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Research Article

An Empirical Study on the Correlation between Educational Input and Upgrading of Industrial Structure under the Background of Beijing-Tianjin-Hebei Coordinated Development*

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Abstract

Higher education is an important base for scientific research and personnel training, and the upgrading of industrial structure is inseparable from advanced technology and high-quality talents. Based on the research on the correlation between education input and the upgrading of industrial structure under the background of Beijing-Tianjin-Hebei coordinated development, this paper analyzes the present situation of higher education input-output and the upgrading of industrial structure in Beijing-Tianjin-Hebei region by means of statistical analysis. By introducing the method of regression analysis, this paper makes an empirical analysis of the correlation between the input-output of education and the optimization and upgrading of industrial structure. The results show that the input of education can support and lead the upgrading of industrial structure. The upgrading of industrial structure has feedback and promotion effect on educational investment. This research has certain guiding significance to promote the positive interaction between education input and upgrading of industrial structure in Beijing-Tianjin-Hebei region, and to realize the coordinated development in Beijing-Tianjin-Hebei region.

Keywords

Beijing-Tianjin-Hebei Coordinated Development • Education Input • Industrial Economy • Upgrading of Industrial Structure

1. Hebei Social Science Fund Project in 2016 (HB16YJ052) "Study on the Sustainable Development and Radiation Effect of Industrial in Hebei Province Under Beijing-Tianjin-Hebei Coordinated Development"
2. Hebei Social Science Fund Project of 2017(HB17SH026) "Study on the employment capacity gap and improvement path of the new generation of migrant workers in our province under the background of industrial transformation and upgrading in Beijing-Tianjin-Hebei region"
3. Hebei Province Human Resources and Social Security Project in 2018(JRS-2018-3036) "Study on the Incentive Mechanism of Flexible Talents Introduced in the Strategic Emerging Industry of Hebei Province under Beijing-Tianjin-Hebei Coordinated Development"

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Beijing-Tianjin-Hebei coordinated development strategy is one of the three new national strategies in China and its purpose is to optimize the spatial distribution of regional industries and improve the capacity of industrial cooperation among the three regions as a whole of coordinated development to build a new type of capital economic circle adapting to the future development (Yung & Hsu, 2006), therefore, the optimization and upgrading of industrial structure is the most important point to realize the Beijing-Tianjin-Hebei coordinated development. Advanced technologies and highly qualified talents are the core factors and motivation to promote the optimization and upgrading of the industrial structure (Azadegan & Wagner, 2011), while most of the advanced technologies and high-quality talents come from higher education, and the input and output efficiency of higher education is decisive to the R & D and progress of science and technology, the transmission of specialized human capital, and the promotion of industrial transformation and upgrading (Wedul, 1974).

The input of high education (Washburn, 1906) refers to that sum of inputs by the state and society for the teacher resource and funds of higher education, and also refers to human capital input in higher education. The output of higher education (Weijnen & Herder, 2000) refers to the total amount of students formed and cultivated as social human capital by higher education. The ultimate goal of industrial structure optimization and upgrading is to make the needs, supply, and technologies adapted to employment structure. It is a dynamic process to improve the overall development level of the industrial structure (Rodrguez, De, Ciurana & Elas, 2006). Schultz explained at the Annual Meeting of American Economic Association that input in human capital can effectively promote economic growth, while Denison pointed out that input in education is essentially input in human capital, and Barro et al demonstrated that educational inputs can promote output growth and economic development (Jan, 1983). Zhang Qichun et al believe that the quality of talents plays an important role in promoting the optimization and upgrading of industrial structure. Chen Chao made clear the relationship between the structure of higher education and the adjustment of industrial structure. Xu Changqing used principal component analysis to find that there is no obvious positive relationship between input and academic output of higher education in China. The result of Zhang Xiaobo's research shows that the input and output efficiency of "985" institutions remains to be further improved (Cheng & Liu, 2017). After Beijing-Tianjin-Hebei coordinated development strategy was put forward, many domestic scholars studied the problems, countermeasures and specific development routes in the course of the coordinated development of Beijing-Tianjin-Hebei industry, and some scholars also studied the coordinated development of of regional higher education in the background of the coordinated development of Beijing-Tianjin-Hebei industry (Liu, Hu & Liu, 2017), but it is found that the research results on the correlation between educational input and the upgrading of industrial structure are very limited.

