An Empirical Study on the Supportive Role of High-end Producer Services in Manufacturing Industry of Guangxi: Based on Gray Correlation Theory

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Keywords: High-end producer services, Manufacturing industry, Gray correlation theory, Guangxi.

Abstract. This paper uses the gray correlation theory to carry out a quantitative study on the supportive role of producer services in manufacturing industry of Guangxi province based on the statistics of Guangxi's high-end producer services and manufacturing industry between 2008 and 2013. The study result shows that while the correlation is relatively high between manufacturing industry and producer services like scientific research, technical service, geological prospecting service, commercial service, financial service, and real estate service, it is still low between manufacturing industry and emerging producer services including information transmission, computer service, and software industry. Therefore, Guangxi should strive to balance the development of high-end producer services, so as to give a full play to its supportive role in manufacturing industry development.

Introduction

As the supporting service industry for manufacturing industry, producer service industry is a newly emerging industry separated from the product and service function of the manufacturing industry. For recent years, Guangxi has been developing fast in industrialization. However, the supporting service industry fails to catch up with the pace, which, on the other hand, has dragged down the development of Guangxi's industrialization. In the current world, the prerequisite for transforming the economic growth mode and achieving new industrialization is to develop modern industry, especially the high-end producer service industry. Only with a comprehensive development of modern supporting service industry including R&D, design, intermediary, marketing, finance and investment surrounding high-end manufacturing industry can the manufacturing industrial chain be further extended and the industry agglomeration and radiation be strengthened. In addition, the document published by the state council on further promoting Guangxi's economical and social development states clearly that during Guangxi's transformation into an high-end manufacturing base, the government will give priority to the development of producer services including modern logistics, finance, convention and exhibition, and information services. Therefore, a study on the supportive role of high-end producer service industry in high-end manufacturing is necessary.

In recent years with the industrial upgrade, there has been an increasing number of domestic researches on the relationship between producer service industry and manufacturing industry. Melita Rant (2007) held the view that the producer service and manufacturing industry was interdependent and they were going towards a mutually interactive relationship in the future[1]. Basant K. Kapur (2012) echoed the view by pointing out that the integration and interaction between the two industries was irresistible after the two industries experienced an increasingly closer relationship from separation, symbiotic interaction, to integration[2]. A number of researches were carried out on other provinces. For example, Seyed (2011) used made a comparison between Jiangsu, Zhejiang, and Shanghai on the integration of producer service industry with the manufacturing industry by using the input-output table[3]. However, few researches have been carried out on the relationship between the two industries in the southwest region of China, especially Guangxi province. The current research in this region was limited to the sole development of the two industries. For instance, Ian Foster,Markus Fidler,Alain Roy (2011) acknowledged great

difficulties in innovative development mode of service industry in underdeveloped provinces like Guangxi, which were mainly hindered by a severe shortage of industrial supply, low proportion of service industry, and a low level of technological innovation[4]. Yu Guang-gui(2013), by analyzing the current development of logistics, finance, information service, real estate service, scientific research, and technology service industry, found out tree main problems in Guangxi's service industry: a small economic scale and a low level of development; insufficient demand from manufacturing industry, which contributed to a weakened synergy between the two industries; and last, low degree of agglomeration[5]. Li Ning (2013) attributed the current underdeveloped producer service in Guangxi to the weak foundation of the tertiary industry in the Beibu gulf economic zone of Guangxi[6]. Hu Li-hua (2014), by using the location quotient, found out that the traditional producer service industry in Guangxi was imbalanced in agglomeration areas, the newly emerging producer service industry in Guangxi had a low degree of agglomeration, and the industrial layout of the producer service industry in Guangxi was unreasonable[7].

Few researches have been conducted on the correlation relationship between the two industries in Guangxi because the relevant data was incomplete. In particular, a lack of large sample data of empirical study resulted in qualitative rather than quantitative research in this regard, which made it impossible to study the relationship between the two industries. Given the above fact, this article aims to find out the most supportive service industries to manufacturing industry in Guangxi and make proposals based on the findings by using the gray correlation model based on small sample data and conducting an empirical study of Guangxi's high-end producer service and manufacturing industry.

Research Method

The gray correlation analysis is an important component of the gray system theory. By observing the similarity degree of a series of curve shapes, one can find the closeness of the system feature behavior series and the relevant factor behavior series, therefore determining the primary cause and secondary cause to the development of the system. Compared to the classic quantitative analysis, the gray correlation analysis has no size requirement of the sample and required no knowledge of the distribution. Therefore, it is more widely applied. Gray correlation analysis includes the narrow gray correlation analysis and the general gray correlation analysis. This article adopts the narrow gray correlation analysis method. The procedure is as follows:

(1) Select the parameter series and comparative series of the original data.

