A Study on Contribution Rate of Higher Education to Economic Growth in Bohai Rim Region, China

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Abstract: In order to study the contribution rate of education to economic growth, the contribution rate of higher education to economic growth in Bohai Rim of China from 2005 to 2017 is calculated by using the improved Cobb-Douglas (C-D) production function model and the results are compared with the average of China. The results show that the contribution rate of higher education to economic growth in Bohai Rim is 8.82%, which is higher than the national average level. But the regional differences in the development of higher education in Bohai Rim region are relatively obvious. contribution rate of higher education in Tianjin to economic growth is 16.99%, more than twice the national average level. The contribution rate of Shandong Province and Hebei Province are both behind from the national average level. The contribution rate of Liaoning Province is basically the same as the national level. According to the actual development of higher education in Bohai Rim region of Chinai, the countermeasures and suggestions on how to enhance the contribution rate of higher education to economic growth are put forward.

Keywords: Bohai Rim region; higher education; economic growth; contribution rate

1. Introduction

Compared with the traditional resource-based economic society, in the modern knowledge-based economic society, economic growth no longer only depends on basic production factors such as capital and labor force, but also needs modern production factors such as knowledge and technological innovation. The key factor determining the imbalance of regional economic development is no longer the natural endowment, but the application of knowledge and innovation ability. Therefore, the development level of regional higher education has a great impact on the level of regional economic development. What is the contribution rate of regional higher education to economic growth? Is there any difference in the contribution of regional higher education to economic growth among regions? Those have become an urgent problem for us to solve.

Scholars at home and abroad have done a lot of empirical research on measuring the contribution rate of education to economic growth. The main research methods used are the remainder analysis method, the growth factor analysis and labor simplification method, among which the growth factor analysis of Denison is the mainstream [1]. Based on the endogenous economic theory, Dennison put forward a method to calculate the contribution rate of education to economic growth, and used this method to calculate that the contribution rate of education to economic growth in the United States was 20% in 1922-1957 [1]. Madison used this method to estimate the contribution of higher education to the average economic growth rate of the six western countries from 1913 to 1984 [2]. Cui Yuping calculated the contribution rate of higher education to economic growth in China from 1982 to 1990 [3]. Cai Wenbo and Wang Bangquan calculated the contribution rate of higher education to economic growth in 12 western provinces of China [4]. Lin Fengli calculated the contribution rate of higher education to economic growth in Jilin Province from 2000 to 2012 [5]. Yang Tianping and Liu Zhaoxin calculated the contribution rate of higher education in China from 2001 to 2011 was 3.62% [6]. Tian Yuan obtained the contribution rate of higher education to economic growth in Shandong Province from 1990 to 2010 was 0.62% [7]. In addition, some scholars had explored different measurement methods. Using the input-output method, Cheng Tao made an empirical analysis of the impact of the expansion of higher education enrollment on economic growth in Inner Mongolia [8]. Zhu Yingchun calculated the contribution rate of Chinese higher education to economic growth based on the panel data of 31 provinces from 1996 to 2006 [9]; Guo Lin empirically analyzed the impact of higher education on economic growth in Beijing from the perspective of total factor productivity [10]; Zhu Xiaodong and others examined the difference of contribution of higher education to economic growth from the perspective of elasticity of human capital output [11].

The Bohai Rim region has become the third pole of China's economic growth after the Pearl River Delta and the Yangtze River Delta. It includes Tianjin, Hebei Province, Liaoning Province and Shandong Province. It is

an important political, economic, cultural and international communication center in northern China. As an important force to promote regional, economic and social development, the higher education in Bohai rim Region has developed rapidly. According to statistics, in 2018, there are 436 ordinary colleges and universities in the Bohai Rim region, accounting for 14.75% of the total number of colleges and universities in China [12]. However, what is the contribution rate of higher education resources to regional economy in the Bohai Rim region? How can we increase the contribution rate of higher education to regional economy under the coordinated development strategy of the Bohai Rim region?No special research has been carried out by scholars. Based on the existing research results of the contribution rate of higher education to regional economy, this paper made an empirical study on the contribution rate of higher education to economic growth in the Bohai Rim region from 2005 to 2017.Therefore, suggestions can be made to improve the contribution rate of higher education to regional economy under the coordinated development strategy of the Bohai Rim region.

