Analysis of Regional Comparative Advantage and Its Driving Factors of Manufacturing Industry：Based on the Panel Data of Manufacturing Industry in Chongqing

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Keywords: Regional Comparative Advantage, Manufacturing Industry, Driving Factor, Chongqing.

Abstract: Based on the revealed comparative advantage index, this paper constructs the industrial regional comparative advantage index, and constructs the econometric model of manufacturing industrial regional comparative advantage including labor, capital, and technological factors, etc. Based on the panel data analysis of Chongqing manufacturing industry and its sub-industry, it is concluded that labor factor contributes significantly to the regional comparative advantage of Chongqing manufacturing industry, while technical factor and capital factor have limited and insignificant effects. However, there are significant differences among labor factor, technical factor and capital factor in the driving force of regional comparative advantage in different industries. The difference of industries indicates that relying on labor factor to drive the regional comparative advantage of Chongqing manufacturing industry has diminishing marginal effect, so the improvement of regional comparative advantage must be realized by implementing innovation strategy based on technological progress.

1 INTRODUCTION

The theory of comparative advantage originated from international trade has been widely used in regional economic analysis and industrial upgrading analysis in recent years (Wang, Zhang, 2018, Chen, et al, 2018, Zhang, et al., 2018, Zhao, Chen, 2020). Earlier, R. Hausman of Harvard University (2003) proposed an evolution theory of comparative advantage based on the theory of comparative advantage. According to the theory, the upgrading of products from simple to complex is the evolution and development process of comparative advantage, and such upgrading path is closely related to the initial industrial structure and comparative advantage (Hausmann, Rodrik, 2003, Hidalgo, et al., 2007, Wu, Zhang, 2012, Wang, 2013). Some Chinese scholars also used the theory of comparative advantage to conduct in-depth studies on China's industrial transfer, industrial transformation and upgrading. For example, Wang Tuzhan and Zhang Yue (Wang, Zhang, 2018) analyzed the space-time evolution of China's regional manufacturing comparative advantage by establishing the mechanism of explicit and potential comparative advantage (Wang, Zhang 2018). Chen Guosheng *et al.* (2018) analyzed the comprehensive effect of comparative advantage and competitive advantage on China's manufacturing industry transfer by using panel data (Chen, et al., 2018).

China is in the process of transformation and upgrading from a manufacturing giant into a manufacturing power, but there are obvious differences among different regions in the development path of manufacturing industry upgrading. Chongqing, an important manufacturing city in western China, experienced an obvious decline in economic growth around 2018, especially in the growth of industrial added value of the manufacturing industry. In order to solve this problem, this paper will construct the industrial regional comparative advantage index and the measurement model of manufacturing regional comparative advantage, combined with the panel data of Chongqing manufacturing industry, analyzes the temporal and spatial changes of Chongqing manufacturing industry regional comparative advantage, and deeply analyzes the driving factors of Chongqing manufacturing industry and regional comparative advantage in various industries.

Wang, C. and Mu, T.
Analysis of Regional Comparative Advantage and its Driving Factors of Manufacturing Industry: Based on the Panel Data of Manufacturing Industry in Chongqing.
DOI: 10.5220/0011231900003440
In *Proceedings of the International Conference on Big Data Economy and Digital Management (BDEDM 2022)*, pages 695-701
ISBN: 978-989-758-593-7

2 RESEARCH DESIGN

2.1 Industrial Regional Comparative Advantage Index

Balassa, an American economist, put forward the RCA index (Revealed Comparative Advantage Index) in 1965. Reference the concept and connotation of RCA index, and existing research results (Wang, Zhang, 2018, Chen, et al., 2018, Zhang et al., 2018), we constructed the industrial regional comparative advantage index as follows:

$$DCAij=(Hij/Yi)/(Hj/Y) \quad (1)$$

The above formula represents the ratio between the share of industry j in region i in the regional total output and the share of industry j in the national total economic output. In the formula, DCAij Represents the index of regional comparative advantage of industry j in region i, Hij Represents the industrial added value of industry j in region i, Hj Represents industrial added value of China's J industry, Yi Represents the gross domestic product of region i, and Y represents the gross domestic product of China. DCA and RCA have the same meaning, that is, when DCA value is greater than 2.50, an industry has a strong comparative advantage; when DCA value is between 0.80 and 1.25, an industry has a medium comparative advantage; when DCA value is below 0.8, it is at a comparative disadvantage.

