1.01                     | 1.28                        | 1.29                       |
| Ding'an      | 23.78                   | 4.32                          | 9.82                         | 9.64                      | 0.99                     | 1.37                        | 1.35                       |
| Tunchang     | 19.14                   | 4.39                          | 8.84                         | 5.90                      | 1.00                     | 1.24                        | 1.24                       |
| Chengmai     | 56.27                   | 9.17                          | 18.79                        | 28.31                     | 1.01                     | 1.56                        | 1.57                       |
| Lingao       | 78.14                   | 15.22                         | 37.86                        | 25.06                     | 1.07                     | 1.27                        | 1.37                       |
| Danzhou      | 74.05                   | 20.43                         | 48.99                        | 4.63                      | 1.05                     | 1.04                        | 1.09                       |
| Dongfang     | 26.28                   | 9.03                          | 15.23                        | 2.03                      | 1.06                     | 1.05                        | 1.11                       |
| Ledong       | 46.11                   | 13.40                         | 20.81                        | 11.90                     | 1.06                     | 1.20                        | 1.27                       |
| Qiongzhong   | 14.95                   | 2.13                          | 3.75                         | 9.07                      | 0.98                     | 1.83                        | 1.78                       |
| Baoting      | 13.65                   | 1.80                          | 3.67                         | 8.17                      | 1.01                     | 1.82                        | 1.84                       |
| Lingshui     | 29.86                   | 8.66                          | 17.91                        | 3.29                      | 1.08                     | 1.07                        | 1.16                       |
| Baisha       | 15.11                   | 2.30                          | 4.34                         | 8.47                      | 0.92                     | 1.65                        | 1.52                       |
| Changjiang   | 19.20                   | 5.21                          | 10.53                        | 3.46                      | 1.06                     | 1.13                        | 1.20                       |

According to the calculation results of the national growth effect, it can be seen that the national growth effect of all regions in the whole province is less than the actual total increment, indicating that the agricultural development in Hainan Province is relatively balanced, and all regions in Hainan province jointly have driven the agricultural development of the province. Although Wuzhishan has the least national growth effect, it is also one of the driving forces for Hainan's agricultural development. This is because the agricultural added value of Hainan Province accounts for a large proportion of GDP, and the upgrading of the mode of agricultural production is promoted throughout the province, which jointly promote the development of agriculture in the whole province.

The industrial mix effect of each region and the total increments have a high contact ratio, and they are also the most important components of the total increment. Lingao and Danzhou are still in the first echelon, but the industrial mix effect of Danzhou is higher than that of Lingao by 1 billion yuan, ranking the first. Wenchang, Qionghai, Haikou and Sanya are following closely behind, and the gap with the first echelon is relatively small. The industrial mix effect of other regions is also positive, indicating that the industrial structure of Hainan Province is excellent and reasonable, and the structural effects have the strongest driving force for agricultural development in the whole province.
The local share effect denotes the deviation caused by the difference between the regional growth rate and the province's average growth rate. This numerical value indicates the effect of regional relative competitiveness on agricultural economic growth. Chengmai and Lingao are the two regions with the strongest agricultural competitiveness in the province. The local share effect of these two regions is more than 2.5 billion yuan, which is far ahead of other regions. From the comprehensive perspectives of the structural effect and the local share effect of each region, the agriculture in Haikou and Wenchang is structurally driven. The driving force of agricultural development comes from the agricultural foundation and its reasonable layout. The location competitiveness is insufficient, indicating that the two regions are weaker than others in this regard. The positive effects of the location to the agricultural development are very limited, and may even become one of the reasons hindering the further development of agriculture. Agricultural development in other regions belongs to the fast-growing type, and the structure, competitiveness, and location can be organically combined to promote the local agricultural development.

The analysis of the relative growth rate shows that only Haikou and Wenchang’s agricultural growth rate is lower than the provincial average, and the growth rate of agriculture in other regions are faster. It can be seen from the structural effect index that the index of Wuzhishan, Qiongzhou, Ding’an and Baisha are less than 1, while the structural effect index of other regions is greater than 1. Lingao and Danzhou not only have the largest the industrial mix effect of the whole province, but also the highest structural effect index in the province. Therefore, the two places are the areas that have the most reasonable agricultural industrial structure of the province. In addition, though the relative growth rate of Haikou and Wenchang is relatively low, the structural effect index is greater than 1, indicating that the agricultural development of Haikou and Wenchang mainly depends on a good industrial structure. Similar to the calculation results of the relative growth rate, the growth effect index of Haikou and Wenchang is less than 1, and that of other regions is greater than 1. Baoting and Qiongzhou have the highest growth effect index, the agricultural development of which are most dependent on the its competitiveness in the whole province. Chengmai’s growth effect index ranks the third in the province, and the total increment is high, indicating that the agriculture of Chengmai has strong competitiveness. The location advantage of being adjacent to Haikou which has a huge consumer market, is the basis for Chengmai’s agricultural development.