2. Research Methods

2.1. The Calculation Model of the Contribution Rate of Higher Education to Economic Growth

The C-D production function model was proposed by the mathematician Cobb and the economist Douglas [13]. Based on C-D production function, the method of calculating the contribution rate of higher education to economic growth was constructed in this paper. The expression of C-D production function is as follows:

$$Y=AK^{\alpha}L^{\beta} \tag{1}$$

In formula (1),Y is the output level, A is the technical level, K is the capital input level, L is the labor input level, α is the elasticity coefficient of capital output, and β is the elasticity coefficient of labor output. In order to reflect the role of education, the labor input level (L) is replaced by the product of the base period labor input (L_0) and education input (E_0). Then taking logarithm on both sides of the formula to find the derivative, we can get:

$$y=c+\alpha k+\beta l_0+\beta e_0 \tag{2}$$

In formula (2), y is the average annual growth rate of economy, c, k, l_0 and e_0 are the average annual growth rates of technological progress, capital investment, labor investment and education investment, respectively. Therefore, the contribution rate of education to economic growth is:

$$R_e = \frac{\beta e_0}{y} \tag{3}$$

In formula (3), β is the coefficient of labor input growth rate. According to the existing research, β is 0.73

[14]. $E_0(e_0)$ is the growth rate of education investment, which often uses other indicators for alternative calculation. In the calculation of the growth rate of education investment, the growth rate of education composite index (E) replaces e_0 for calculation in this paper.

$$R_e = \frac{0.73 \times E}{y} \tag{4}$$

2.2. Calculation of the Growth Rate of the Education Comprehensive Index (E)

The education comprehensive index reflects the education level of the employees in a certain year and a certain region. The calculation formula is as follows:

$$E = \sum L_i S_i \tag{5}$$

In formula (5), L_i is the labor simplification index of the i-th education level. Based on the existing research, the labor simplification indexes of primary school, junior middle school, senior middle school and junior college are 1.0, 1.2, 1.4 and 2.0 respectively in this paper. S_i is the average education years of employees, which is calculated by using the percentage data of education level distribution of the employees.

$$S_i = N_i \sum X_i \tag{6}$$

In formula (6), N_i is the education years of all levels, X_i is the percentage of the education level distribution.

According to formula (5) and (6), the comprehensive index of education per capita in any year can be calculated, and the average annual growth rate of the education comprehensive index (E) in a region can be obtained by using the geometric average method. In order to calculate the contribution rate of higher education to economic growth, the proportion of higher education in the average annual growth rate of the education comprehensive index needs to be calculated.

$$E_h = \frac{E - E_1}{E} \tag{7}$$

In formula (7), E_1 is the average annual growth rate of the comprehensive index of education excluding higher education.

3. Empirical Analysis

In this study, based on the statistical data of 2005 and 2017, the contribution rate of higher education to economic growth in Bohai rim region was calculated .The education level distribution of employees came from China's Labor Statistics Yearbook in 2006 and 2018, and the data of economic output value came from China's statistics yearbook. The results are shown in Table 1 and Table 2.

Table 1. Distribution percentage of education level of employees in China and Bohai rim region in 2005 and 2017

Province	Year	Uneducated	primary school	Junior middle school	Senior middle school	Junior college	Bachelor degree	Postgraduate diploma
China	2005	7.8	29.2	44.1	12.1	4.5	2.1	0.2
	2017	2.3	16.9	43.4	18.0	10.6	8.0	0.8
Hebei	2005	3.5	24.7	54.5	11.8	3.7	1.7	0.1
	2017	0.9	12.3	49.8	19.5	10.8	6.2	0.5
Tianjin	2005	1.6	15.6	45.1	22.9	8.3	6.0	0.5
	2017	0.4	7.1	34.4	22.2	14.9	18.7	2.3
Liaoning	2005	1.5	22.5	53.2	13.0	6.3	3.3	0.2
	2017	0.4	11.2	51.3	15.0	11.3	9.9	0.9
Shandong	2005	8.4	25.4	49.3	11.8	3.4	1.6	0.1
	2017	2.4	14.3	46.5	19.6	9.7	6.6	0.6

Table 2. The GDP of China and Bohai rim region in 2005 and 2017 (100 million RMB)

year	China	Hebei	Tianjin	Liaoning	Shandong
2005	183867.9	10012.0	3905.0	8047.0	18366.0
2017	496200.2	34016.0	18549.0	23409.0	72634.0