Based on the above analysis and combined with the actual situation of Beijing, Tianjin and Hebei, this paper analyzes the present situation and existing problems of education input and the upgrading of industrial structure, and then carries out the qualitative and quantitative analysis of the interactive relationship between education input and the upgrading of industrial structure by means of regression analysis. The results show that education input has a supporting and leading effect on the upgrading of industrial structure, and the upgrading of industrial structure has feedback and promotion effect on educational input.

Analysis of Higher Education Input-Output and Upgrading of Industrial Structure in Beijing-Tianjin-Hebei Region

Analysis on the present situation of higher education input-output

Table 1 shows the situation of education input in Beijing, Tianjin and Hebei from 2012 to 2016. It can be seen from the table that the ratio of education expenditure to GDP does not change greatly, but the input of higher education expenditure shows the trend of increasing year by year. In addition, the growth rate of the total number of teachers and staff is also obvious.

Table 1
2012-2016 Education Input in Beijing-Tianjin-Hebei Region

Years	Education funds as a percentage of GDP (%)	Per capita education expenditure (yuan)	Total number of faculty and staff (Ten thousand people)	Number of dedicated teachers (Ten thousand people)
2012	1.39	23584.84	2.2056	0.695
2013	1.41	25377.52	2.2326	0.731
2014	1.47	26062.63	2.2853	0.742
2015	1.52	27586.73	2.2932	0.763
2016	1.53	29425.34	2.3017	0.798

According to statistics (Jun, Xiaomin & Management, 2014), the gross enrollment rate of colleges and universities in Beijing, Tianjin and Hebei increased from 30% in 2012 to 45.36% in 2016. Figure 1 shows the output of education in Beijing, Tianjin and Hebei from 2012 to 2016. The output of education studied in this paper is mainly the output of human capital. It can be seen from the figure that higher education provides a large number of specialized talents for the society. The average number of professional technicians per 10,000 workers increased from 5,166 in 2012 to 6,327 in 2016, raised by 22.47%. The investigation results show that the status of education input and output in Beijing, Tianjin and Hebei from 2012 to 2016 continues to improve.

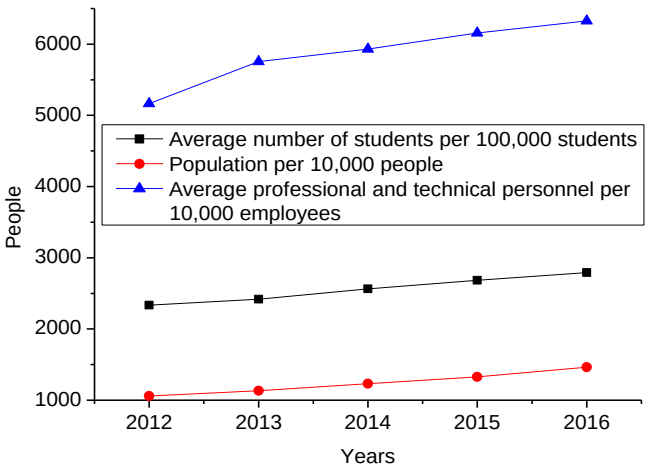

Figure 1. 2012-2016 Education output in Beijing-Tianjin-Hebei region.

Analysis of the present situation of industrial structure upgrading

The proportion of tertiary industrial structure is constantly optimized. Table 2 shows the contribution rate of tertiary industries in the gross product of Beijing, Tianjin and Hebei from 2012 to 2016. It can be seen from the table that the contribution rate of the primary industry has declined slightly, but keeps stable as a whole and the contribution rate of the tertiary industry has surpassed the secondary industry since 2014. In general, the tertiary industrial structures present a good overall trend, and are developing in the direction of rationalization.