2.2 Econometric Model of Industrial Regional Comparative Advantage

There have been analysis and research on the measurement of industrial comparative advantage, most of which are based on Cobb-Douglas production function to construct an econometric model to analyze the influence of various factors such as labor factors and capital factors on industrial comparative advantage. For example, Liu Wei and Liu Guozhen (2015) used Cobb-Douglas production function to construct an econometric model of regional industrial comparative advantage of labor, capital, foreign capital and technological factors (Liu, Liu, 2015). Zhang Yue *et al.* (2018) constructed an econometric model of comparative advantage based on traditional international trade theories such as Heckschel-Ohlin (HO) theory and Porter's competitive advantage theory (Zhang, et al., 2018).Wang Tuzhan and Zhang Yue (2018) pointed out that technological level, factor endowment, economies of scale, agglomeration effect and institutional factors are all important sources of explicit comparative advantage of regional manufacturing (Wang, Zhang, 2018). Based on Cobb-Douglas production function and traditional international trade theories such as Heckschel-Ohlin (HO) theory, and based on existing research results, this paper establishes an econometric model of industrial regional comparative advantage based on the sources of traditional comparative advantage including capital, labor and technological progress, as follows:

$$DCAit = a + \alpha Lit + \beta Kit + \gamma TEit + \xi i \quad (2)$$

The model represents the driving factors of the regional comparative advantage of i industry in period t, and ξ represents other disturbances. The model mainly investigates the influence of each driving factor on the change of industrial location comparative advantage, Kit is the index of capital factor, indicating the capital input of i industry in period t. Lit is the labor factor index, indicating the annual labor input of industry i in period t. Technical factor index TEit is the change of the technological level of i industry in period t. This paper uses the method of total labor productivity for technical factor to comprehensively reflect the relative level of the regional manufacturing industry and the production technology, operation and management, technical proficiency and labor enthusiasm of the employees in all local industries (Wang and Zhang 2018, Zhang *et al.* 2018, Liu and Liu 2015).

3 DATA DESCRIPTION

The sample data is from the "China Statistical Yearbook", "China Industrial Economic Statistical Yearbook" and "Chongqing Statistical Yearbook" over the years. The selected manufacturing sub industries are selected according to the national economic industry classification standard of the National Bureau of Statistics of China, and 25 manufacturing sub industries are selected according to the availability of data. The statistical data of each manufacturing sub industry is from the statistical data of industrial enterprises above designated size from 2008 to 2018. From the collected data of manufacturing sub industries in Chongqing, there is only statistical data of transportation equipment manufacturing industry from 2008 to 2011, while from 2012 to 2018, it is divided into two industries, namely automobile manufacturing industry and railway, ship aerospace and other transportation equipment manufacturing industry, in order to unify data analysis, the data from 2012 to 2018 is integrated into the data of transportation equipment manufacturing industry for analysis and processing.

Through the comparative analysis of the statistical data caliber of Chongqing in different periods, we can find the industrial added value of manufacturing sub industries from 2008 to 2011. There is a lack of statistical data on the industrial added value of manufacturing sub industries from 2012 to 2018. Therefore, for some years it’s calculated from the industrial added value of manufacturing sub industries in the previous year, as well as the annual price index and growth rate of industrial added value of manufacturing sub industries. For the years from 2012 to 2018 when there is no data on the growth rate of industrial added value of manufacturing sub industries, the industrial added value production method is used for estimation, that is, from the perspective of the formation of the value of products and labor services in the process of industrial production, the value of intermediate inputs in the production process is excluded, so as to we obtain the industrial added value of each industry in the current year. The labor factor index collects the average number of employees in each industry in that year. The capital factor index collects the paid-in capital of each industry in the current year. For technical factors, the total labor productivity of each industry in the current year is collected. For the lack of data of the total labor productivity of each industry in Chongqing in some years from 2008 to 2018, the industrial added value of each industry in the current year was divided by the average number of employees in each industry in the current year. In the model, all explanatory variables are logarithmic processed with the original data, namely:

Kit=LN (paid-in capital of i industry in period t)

Lit=LN (average annual labor input to industry i in period t)

TEit=LN (Total labor productivity of industry i in period t)

