Empirical Study on the Relationship between Chemical Industry Agglomeration and Regional Economic Growth in Anhui Province

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In order to study the relationship between industrial agglomeration and regional economic growth in Anhui Province, firstly, this paper introduces the distribution and the existing problems of chemical industry in the areas along the Yangtze River there. Secondly, the agglomeration degree of the chemical industry along the river is calculated in accordance with the location entropy index and the industrial structure convergence analyzed based on the similarity coefficient of industrial structure. The correlation between industrial agglomeration and industrial economic growth is analyzed and the elasticity of industrial agglomeration calculated through the model in the paper. Finally, according to the deep analysis of indicators, it puts forward several development strategies and implementation measures for optimizing the chemical industry structure through industrial agglomeration from the perspective of the enterprises themselves and the government's support.

The results show that the agglomeration of chemical industry in cities of the Yangtze River Delta is stronger, which is of great significance for the petrochemical enterprises along the Yangtze River to make clear their development direction and to enhance their innovation capabilities. From the above, it can be concluded that the agglomeration of chemical industry in the region along the Yangtze River has a positive correlation with the whole economic development along the Yangtze River in Anhui Province, and the agglomeration degree of the chemical industry will affect the gross industrial value of the regional economy.

1. Introduction

The chemical industry is one of the basic industries of the national economy. At present, urged by global economic restructuring and the development of high technology, the third petrochemical industrial structure adjustment featuring assets reorganization (Li et al., 2014), concentration on the core business, and development from capital intensive to technology intensive, is developing to a deeper level. Under the context that the international chemical industry and capital is increasingly transferring to China (He et al., 2014), including the Yangtze River Delta region, Anhui's industrial belt is facing new development opportunities (Song and Van Geenhuizen, 2014). How to develop the chemical industry in Anhui Province and speed up the industrial agglomeration has become an imminent task. Located in the Yangtze River Delta region (Marton, 2013), Anhui Province possesses the favourable conditions for developing international chemical industry bases with its unique advantages in location and well-developed infrastructure.

At present, a number of distinctive and complementary petrochemical industrial bases have been established in the province (Cheong and Wu, 2014). It is of great significance for the petrochemical enterprises along the Yangtze River to make clear their development direction and to enhance their innovation capabilities by studying the agglomeration degree of chemical industry along the Yangtze River, comparing the impact of agglomeration development on the local economy (Delgado M et al., 2014), and guiding the chemical industry from the macro level to enhance its competitiveness. In brief, it is of more realistic significance to clarify how chemical industry agglomeration can play a role in economic development and regional economic disparities for areas with a high-speed economic growth like Anhui Province (Büttner, 2013).

2. Development Status and Existing Problems of Chemical Industry along the Yangtze River in Anhui Province

2.1 Factor analysis of agglomerational development of chemical industry

Chemical industry, one of the basic industries of the national economy, is closely related to the national economy and people's life. It is an important basic industry and raw material supplier of the national economy for every country (Garcia–López and Muñiz, 2013). With the continuous development of high-tech in other areas, the chemical industry is undergoing a profound change, with a gradually increasing proportion of the fine chemical and chemical new materials in chemical industry in developed countries. At present, the development of the world's chemical industry presents the following characteristics (Essletzbichler, 2015).

(1) Chemical industry is an industry with obvious economies of scale. Its obvious scale economy and scope economy determine the high capital intensity and high-tech intensity of the chemical industry. With such a huge scale of production, obviously, on the one hand, it requires huge investment, large area of land and high-tech support; on the other hand, it also needs to strengthen the coordinated development of supporting capacity around the main industry. The organizational characteristics of industrial clusters are well suited to meet the demand of the development of chemical industry. First of all, the division of labor system can meet the demand for collaborative support in a regional scope. Secondly, the learning mechanism and innovation system of the cluster can better promote the derivation of chemical products, so that the organic combination of scale economy and scope economy can be achieved under the premise of prominent main business (Arias et al., 2013).