Large deviation between industrial structure and employment structure. The deviation of industrial structure is used to measure whether the industrial sector's output value structure and labor employment structure are synchronized and symmetrically coordinated. The closer the index is to zero, the better the benefit of industrial structure is.

Table 2
Contribution Rate of Tertiary Industries in the GDP of Beijing-Tianjin-Hebei Region in 2012-2016

Years	Primary industry	Secondary industry	Tertiary Industry
2012	5.6	48.8	45.7
2013	4.8	48.4	46.9
2014	4.7	47.2	48.2
2015	4.5	47.6	49.4
2016	4.4	48.3	49.2

$$\text{Industrial structure deviation} = \frac{\text{Industrial output value percentage}}{\text{Employment composition percentage}} - 1 \quad (1)$$

Table 3 shows the deviation degree of industrial structure in the Beijing-Tianjin-Hebei region from 2012 to 2016. It can be seen from the table that the deviation degree of structure of the primary industry is large and negative, indicating that the composition of output value is obviously smaller than that of employment. The structural deviation of the secondary and tertiary industries is gradually reduced, which shows that the industrial structure and employment structure are becoming more and more reasonable.

Table 3
2012-2016 Beijing-Tianjin-Hebei Region Industrial Structure Deviation

Years	Primary industry	Secondary industry	Tertiary Industry
2012	-0.8	0.6	0.3
2013	-0.8	0.6	0.2
2014	-0.8	0.6	0.2
2015	-0.7	0.5	0.2
2016	-0.7	0.4	0.15

Qualitative and Quantitative Analysis of the Interactive Relationship between Educational Input and Upgrading of Industrial Structure

Analysis on the correlation between educational output and industrial structure optimization and upgrading

Measurement of industrial structure optimization and upgrade level. In this paper, four first-class indexes such as industrial structure height, rationalization, benefit and green are selected, and the structure

upgrading level is measured by Regression method to obtain the scores of industrial optimizations and upgrading factors and their comprehensive scores in the Beijing-Tianjin-Hebei region from 2012 to 2016, as shown in Table 4.

Table 4
Industry Optimization Upgrade Factor Score and its Comprehensive Score

Years	F_1	F_2	Overall ratings
2012	1.90834	-0.36148	1.14624
2013	2.44156	-0.7225	1.37553
2014	2.53527	-0.8542	1.54986
2015	2.79501	-0.9052	1.7324
2016	2.95983	-0.9765	1.9866

Correlation regression analysis. In order to sum up the statistical results of education output in Beijing-Tianjin-Hebei region from 2012 to 2016 and the score of industrial optimization and upgrading factors and their comprehensive scores, the comprehensive score of education output and industrial structure optimization and upgrading indexes in Beijing-Tianjin-Hebei region from 2012 to 2016 are obtained, as shown in Figure 2, and it can be seen that the change direction of education output and industrial structure optimization and upgrading in Beijing-Tianjin-Hebei region is consistent.

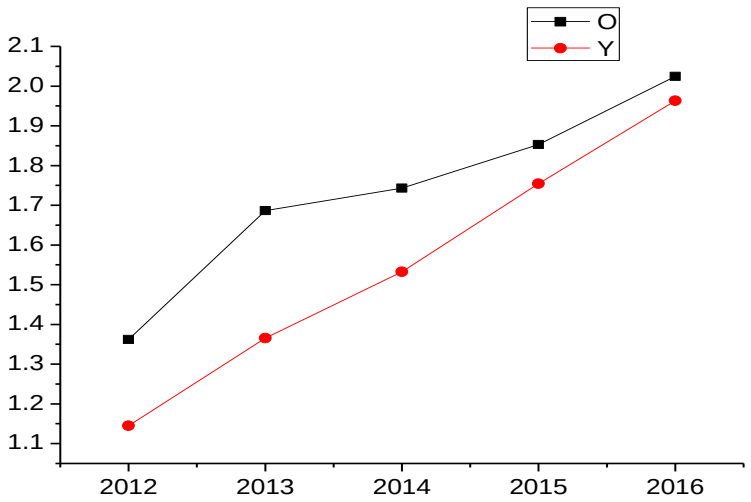

Figure 2. Comprehensive scores of educational outputs and industrial Structure optimization and upgrading indexes.