4 DATA ANALYSIS

4.1 Industrial Regional Comparative Advantage

This paper uses the concept and connotation of the explicit comparative advantage index to construct the industrial regional comparative advantage index. The industrial regional comparative advantage index represents the ratio of the share of an industry in the regional total output to the share of the industry in the national total economic output. Through data collection and analysis, the typical industrial regional comparative advantage of Chongqing's manufacturing industry and its sub sectors is shown in Table 1. The analysis results show that the overall regional comparative advantage of Chongqing's manufacturing industry in each year from 2008 to 2018 is less than 1, reaching the highest value of 0.8542 in 2015, showing a weak trend of manufacturing regional comparative advantage. The overall regional comparative advantage of manufacturing industry increased from 0.6005 in 2008 to 0.657 in 2018, indicating that the regional comparative advantage of manufacturing industry has improved somewhat. In terms of the development trend of Chongqing's manufacturing regional comparative advantage, the manufacturing regional comparative advantage increased from 0.6005 in 2008 to 0.8542 in 2016, but declined to 0.6826 in 2017 and 0.6570 in 2018, showing an inverted "U" structure to a certain extent (as shown in Figure 1).Specific to manufacturing sub industries, the development trend of regional comparative advantage is also different.

Table 1: Manufacturing industry regional comparative advantage in Chongqing.

industry	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
HY0	0.6005	0.6598	0.6784	0.6767	0.6604	0.7015	0.7560	0.8241	0.8542	0.6826	0.6570
HY1	0.4515	0.4767	0.5249	0.5130	0.4952	0.5043	0.5404	0.5885	0.6404	0.5068	0.4593
HY2	0.4100	0.4502	0.4655	0.4329	0.3778	0.4218	0.4302	0.4610	0.4543	0.4055	0.3538
HY3	0.9238	0.9001	0.8843	0.8382	0.8348	0.8279	0.8015	0.7062	0.6104	0.6533	0.9536
HY4	0.2437	0.3118	0.3075	0.2606	0.2478	0.2396	0.2173	0.2097	0.2029	0.1009	0.0556
HY5	0.1316	0.1221	0.1569	0.2138	0.2126	0.2232	0.2419	0.2369	0.2130	0.1458	0.1108
HY6	0.3307	0.3296	0.3678	0.4953	0.4909	0.5304	0.5331	0.5367	0.5790	0.4904	0.4701
HY7	0.0801	0.0959	0.1211	0.1361	0.1169	0.1349	0.1947	0.2651	0.2818	0.3238	0.3424
HY8	0.4406	0.5639	0.5132	0.5894	0.5297	0.5887	0.5359	0.3767	0.4144	0.3829	0.4158
HY9	0.3784	0.5396	0.6814	0.5223	0.6348	0.7171	0.7938	0.8196	0.8249	0.6964	0.7989
HY10	0.6795	0.7819	0.8047	0.7833	0.7317	0.7958	0.9052	1.0055	0.8860	0.6972	0.7348
HY11	0.0717	0.1035	0.0773	0.0659	0.0696	0.0581	0.0706	0.0858	0.0818	0.0553	0.0671
HY12	0.5561	0.5623	0.5757	0.5858	0.4940	0.4519	0.4432	0.4595	0.4480	0.3488	0.3553

HY13	0.9482	0.9299	0.7902	0.7107	0.6859	0.7038	0.7243	0.8824	0.8981	0.6828	0.6521
HY14	0.0623	0.0742	0.0730	0.0533	0.0166	0.0327	0.0354	0.0632	0.0928	0.1313	0.1217
HY15	0.3089	0.3762	0.4174	0.5112	0.5865	0.6476	0.6462	0.6671	0.7237	0.6340	0.5102
HY16	0.7023	0.6909	0.7462	0.7299	0.7028	0.7203	0.7605	0.8100	0.8244	0.6250	0.6789
HY17	0.3770	0.3764	0.4923	0.5517	0.4542	0.4698	0.4692	0.4893	0.4043	0.2602	0.3317
HY18	0.8648	0.7896	0.7405	0.6484	0.5852	0.5920	0.6475	0.6887	0.6875	0.5453	0.4600
HY19	0.3063	0.3562	0.4144	0.5794	0.4995	0.5073	0.5670	0.6680	0.6914	0.4392	0.4590
HY20	0.5224	0.6561	0.6411	0.5235	0.4967	0.5063	0.5537	0.6093	0.6816	0.5871	0.5822
HY21	0.4167	0.5158	0.5128	0.3729	0.3085	0.3859	0.4166	0.4707	0.5380	0.3850	0.3879
HY22	3.0335	2.9579	2.7291	2.6890	2.6366	2.7617	2.8292	2.9108	2.9000	2.1655	1.8328
HY23	0.5010	0.5391	0.5993	0.6418	0.6500	0.5923	0.6359	0.6826	0.6497	0.4988	0.4553
HY24	0.0888	0.1232	0.2060	0.6282	0.9848	1.2458	1.4991	1.5501	1.6992	1.5796	1.6440
HY25	0.7606	0.7879	0.9185	0.7256	0.9233	0.8263	0.8424	0.8055	0.7424	0.6324	0.5555