3.1. The Average Education Years of Employees in Bohai Rim Region

In order to calculate the average education years of employees in the Bohai Rim region, this study defines the education years of primary school, junior middle school, senior middle school, junior college, undergraduate and graduate students as 6, 3, 3, 3, 4 and 3 years. Using the statistical results in Table 1,1the average education years of employees are calculated according to formula (6), and the results are shown in Table 3.As can be seen from Table 3, except for Shandong Province, the average years of education and education level of the employees in other areas around Bohai Sea are higher than the national average, and the level of Tianjin is the highest. It shows that there are a certain amount of excellent talents gathered in the area around Bohai Sea, and the quality of human resources is good, which can play a supporting role in the development of regional economy.

Table 3. The average education years of employees in China and Bohai Rim in 2005 and 2017

Province	Year	Primary school	Junior middle school	Senior middle school	Junior college	Bachelor degree	Postgraduate diploma	The average education years
China	2005	5.53	1.89	0.57	0.20	0.09	0.01	8.29
	2017	5.86	2.42	1.12	0.58	0.35	0.02	10.35
Hebei	2005	5.79	2.15	0.52	0.12	0.07	0.00	8.65
	2017	5.95	2.60	1.11	0.53	0.27	0.02	10.48
Tianjin	2005	5.90	2.48	1.13	0.44	0.26	0.02	10.23
	2017	5.98	2.78	1.74	1.08	0.84	0.07	12.49
Liaoning	2005	5.91	2.28	0.68	0.29	0.14	0.01	9.31
	2017	5.98	2.65	1.11	0.66	0.43	0.03	10.86
Shandong	2005	5.50	1.99	0.51	0.15	0.07	0.00	8.22
	2017	5.86	2.49	1.10	0.51	0.29	0.02	10.27

3.2. Growth Rate of Education Comprehensive Index (E) in Bohai Rim Region

According to formula (5), the education comprehensive index (E) of the national and Bohai Rim employment in 2005 and 2017 were calculated respectively, and the results are shown in Table 4. Furthermore, the geometric average method was used to calculate the average annual growth rate (E) of the comprehensive index of education in China and Bohai Rim region and the average annual growth rate (E_1) of the comprehensive index of education excluding higher education. According to the formula (7), the proportion of the average annual growth rate of higher education in the comprehensive index of education (E_h) was calculated. The results are shown in Table 5.

As can be seen from Table 5, the proportions of higher education in Hebei Province, Tianjin and Liaoning Province to the average annual growth rate of the education comprehensive index are higher than the national average level, which shows that higher education of these three regions has a greater impact on the average annual growth rate of the education comprehensive index. The development of higher education in Tianjin and Liaoning Province is more prominent than that in other two places. The development of higher education in Hebei Province is slightly higher than the national level, while the development of higher education in Shandong Province is relatively backward compared with the national level.

Table 4. The education comprehensive index of China and Bohai Rim employment in 2005 and 2017

Year	China	Hebei	Tianjin	Liaoning	Shandong
2005	9.20	9.48	12.90	10.48	9.04
2017	12.23	12.26	15.73	12.35	12.03

Table 5. The growth rate of the education comprehensive index in China and Bohai Rim region from 2005 to 2017(%)

Index	China	Hebei	Tianjin	Liaoning	Shandong
the average annual growth rate of education comprehensive index	2.40	2.17	2.35	1.38	2.41
the average annual growth rate of education comprehensive index excluding higher education	1.54	1.30	0.98	0.43	1.59
the proportion of higher education in the average annual growth rate of the education comprehensive index	35.83	40.09	58.30	68.84	34.02

3.3. The Contribution Rate of Higher Education to Economic Growth

According to the statistical data in Table 2, the contribution rate of education to economic growth in China and Bohai Rim region were calculated by formula (4). At the same time, using the calculated proportion of higher education in the annual growth rate of the education comprehensive index, the contribution rate of higher education to economic growth of China and Bohai Rim region were calculated. The calculation results are shown in Figure 1.