(2) Chemical industry is a typical industry of chain development. The characteristics of long industrial chain and high degree of product correlation determine the high consistency and high integration between the upstream and downstream industries of the chemical industry and the related auxiliary industries. Only by fully considering the close connection between the productions of various products, can the chemical industry achieve the best benefit of the whole production.

2.2 Problems existing in the agglomeration development of chemical industrial parks along the Yangtze River

According to the international development of chemical industry, chemical industry cluster develops in the form of parks. Anhui chemical industry cluster along the Yangtze River to a large extent is represented by the emerging chemical industry park (Takahashi et al., 2013). The general characteristics of the chemical park is that a large number of chemical enterprises concentrate in a certain region, however, the concentration of chemical enterprises in geographical location and sharing of public goods does not necessarily produce agglomeration effect. The problems existing in the development of the chemical industry cluster along the Yangtze River in Anhui province are mainly manifested in the following aspects.

(1) The enterprise distribution is scattered, with small scale. The chemical enterprises along the Yangtze River feature scattered distribution and small scale, which not only restricts the ability of enterprises to extend the industrial chain and market competitiveness, but also brings great pressure to environmental governance. Many chemical industries along the Yangtze River in Anhui are small and medium-sized enterprises. With the large foreign chemical enterprises entering the region, these small and medium-sized chemical enterprises have been in a disadvantageous position in the market competition.

(2) There lacks technological innovation. A lot of manpower and material resources have been devoted to the scale of equipment, introduction of foreign capital, and others in the chemical industrial park of national, provincial and municipal levels along Yangtze River in Anhui province, whose development model is dominated by new projects, without enough attention to the attraction of domestic and foreign research and development center, science and technology entrepreneurship center, technology incubation center and core technology, and to the technological progress of existing projects and the upgrading of products. In addition, there are many problems existing in talent agglomeration. There is a shortage of senior talents, especially the academic leaders and compound talents, which is bound to seriously affect the scientific and technological progress, competitiveness and development potential.

3. Empirical Study on Agglomeration of Chemical Industry and Regional Economic Growth in the Yangtze River Delta

3.1 Advantages of agglomerational development of chemical industries in cities along the Yangtze River

From the data of Figure 1, it can be seen that the location entropy index of chemical industry in Nanjing is greater than 1.5, with a continuous growth trend. During the 10 years from 1999 to 2008, the location entropy index has increased by 14%. In addition, the degree of chemical industry agglomeration in Zhenjiang has also

been significantly improved. In contrast, there is no obvious agglomerational development of chemical industry in Wuxi and Changzhou, both in the average level, and the agglomeration index has not increased, either. It can be seen from Figure 2 that there were relatively bigger changes in the chemical industry of the three cities along the Yangtze River. At the beginning of 1999, the agglomeration degree of chemical industry in Yangzhou was very obvious, with a location entropy index close to 1.6. However, by the end of 2008, the location entropy index of Taizhou exceeded 1.7, which was significantly higher than that of the other two cities. Chapter 2 Based on the status quo of chemical industry development along both sides of the Yangtze River, the convergence degree of chemical industry structure along the Yangtze River is analyzed.
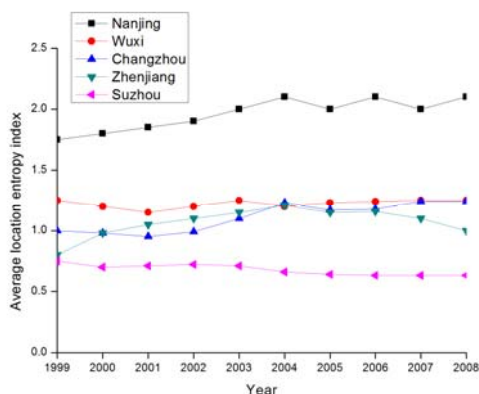