Data source: According to the original data collation calculation. Industry Code Description : HY0: Manufacturing industry;HY1: Agricultural and sideline food processing industry; HY2: Food manufacturing; HY3: Tobacco products industry; HY4: Textile industry; HY5: Textile clothing, shoes and hats manufacturing; HY6: Leather, fur, feather (feather) and its products; HY7: Wood processing and wood, bamboo, rattan, palm and grass products; HY8: Furniture manufacturing; HY9: Paper and paper products industry; HY10: printing and recording media; HY11: Petroleum processing, coking and nuclear fuel processing industry; HY12: Manufacturing of chemical raw materials and chemical products; HY13: Pharmaceutical manufacturing; HY14: Chemical fiber manufacturing; HY15: Rubber products industry; HY16: Non-metallic mineral products industry; HY17: Ferrous metal smelting and rolling processing industry; HY18: Non-ferrous metal smelting and rolling processing industry; HY19: Metal products industry; HY20: General equipment manufacturing; HY21: Manufacturing of special equipment; HY22: Manufacturing of transportation equipment; HY23: Electrical machinery and Equipment manufacturing; HY24: Communication equipment, computer and other electronic equipment manufacturing; HY25: Instrument and cultural and office machinery manufacturing.(HY1-HY25 are for manufacturing sub industries).

4.1.1 Manufacturing Sub Industry Analysis with Strong Regional Comparative Advantage

From 2008 to 2018, the manufacturing sub industries with strong regional comparative advantage in Chongqing are transportation equipment manufacturing and communication equipment, computer and other electronic equipment manufacturing. From the perspective of development trend, the regional comparative advantage of transportation equipment manufacturing decreased year by year, and its DCA decreased from 3.0335 in 2008 to 1.8328 in 2018.The manufacturing industry of communication equipment, computer and other electronic equipment showed a trend of increasing regional comparative advantage year by year, and showed a rapid growth during 2008-2012. DCA increased from 0.0888 in 2008 to 0.9848 in 2012, and even increased to 1.644 in 2018.

4.1.2 Manufacturing Sub Industry Analysis with Inferior Regional Comparative Advantage

In addition to transportation equipment manufacturing and communication equipment, computer and other electronic equipment manufacturing, the regional comparative advantage of other manufacturing industry in Chongqing is at disadvantage. From 2008 to 2018, Chongqing regional comparative advantage in manufacturing improved industry of leather, fur, and feathers (fine hair) and its products, wood processing and wood, bamboo, cane, palm, grass products, chemical fiber industry, paper and paper products, rubber products, printing and recording media industry, fabricated metal products. Among them, the DCA of paper and paper products industry, printing industry and recording media industry is close to 1, while the DCA of other industries is less than 0.5, indicating that the regional comparative advantage of other industries is weak.

From 2008 to 2018, Chongqing regional comparative advantage to degradation in the manufacturing industry: textiles, pharmaceutical manufacturing industry, non-ferrous metal smelting and rolling processing industry, instruments and meters, and culture, office machinery manufacturing industry. Among them, non-ferrous metal smelting and rolling processing industry and instrument is a traditional industry in Chongqing, but showed a trend of decline in the regional comparative advantage. From 2008 to 2018, the regional comparative advantage of most manufacturing sub industries in Chongqing presents an inverted "U" shaped structure to a certain extent (as shown in Figure 1). The regional comparative advantage

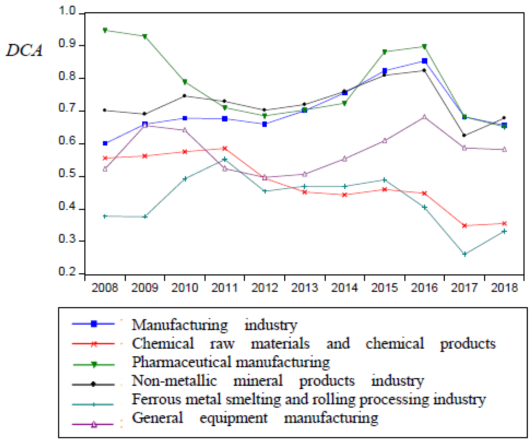

Figure 1: Comparative advantage of Manufacturing industry and some industries in Chongqing.

shows a significant peak in 2015 or 2016, but a significant downward trend after 2016.This is consistent with the changing trend of Chongqing's industrial added value in recent years.