Note. O is an independent variable, which is the input of higher education, and Y is the dependent variable. It is the optimization index of industrial structure.

According to the comprehensive scores of the two sets of indexes shown in Figure 2, the linear and non-linear quadratic curve fitting is performed using SPSS software, and the model is as follows:

$$Y = -0.1 + 1.757O + 0.092O^2 \quad (2)$$

Figure 3 is a fitting graph of comprehensive scores of educational output and industrial structure upgrading. It can be seen from the figure that there is no perfect linear relationship between the two, but the correlation is significant, and the educational output has a certain promoting effect on industrial structure upgrading, and there is a process of gradual adjustment and adaptation between them.

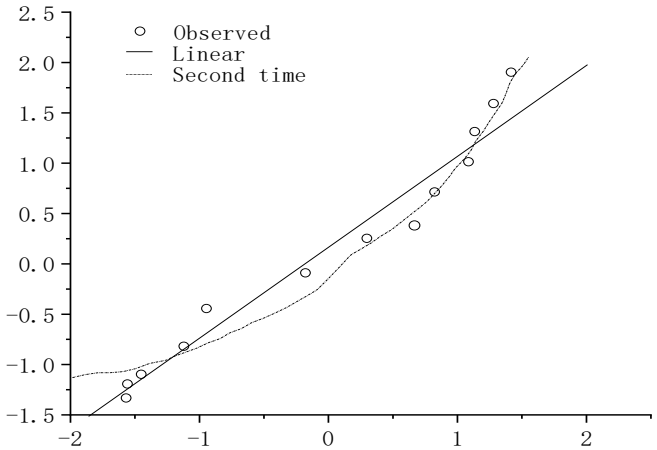

Figure 3. Comprehensive score matching diagram of educational output and the upgrading of industrial structure.

The education input has the supporting and the leading function to the industrial structure upgrading

Through the above analysis results, it can be concluded that the education input has certain supporting and leading function to the industrial structure upgrading, and the concrete manifestation is that technology is the premise and foundation of the industrial structure upgrading, and reasonable education input can improve the output efficiency of higher education and provide high-level scientific and technological personnel and advanced technology for upgrading the industrial structure. In addition, through different levels of education and different professional settings, higher education can enable students at different levels to form different levels of knowledge accumulation, they can play different roles in the industries, and junior college students pay more attention to practice operations, solving the technical problems in the process of operation, while graduate students and higher-level human capital can carry out scientific research and innovation. They all influence the technical structure of the industries from different angles and levels, and promote the upgrading of the industrial structure.

The upgrading of industrial structure has feedback and promoting effect on educational input

Generally speaking, the level of national understanding of education will increase with the improvement of economic level, and the input in education will increase at the same time. Therefore, after the industrial structure

is optimized and upgraded, the economic development will be promoted, and the corresponding input in education will increase gradually. At the same time, the upgrading of industrial structure can promote colleges and universities to optimize the professional structure and hierarchy structure and make it reasonable through the demand for talents and employment pressure.

Conclusion

Under the background of national strategy of Beijing-Tianjin-Hebei coordinated development, this paper studies the correlation between educational input and upgrading of industrial structure. The concrete conclusions are as follows:

Through the statistical analysis of the educational input in Beijing-Tianjin-Hebei region from 2012 to 2016, it is found that the educational input and output in Beijing-Tianjin-Hebei region continue to improve.

The analysis of industrial upgrading situation in Beijing, Tianjin and Hebei from 2012 to 2016 shows that the proportion of tertiary industrial structure is constantly optimized, and the deviation between industrial structure and employment structure is larger.

Based on the analysis of the present situation of higher education input-output and industrial structure upgrading in Beijing-Tianjin-Hebei region from 2012 to 2016, this paper makes qualitative and quantitative analysis of the interaction between educational input and industrial structure upgrading. The result shows that the education input has the supporting and leading function to the industrial structure upgrading, and the industrial structure upgrading has the feedback and promotion function to the education input.

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