Figure 1: Changes of agglomeration degree of chemical industry along the Yangtze River in 1999-2008
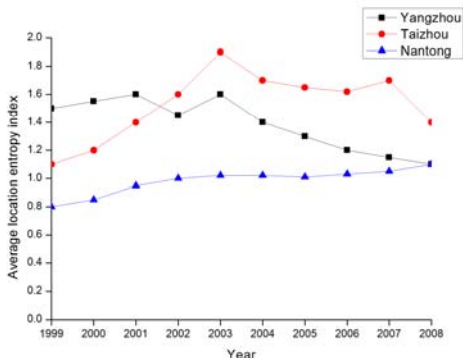

Figure 2: Changes of agglomeration degree of chemical industry along the north bank of the Yangtze River in 1999-2008

Figures 3, 4 and 5 show the different results from the comparison of chemical industrial structure in seven cities along the Yangtze River to the chemical industrial structure in three of them in 2006. The specific analysis is as follows. Through Figure 3 we can get a more intuitive understanding that compared with the chemical industry structure of Wuxi in 2006, the industrial structure of Suzhou, Changzhou, Zhenjiang, Yangzhou and Nantong has a higher degree of convergence, particularly, there is a high similarity in chemical industry structure of Wuxi, Suzhou and Yangzhou. From Figure 4, we can see that the chemical industry structure of Yangzhou, Suzhou, and Wuxi is similar to that of Nantong, with a relatively lower convergence degree to the chemical industry structure of Nanjing and Taizhou. Fundamentally, the reason is that the agglomeration degree of chemical raw materials and chemical products manufacturing industry in Nanjing and pharmaceutical manufacturing industry in Taizhou is significantly higher than other regions. Besides, different from other regions, the oil processing and coking industry have also formed a more obvious agglomeration in Nanjing and Taizhou. From Figure 5 it can be seen that the chemical industry structure of Nantong, Suzhou and Changzhou is similar, with a higher similarity coefficient, while the convergence degree of chemical industry structure in Nanjing, Yangzhou and Taizhou is relatively lower.
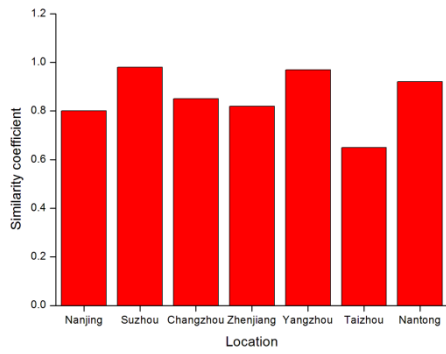
Figure 3: Similarity coefficients of industrial structure between the areas along the Yangtze River and Wuxi in 2006
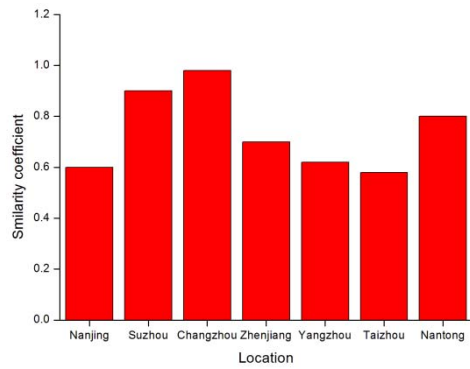

Figure 4: Similarity coefficients of industrial structure between the areas along the Yangtze River and Yangzhou in 2006
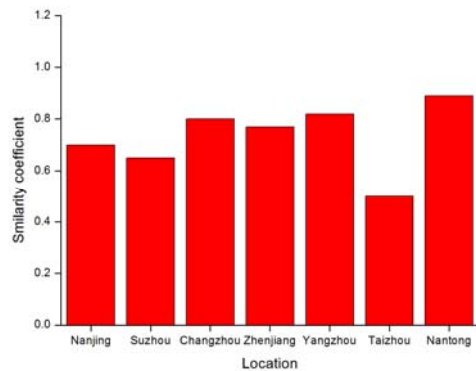

Figure 5: Similarity coefficients of industrial structure between the areas along the Yangtze River and Nantong in 2006