The parameter series is $X_0 = \{x_0(k) \mid k = 1, 2, 3, ..., n\}$. n indicates the series length; the comparative series is $X_i = \{x_i(k) \mid k = 1, 2, 3, ..., n\}$, which represents the value of i in the year n.

(2) Use the dimensionless method. Given the fact that the order of magnitude of data may be inconsistent, the series needs to be initially processed to obtain the primary data with the same order of magnitude by using the dimensionless method before coming to the gray correlation analysis. The formula is as follows:

$$X_i' = \frac{X_i}{x_i(1)} = \left(x_i'(1), x_i'(2), x_i'(3), ..., x_i'(n)\right) \tag{1}$$

(3) Calculate the absolute difference of the parameter series and comparative series. The diversity series is $\Delta_i = \left|x_i'(k) - x_0'(k)\right|$. The difference series is $\Delta_i = \left(\Delta_i(1), \Delta_i(2), ..., \Delta_i(n)\right)$.

(4) Calculate the correlation coefficient. The correlation coefficient represents the similarity degree of the parameter series and the comparative series. The greater the coefficient is, the more similar the two curve shapes are. Otherwise, the more different the two curve shapes are. The formula is as follows:

$$\gamma_i(k) = \frac{\Delta(\min) + \xi\Delta(\max)}{\Delta_i(k) + \xi\Delta(\max)} \tag{2}$$

ξ is the resolution ratio. Generally the value of ξ is 0.5.

(5) Calculate the correlation degree. As the correlation coefficient is the correlation degree on each point of parameter series and comparative series, there can be multiple values. Therefore, the average value must be calculated for an overall comparison. The correlation formula is as follows:

$$\gamma_i = \frac{1}{n}\sum_{k=1}^{n}\gamma_i(k), i = 1, 2, 3, ..., n \tag{3}$$

Empirical Analysis

Data sources. High-end producer services have strong spillover effects which can not only serve as the driving force behind the upgrade of the service and manufacturing industries but also can improve overall economic competitiveness. The very basic feature of the high-end producer service should be high-tech support, strong technical relevance, and the ability to lead other industrial in upgrading[8].

So this paper selected added value of information transmission, computer services and software industry, finance, real estate, business services, scientific research, technical services and geological prospecting industries in Guangxi, all of which are high-end producer services by that definition, and used gray correlation analysis method to research the relationship of added values between manufacturing industries and the selected service industries. The time period is 2007-2012 and the data is collected from the "Guangxi statistical Yearbook 2008-2013." The specific data is in Table 1.

Table 1 The added value of Guangxi's high-end producer service and manufacturing industries from 2007 to 2012 (unit: 100 million RMB)

year	Info	finance	Real estate	business service	Sci-tech services	Producer service	High-end Producer service	Manufacturing
2012	198.78	573.05	489.43	221.96	74.95	2183.74	1558.17	4544.12
2011	195.1	455.37	465.68	160.81	72.24	1927.40	1339.2	4140.52
2010	145.53	384.53	405.79	114.88	58.51	1589.41	1109.24	3211.24
2009	150.67	336.82	348.98	105	61.37	1381.59	1002.84	2890.24
2008	152.48	249.01	282.96	80.44	56.27	1359.46	1000	2176.36
2007	173.87	150.35	239.45	52.81	48.84	976.54	665.32	1780.03

Gray Correlation Analysis

Initial Value Processing

In order to make the indicators computable and eliminate the influence of different orders of magnitude, this paper used the initial value method to process the original sequence in Table 1. Table 2 lists the processed data.

Table 2 Results of initialization

year	2007	2008	2009	2010	2011	2012
$x_0^{'}$	1.0000	1.2227	1.6237	1.8040	2.3261	2.5528
$x_1^{'}$	1.0000	0.8770	0.8666	0.8370	1.1221	1.1433
$x_2^{'}$	1.0000	1.6562	2.2402	2.5576	3.0287	3.8114
$x_3^{'}$	1.0000	1.1817	1.4574	1.6947	1.9448	2.0440
$x_4^{'}$	1.0000	1.5232	1.9883	2.1753	3.0451	4.2030
$x_5^{'}$	1.0000	1.1521	1.2566	1.1980	1.4791	1.5346
$x_6^{'}$	1.0000	1.3921	1.4148	1.6276	1.9737	2.2356

Calculation of Gray Correlation Analysis

After the data is calculated in formula 2, the gray correlation coefficients between Guangxi's high-end producer services and manufacturing industries can be obtained, as shown in Table 3.

Table 3 Correlation coefficients of producer services and manufacturing industries

year	2007	2008	2009	2010	2011	2012
x_1	1.0000	0.7057	0.5215	0.4603	0.4066	0.3692
x_2	1.0000	0.6560	0.5732	0.5235	0.5410	0.3966
x_3	1.0000	0.9522	0.8318	0.8831	0.6840	0.6183
x_4	1.0000	0.7333	0.6933	0.6891	0.5342	0.3333
x_5	1.0000	0.9229	0.6930	0.5768	0.4948	0.4477
x_6	1.0000	0.8295	0.7980	0.8239	0.7008	0.7224
x_7	1.0000	0.7463	0.8764	0.8578	0.7873	0.7965

Calculation of Gray Correlation Degree

Table 4 lists the Gray Correlation Degree,which is calculated in Equation 3.