4.2 Analysis of Driving Factors of Regional Comparative Advantage

Combined with Cobb-Douglas production function and Heckschel-Ohling(HO) traditional international trade theory, the econometric model based on the traditional sources of comparative advantage including capital, labor and technological progress is established(see section 2 model settings above).In the analysis process, model 1 is set as the general situation of Chongqing manufacturing industry for data inspection and analysis, and model 2 is the data analysis of Chongqing manufacturing sub industries. The model mainly studies the influence of driving factors on the change of manufacturing industry and regional comparative advantage of each manufacturing sub industry.

4.2.1 Formal Test of Model Setting

According to the set econometric model of regional comparative advantage, this paper analyzes the driving factors of regional comparative advantage of Chongqing manufacturing industry and 25 manufacturing sub industries by using regional comparative advantage, capital factor, labor factor and technology factor. The explained variable DCA in the model represents the comparative advantage of manufacturing industry and various sub-industries. The explained variables are labor factor variable L, capital factor variable K and technology factor variable TE. The variables are annual data, and the sample range is from 2008 to 2018.In this paper, software EVIEWS10.0 was used, and analysis showed that R^2=0.9317, F=11.4249 in model 1, indicating that 93.17% of the variation of manufacturing regional comparative advantage can be explained by their respective variables, and the significance probability reaches 0.000, indicating significant regression. For model 2, according to the test method of model setting provided by Gaotiemei (2006)(N=25, k=3, T=11), F1=180.284, F2=151.743, F1 and F2 are greater than the corresponding critical value, so the variable coefficient model is selected for analysis(Gao 2006).The variable coefficient panel model can be divided into random effect and fixed effect according to different individual effects of intercept items. Hausman test is used to process variables. The results of Hausman test show that the P value of this model is 0, less than 0.05, which rejects the null hypothesis. The null hypothesis of Hausman test believes that the random effect model should be established. Based on the above tests, the regression model adopted in this paper is fixed effect variable coefficient panel model. Model 2 tests R^2=0.9904, and the significance probability reaches 0.000, which indicates that the change of regional comparative advantage can be explained by 99.04% of independent variables, and the fitting effect of the model is very good.

4.2.2 Model Estimation

For model 2, a panel model with fixed effects and variable coefficients was used to perform regression analysis on all variables, using the method of cross-sectional weighting. As for the estimation method, panel correction standard error (PCSE) method is adopted, and the results are shown in Table 2.

Table 2: Econometric model analysis results (Unit: None).

	industry	α	T statistic of α	β	T statistic of β	γ	T statistic of γ
Model 1	HY0	0.779	3.437	0.011	0.073	0.176	-0.467
	HY1	0.384	2.674	-0.255	-1.301	-0.022	0.610
	HY2	0.254	1.459	-0.151	-0.871	0.057	-0.468
	HY3	0.594	2.368	0.015	0.280	0.051	1.107
	HY4	0.179	0.647	-0.010	1.036	-0.003	0.243

Model 2	HY5	0.176	2.480	-0.011	-0.099	0.122	-0.112
	HY6	0.283	3.284	-0.185	-1.048	0.130	1.429
	HY7	0.160	0.988	-0.099	-0.295	-0.227	1.098
	HY8	0.508	2.363	-0.308	-4.378	0.291	-0.889
	HY9	0.509	2.641	-0.143	-1.812	-0.090	4.131
	HY10	0.046	-0.211	0.176	1.054	0.007	-0.553
	HY11	0.020	0.251	0.005	-0.156	0.099	0.196
	HY12	0.292	0.562	-0.261	-0.538	-0.322	-0.270
	HY13	0.075	0.547	0.139	1.757	0.056	-2.847
	HY14	0.057	0.615	-0.007	-0.107	0.230	0.763
	HY15	0.387	3.499	-0.128	-1.947	0.274	2.807
	HY16	0.617	2.288	-0.432	-0.910	0.134	0.610
	HY17	0.256	3.808	-0.072	-1.622	-0.066	1.488
	HY18	0.351	2.049	-0.220	-1.641	0.127	-0.742
	HY19	0.746	3.615	-0.307	-2.401	-0.169	1.100
	HY20	0.609	2.575	0.096	0.480	0.028	-0.938
	HY21	0.378	2.731	-0.063	-0.666	2.008	0.482
	HY22	1.023	-0.517	-2.233	-19.385	0.319	6.876
	HY23	0.482	2.187	-0.370	-2.567	-0.318	1.216
	HY24	0.654	7.725	0.095	-4.494	-0.174	2.988
	HY25	0.793	4.606	-0.017	-0.285	0.176	-1.188