3.2 Measurement results analysis of industrial agglomeration and industrial economic growth

As shown in Figure 6, the major method for analyzing the correlation between industrial agglomeration and industrial economic growth is to describe the relationship between the two by establishing a regression model between the chemical industry total industrial output value and location entropy index.
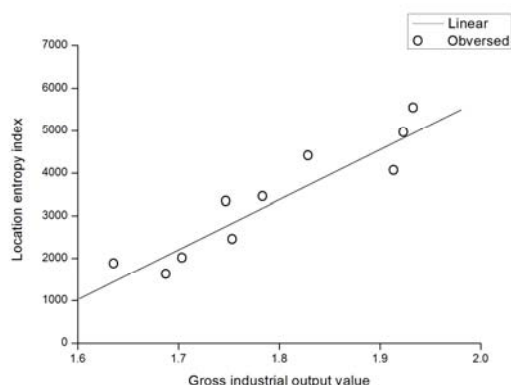
Figure 6: Correlation between industrial agglomeration and industrial economic growth

Scatter plots show that the relationship between the two variables is approximately linear, so the linear model selected above may be appropriate. The above empirical analysis shows that there is a high positive correlation between the degree of agglomeration of the chemical industry along the Yangtze River and the total industrial output value of the region.

Our research suggests that the deep determinants of the positive correlation between agglomeration of the chemical industry along the Yangtze River in Anhui province and the regional industrial output value are technological progress and technological innovation. For the chemical industry with technological competitive advantages, what is more important than the scale advantage is the continuous improvement of technical level and product structure of the industry. With a large scale and large investment, Anhui chemical industry agglomeration also features technology-intensity and faster product replacement. Both the development of new products and the improvement of production process are the keys to the competitiveness of industrial agglomeration. Through the agglomeration elasticity of chemical industry Ej we can study the sensitivity of different industrial output changes to the agglomeration degree of chemical industry, as well as the reliability and sensitivity of elasticity. 2001 and 2006 is selected as the time cut-off point to calculate the agglomeration elasticity of chemical industry in Anhui province, as shown in Table 1.

Table 1: Agglomeration elasticity of chemical industry Ej (1999-2008)

Chemical industry	Elasticity of industrial agglomeration/Ej
Chemical processing and coking industry	5.934
Chemical manufacturing	100.755
Pharmaceutical manufacturing	11.517
Chemical fiber manufacturing	31.792
Rubber manufacturing	20.056
Plastics manufacturing industry	7.030

It can be seen from Table 2 that the agglomeration elasticity of various industries within the chemical industry is very obvious, all of which has a certain scale effect. Relatively speaking, the industry with the largest agglomeration elasticity within chemical industry is chemical raw materials and chemical products manufacturing industry, with elasticity greater than 100, indicating that small increase in industrial agglomeration degree will lead to substantial increase in the total output value of the local economy. It means that the scale economy effect of the industry is very obvious. The agglomeration elasticity of chemical industry can reflect that the changes in agglomeration level of different chemical industries will have different impacts on the growth of industrial economy.

4. Conclusions

This paper mainly studies the agglomeration effect within the chemical industry from the perspective of empirical analysis. It also studies the relationship between the agglomeration degree of chemical industry and the regional GDP, while analyzing the effect of industrial agglomeration on local economic growth. There is a

high positive correlation between the agglomeration degree of the chemical industry along the Yangtze River and the regional industrial output value in Anhui. Taking the cities along the Yangtze River as an example, it can be seen that there is still room for improvement of local economic performance by agglomeration of chemical industry through technological progress, technological innovation, and completion of chemical industry chain. The industry agglomeration within the chemical industry has a certain scale effect, with obvious difference in elasticity. Relatively speaking, the chemical industry with the best agglomeration elasticity is the chemical raw materials and chemical products manufacturing, followed by chemical fiber manufacturing industry and rubber products industry. Besides, there are also strong economies of scale in two types of industries, pharmaceutical manufacturing industry and oil processing and coking industry.

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