From Figure 1, the contribution rate of higher education in Tianjin to economic growth is higher, more than twice the average level in China, but the contribution rate of higher education in Hebei Province and Shandong province lags behind the average level in China. The contribution rate of higher education to economic growth in Liaoning Province is basically the same as the average level in China. This shows that the balance of the higher education development in Bohai Rim region is poor. The contribution of higher education in Tianjin to economy growth has reached a higher level, but the higher education in Shandong Province, Hebei Province and Liaoning Province still needs further development.
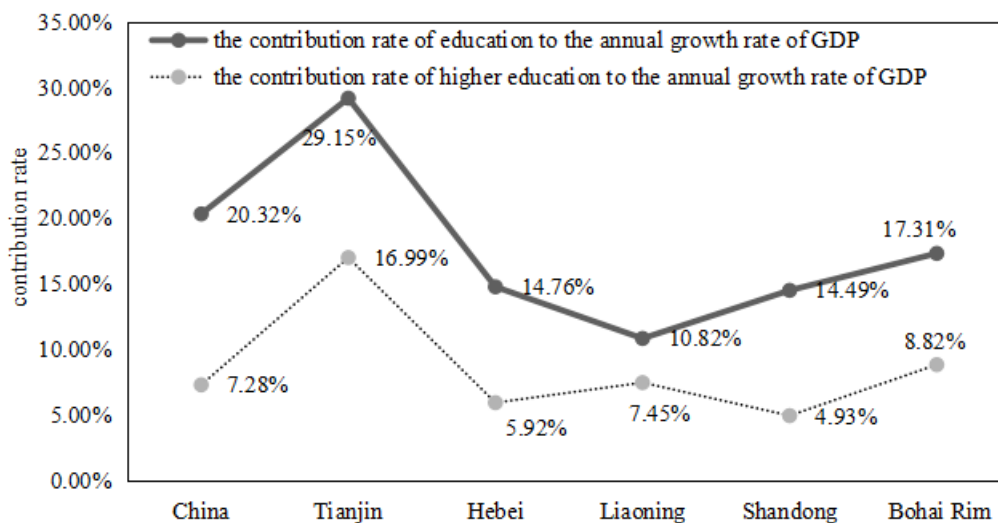

Figure 1. The contribution rate of education and higher education to economic growth in China and Bohai Rim region

4. Conclusions and Suggestions

In this study, combined with the education and economic related statistical data of the Bohai Rim region in 2005 and 2017, the contribution rate of higher education to economic growth in the Bohai Rim region was calculated by the improved C-D production function. The study found that the contribution rate of higher education to economic growth in the Bohai Rim region is 8.82%, which is higher than the average level in China, but the balance of higher education development in the Bohai Rim region is poor. Among them, the contribution rate of higher education in Tianjin to economic growth is higher, reaching 16.99%, which is far higher than the average level in China; the next is Liaoning Province, whose contribution rate of higher education to economic growth is 7.45%, slightly higher than the average level in China; the contribution rate of higher education in Hebei Province and Shandong Province is relatively low, only 5.92% and 4.93% respectively, which are lower than the average level in China. The higher education in these two areas needs rapid development.

In view of the current situation of the development of higher education in Bohai Rim region, the following suggestions are put forward:

Promoting the coordinated development of higher education in Bohai Rim region. Under the background of

building Bohai economic circle, in order to improve the development level of higher education in Bohai Rim region, promote the role of higher education in economic growth, and realize the balanced development of regional economy and higher education, we need to constantly balance the higher education resources in the Bohai Rim region through policy coordination, inter university cooperation and resource sharing, so as to narrow the gap between other regions and Tianjin in higher education , and realize the overall improvement of higher education in Bohai Rim region.

According to the actual situation of different regions, the differentiated policy measures should be taken. For Hebei Province, Shandong Province and Liaoning Province, where the contribution rate of higher education to economic development is relatively low, it is the key to vigorously develop higher education, actively promote the effective combination of higher education and vocational needs and strengthen the use of higher education for innovative personnel training. And accelerate the interaction between higher education and economy. At the same time, local governments need to establish a good talent mechanism, improve the economic and social environment, so as to attract and retain talents. For Tianjin, where the higher education contributes more to economic development, it is the key to speed up the pace of industrial structure modernization and enhance the ability of independent innovation and transformation of sci-technological achievements. At the same time, the higher education should be based on serving the society, vigorously developing innovative technology, striving to achieve the promotion of scientific and technological achievements, enhancing social production capacity, and promoting the sustainable development of social economy.

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