Table 4 Gray Correlation Degree of Guangxi's producer services and manufacturing industries

Correlation Degree	Info	finance	Real estate	business service	Sci-tech services	Producer service	High-end Producer service
Manufac-turing	0.5441	0.6827	0.7191	0.6681	0.6114	0.8179	0.8182

Make a sorting of the results in Table 3 and the results are as follows: $\gamma_7 \succ \gamma_6 \succ \gamma_3 \succ \gamma_2 \succ \gamma_4 \succ \gamma_5 \succ \gamma_1$, In Guangxi, the correlation between high-end producer services and manufacturing industries is the highest, followed by that between the overall producer service and manufacturing industries. In specific producer service area, the descending order in terms of their relevance to manufacturing industry is the real estate, financial services, business services, scientific research, technical services, and information transmission.

Conclusions and Suggestions

Conclusions

Firstly, manufacturing and producer services have a strong correlation and the gray comprehensive correlation reaches 0.8179, which shows that the development of the manufacturing industry can be driven by the development of producer services. And the correlation between high-end producer services and manufacturing is up to 0.8182, the highest of all, indicating that the development of high-end producer services plays an important supporting role in the development of manufacturing industry.

Secondly, all of the correlations between the whole sectors in high-end producer services and manufacturing industry are greater than 0.5, which indicates that the high-end producer services and manufacturing industry have a deep relevance.

Thirdly, as the representative of emerging industry in the producer services, ITCS(information transmission, computer services and software) has the minimum correlation degree with manufacturing industries, only 0.5441, while the real estate, financial and business services have much higher correlation degree respectively up to 0.7191,0.6827,0.6681, followed by the 0.6114 of scientific research, technical services, and geological prospecting. This exposed the problem of an uneven development of

the high-end producer services with newly emerging producer service sectors lagging far behind. Compared to the traditional high-end producer services, the supporting role of newly emerging service in manufacturing sectors is clearly dwarfed. The underdevelopment of Information transmission, computer services and software industry will significantly impede the transformation and upgrade of the manufacturing industry, which in turn will seriously slow down the pace of economic and social development in Guangxi. On the other hand, the gray correlation degree of the financial sector, real estate, business services and other industries is relatively higher, which indicates that the current development of Guangxi's manufacturing industries rely mainly on traditional manufacturing or service industries. However none of the correlations is higher than 0.8, which could be explained as the result of Guangxi's horizontal manufacturing structure featuring low level of technological and industrial added value.

Suggestions

A mutually coordinated development of producer service and manufacturing industries is the prerequisite for modern industrialization. The high-end producer service plays an important role in the upgrade of the manufacturing industry. In the future, Guangxi should take both industries into consideration when making development strategies and give priority to upgrading high-end producer service industry so as to highlight and fully use the role high-end producer services played in meeting the needs of core production processes including technological innovation, green production, and information integration.

Proceeding from the current situation of Guangxi, firstly, it is necessary to widely apply technologies so as to promote the development of the manufacturing industry. In this regard, Guangxi should accelerate the application of information technology in the producer services, thereby promoting information technology, finance, business services, scientific research and technical services; secondly, Guangxi should foster a favorable institutional environment for the development of producer services and ensure an effective implementation of relevant policies and regulations. In recent years, Guangxi has introduced more than 20 policy documents and strengthened the efforts to support financial sector. For example, A resource-rich region in western Guangxi is established to promote the scientific and technological cooperation in information construction in producer services. These efforts will greatly promote a coordinated development of high-end producer services and manufacturing; thirdly, Guangxi should facilitate the integration of producer service with the international market. By taking advantage of its favorable geographical location, Guangxi can attract large manufacturers, who are specialized in offshore services like R & D, procurement, and marketing. In addition, Guangxi should take an active part in international outsourcing programs, so as to transform Guangxi from a manufacturing base to a manufacturing and service base; fourth, Guangxi should train highly qualified professionals in high-end producer services. High-end producer services industry is a knowledge intensive sector, which requires a working force with professional skills. Therefore it is necessary for Guangxi to focus on the cultivation of high-end producer service professionals in order to leverage the supporting role high-end producer service played in driving the transformation and upgrading of the manufacturing industry.

Acknowledgement

We sincerely thank the guest editors and the anonymous referees for their valuable suggestions and comments. This research is supported by the Ministry of education of Humanities and social science research projects (No.10YJA630162) and the Guangxi Department of education research project (No.YB2014217).

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