The analysis results in Table 2 show that the planting industry and fishery in 2009-2017 are the leading industries in the agricultural industrial structure of Hainan Province, followed by animal husbandry and forestry. Although the agricultural service industry has a low proportion, its growth rate is relatively high, which witnessed a significant improvement compared to 2009. From the calculation results of the national growth effect (N), the five major industries in all regions are positive, and all the regions have jointly promoted the development of planting industry, forestry, animal husbandry, fishery and agricultural service industries in Hainan Province. The share of planting industry and fishery is the largest, but their distribution is quite different: in the planting industry, there are more mountains in the central region, which is not suitable for the development of planting industry. Therefore, the share of planting industry in coastal areas such as Ledong, Qionghai, Haikou and Sanya is significantly greater than that of Central Region. In terms of fisheries, Danzhou and Lingao along the coast of the northwest are the most important fishery zones in whole province, and their share is much larger than that of other regions. The total share of forestry, animal husbandry and agricultural service industry is small, and the gap between regions is small. The province's development is relatively balanced.

| Region      | Planting industry | Forestry | Animal husbandry | Fishery | Agricultural Service industry |
|-------------|-------------------|----------|------------------|---------|-------------------------------|
|             | N     | P      | D      | N     | P      | D      | N     | P      | D      | N     | P      | D      |
| Haikou      | 9.92  | 13.26  | -3.68  | 0.07  | 0.54  | 1.44  | 1.50  | 6.91  | -1.95  | 1.52  | 4.53  | -1.96  | 0.06  | 2.52  | 0.05  |
| Sanya       | 9.62  | 12.85  | 5.83   | 0.02  | 0.17  | 1.01  | 0.36  | 1.68  | -0.70  | 2.81  | 8.39  | -2.62  | 0.05  | 1.99  | 0.15  |
| Wuzhishan   | 0.77  | 1.03   | 0.21   | 0.03  | 0.19  | 0.63  | 0.06  | 0.30  | 0.65   | 0.02  | 0.07  | 0.01   | 0.00  | 0.02  | -0.01 |
| Wenchang    | 9.27  | 12.39  | -1.84  | 0.11  | 0.81  | -1.69 | 1.45  | 6.68  | -2.03  | 4.87  | 14.53 | -8.82  | 0.04  | 1.51  | 0.19  |
The values of the industrial mix effect (P) in all regions and all industries are positive, and greater than the values of the national growth effect (N). In general, the industrial structure of Hainan's all agricultural departments is reasonable, and the development speed in the future will be further improved. In terms of planting industry, the industrial structure of coastal areas is more reasonable than that of the central region, and the differences in location advantages are quite apparent. The excellent industrial structure promotes the growth of planting industry in coastal areas better than inland areas. In terms of fisheries, the structural advantages of Danzhou and Lingao are significant. Wenchang's fishery structural effect is second only to Danzhou and Lingao, which has a high dependence on its industrial structural advantages. Although the P values are positive in the forestry, animal husbandry, and agricultural service industries, the values are small and the structural advantages are not significant.

The competitive effect (D) of the planting industry in coastal areas with a larger national growth effect such as Haikou, Wenchang and Lingao is negative, indicating that the planting industry in these regions does not have a competitive advantage. Chengmai is the region with the strongest location competitive advantage in the planting industry in Hainan Province. In terms of fisheries, though the national growth effect and structural advantages of Danzhou and Lingao take the lead in the whole province, the difference in competitiveness is obvious. Lingao's competitive advantage in fishery is far ahead in the whole province, which is more than six times that of the second place. However, the location competitiveness of Danzhou is negative, only slightly better than that of Wenchang. In addition, Chengmai also has certain competitive advantages, and other regions are not competitive or less competitive. Forestry, animal husbandry and agricultural service industry in most regions have a competitive advantage, but not significant.

4. Conclusion
Based on the above analysis, it is safe to make suggestions on the optimization of agricultural industrial structure in Hainan Province. Firstly, continue to optimize the agricultural industrial structure in Hainan Province, accelerate the development of agricultural industrialization, and increase the output of agricultural products[4]. Secondly, establish a comprehensive and full-process supervision system for the early warning and rapid response of agricultural products’ quality and safety risk, and guarantee the quality and safety of agricultural products. Thirdly, deepen the agricultural industrial chain, enhance the value of agricultural products, and optimize and upgrade the agricultural product business model. Forthly, develop eco-tourism agriculture according to local conditions, explore Hainan’s tropical sightseeing agriculture and homestay tourism, and realize the linkage development of agriculture and tourism[5].

With the gradual deepening of the construction of Hainan free trade port, the agriculture of Hainan faces new opportunities and challenges. Continuously promoting the optimization and upgrading of agricultural industrial structure remains the primary task of agricultural development. Hainan's agriculture should optimize the industrial structure scientifically, exploit resources such as climate, geology and oceans and other resources rationally, and ensure the sustainable use of resources. All regions should adapt to local conditions, foster strengths and circumvent weakness, and actively
promote the development of agriculture to achieve high efficiency, specialization, high-end, and globalization.

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