4.2.3 Analysis of Model Results

The regression coefficient analysis results of driving factors show that DCA of manufacturing industry in Chongqing is positively correlated with labor input, capital input and technological progress, but only labor input has a significant impact on DCA of manufacturing industry, while technological progress and capital input have a limited and insignificant effect on manufacturing regional comparative advantage. At the same time, the contribution of labor input to manufacturing regional comparative advantage is far more than the impact of capital input and technological progress. This conclusion is consistent with the labor population transfer in Chongqing from 2008 to 2018. The transfer of rural labor to the secondary industry and the return of migrant labor from the east are the main driving factors for the formation of comparative advantages of Chongqing manufacturing industry in this period. But on the whole, the marginal effect of labor input on manufacturing regional comparative advantage shows a downward trend, which is reflected in the inverted "U" shaped structure of Chongqing manufacturing regional comparative advantage (as shown in Figure 1).This indicates that the driving factors which promoted the improvement of Chongqing's manufacturing regional comparative advantage from 2008 to 2016 decreased after 2016, while the manufacturing industry in Chongqing did not form new driving factors after 2016, resulting in the decline of manufacturing regional comparative advantage.

In terms of specific sub industries, technological progress has a great positive effect on the regional comparative advantage of transportation equipment manufacturing, metal products manufacturing, electrical machinery and equipment manufacturing, communication equipment computer and other electronic equipment manufacturing, etc. In textile industry, printing industry and pharmaceutical manufacturing industry, capital input has a large positive effect on the formation of industrial regional comparative advantage, but in most other industries, capital input has a very limited effect on the formation of industrial regional comparative advantage. Agricultural and sideline food processing, food manufacturing, tobacco products industry, textile and garment, shoes, caps, leather, fur, and feathers and its products, furniture manufacturing, paper and paper products, rubber products, non-metallic mineral products, ferrous metal smelting and rolling processing industry, non-ferrous metal smelting and rolling processing industry, fabricated metal products, general equipment manufacturing industry, special equipment, communications equipment manufacturing, electric machinery and equipment manufacturing industry of computer and other electronic equipment manufacturing, instrumentation and cultural office machinery manufacturing and other industries, labor input has a great positive effect on the formation of the regional comparative advantage of these industries.

Textile industry, pharmaceutical manufacturing industry, non-ferrous metal smelting and calendering industry, instrument and instrument and culture industry, office machinery manufacturing industry, all showed a declining trend of regional comparative advantage, except pharmaceutical industry, the driving factor of regional comparative advantage is labor input. For most industries, their regional comparative advantage mainly depends on labor input, but these industries do not have strong regional comparative advantage in the whole country. In Chongqing, the industries with strong regional comparative advantage, such as transportation equipment manufacturing (automobile manufacturing and other transportation equipment) and communication equipment, computer and other electronic equipment manufacturing, are mainly driven by technological factors rather than capital factors or labor factors. This shows that the strong regional comparative advantage of manufacturing industry must rely on technological innovation and technological progress.

5 CONCLUSIONS

The analysis above shows that there is a marginal diminishing effect in the regional comparative advantage of Chongqing manufacturing industry driven by labor factors, while the new competitive advantage has not yet formed, which led to a decline in the development of Chongqing manufacturing industry after 2016.The analysis of this paper shows that only technological innovation and technological progress can establish the competitive advantage and enhance the regional comparative advantage of manufacturing industry in Chongqing. Therefore, the development of Chongqing manufacturing industry needs to implement innovation-driven strategy to realize the promotion and development of industrial comparative advantage, so as to enhance the core competitiveness of Chongqing manufacturing industry, therefore, promote the transformation and upgrading of industrial structure, and promote the high-end development of Chongqing manufacturing value chain.

ACKNOWLEDGMENT

This paper is sponsored by the The Social Science Research Major Project of Chongqing Education Commission (20SKGH229).

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