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Research on the Relationship between Higher Educational Investment and Economic Growth in Hebei Province based on the Comparative Analysis of Beijing-Tianjin-Hebei

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Abstract. Firstly, the paper analyzes the expenditures of higher education and regional GDP in Beijing, Tianjin and Hebei from 1999 to 2016, and concludes that the educational expenditures of ordinary colleges and universities have a positive impact on the regional GDP. But in Hebei Province, the impact on the regional GDP is less effective than that in Beijing and Tianjin. Then a comparative analysis on the development level of higher education in Beijing, Tianjin and Hebei shows that Hebei is obviously behind Beijing and Tianjin. Finally, the paper gives some suggestions, such as continuing increasing investment in higher education in Hebei Province, improving the quality of higher education and achieving connotative development.

Keywords: Higher education, economic growth, connotative development, Beijing-Tianjin-Hebei Collaboration.

1. Introduction

As early as the 1950s, Schultz first proposed the theory of human capital. Human capital has a greater impact than physical capital on economic growth. Lots of scholars have studied the relationship between higher education and economic growth for many years [1].

In 2014, the coordinated development of Beijing-Tianjin-Hebei was officially incorporated into the national strategic level. As an important part, the economic and social development of Hebei lags behind Beijing and Tianjin. With large population and education, Hebei Province should develop higher education and provide impetus for economic growth. This paper analyses the relationship between higher education investment and economic growth in the three places.

2. Theoretical Basis and Model Construction

In the study of the relationship between input and output, the "Cobb-Douglas production function" is widely used.

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

Y is industrial output. A is comprehensive technical level. L is labor input. K is capital input [2].

Later, Barro extended the Cobb-Douglas production function and introduced government consumption (G) into the Cobb-Douglas function:

$$Y=AK^{\alpha}L^{\beta}G^{\gamma}$$

The educational expenditures of ordinary colleges and universities is part of government consumption. The paper replaces government consumption (G) with educational expenditures of ordinary colleges and universities(E) [3], and forms the following model:

$$Y=AK^{\alpha}L^{\beta}E^{\gamma}$$

3. Analysis of the Relationship between Higher Education and Economic Growth in Beijing, Tianjin and Hebei

3.1 Variable Selection and Data Source

This paper uses regional GDP to represent economic development(Y). The capital input is expressed by total social fixed assets investment (K). The labor input is expressed by employment (L). The educational investment is expressed by the expenditure on education in colleges and universities (E). Since 1999, colleges and universities have expanded the enrollment scale. Higher education has become more popular, and the influence has expanded. Considering the availability of statistical data, this paper analyzes the time series data from 1999 to 2016 in Beijing, Tianjin and Hebei. The original data of this paper is from the "China Statistical Yearbook" and the "China Education Funding Statistical Yearbook" from 1999 to 2016. Besides, the "China Education Funding Statistical Yearbook" from 1999 to 2002 does not directly provide data on the expenditures of education in ordinary colleges and universities. This paper adds the expenditures on higher education in the central and local government instead.

In order to eliminate the influence of heteroscedasticity as much as possible, the paper logarithms the four variables. And they are respectively expressed by LnY, LnK, LnL, and LnE.

LnY represents the growth rate of GDP. LnK represents the growth rate of fixed asset investment in the whole society. LnE represents the growth rate of labor input. LnE represents the growth rate of educational expenditures of ordinary colleges and universities. α, β, and γ are the regression coefficients of the variables, which indicate the proportion of changes in output caused by the 1% change of the fixed assets investment, labor input and the educational expenditures of ordinary colleges and universities.

3.2 Unit Root Test

Regression analysis is based on the stability of time series. In this paper, the stability of the four sequences are tested by ADF unit root test.

It can be seen from Table 1 that the LnY, LnK, LnL and LnE of the three places are unstable. After the first-order difference of data of Beijing, the absolute value of ADF is greater than the absolute value of the critical value of 10%. Therefore, the four variables are stable after the first-order difference. In Hebei and Tianjin, the four variables are stable after the second-order difference.

Table 1. Results of ADF unit root test

Region	Variable	ADF-Value	Test Regression (c, t, k)	10% Critical Value	Stability
Beijing	LnY	-4.068208	(c, t, 1)	-3.324976	Stable
	LnK	-6.588434	(c, t, 1)	-3.324976	Stable
	LnL	-4.003807	(c, t, 1)	-3.310349	Stable
	LnE	-4.430824	(c, t, 1)	-3.310349	Stable
Tianjin	LnY	-4.208145	(c, t, 2)	-2.690439	Stable
	LnK	-3.453328	(c, t, 2)	-2.68133	Stable
	LnL	-5.411103	(c, t, 2)	-3.324976	Stable
	LnE	-3.311735	(c, t, 2)	-2.673459	Stable
Hebei	LnY	-4.447462	(c, t, 2)	-1.604392	Stable
	LnK	-4.66051	(c, t, 2)	-3.342253	Stable
	LnL	-3.96235	(c, t, 2)	-1.605026	Stable
	LnE	-1.605603	(c, t, 2)	-2.059301	Stable

3.3 Cointegration Test

This paper uses the Johansen test. It can be seen from Table 2 that there is a cointegration relationship among the four variables in the three places at the 5% significance level. Thus, there is a long-term stable equilibrium relationship.

Table 2. Results of cointegration test

Region	Eigenvalue	Trace Statistic	5% Critical Value	Null Hypothesis
Beijing	0.896103	69.93799	47.85613	None*
	0.735044	33.70837	29.79707	Atmost1*
	0.436336	12.45729	15.49471	At most 2
	0.185584	3.284550	3.841466	At most 3
Tianjin	0.838438	72.29583	47.85613	None*
	0.757584	43.12998	29.79707	Atmost1*
	0.579200	20.45639	15.49471	At most 2 *
	0.338290	6.606842	3.841466	At most 3 *
Hebei	0.860016	79.26798	47.85613	None*
	0.762078	47.80837	29.79707	Atmost1*
	0.658676	24.83540	15.49471	At most 2 *
	0.379537	7.636635	3.841466	At most 3 *

3.4 Initial Regression of the Model

From the results of unit root test and cointegration test, it can be seen that the four variables of Beijing, Tianjin and Hebei are all single-order sequences of the same order, and have a long-term stable relationship. Therefore, ordinary least squares estimation (OLS) is performed on LnY, LnK, LnL, and LnE of the three places, respectively. The estimation equations for Beijing, Tianjin and Hebei are:

Beijing:

$$LNY = 0.323273260413*LNE + 0.628427427542*LNK + 0.421337005326*LNL + 5.6470959897$$
$$(3.045132) \quad (5.405204) \quad (2.163777) \quad (7.826912)$$
$$R^2=0.997784 \quad \bar{R}^2=0.997309 \quad F=2101.264$$

According to the preliminary regression results, the value of R^2 is 0.998, indicating that the regression model of Beijing is good. When the significance level is 0.05 degrees of freedom, the critical value of the t-statistic is 2.16. The t-statistic of each explanatory variable is greater than the critical value. So, the significance test is passed. When the significance level is 0.05, the test value of F-statistic is 3.41. So, the F-statistic test of the model passes, and the overall regression equation is significant. The correlation coefficients of the three variables LnK, LnL and LnE are positive values, indicating that the fixed assets investment, the labor input and the educational expenditures of ordinary colleges and universities have contributed to the regional GDP.

Tianjin:

$$LNY=0.255333977811*LNE+0.574894503745*LNK+0.0554801404187*LNL+9.50209165975$$
$$(2.430431) \quad (7.113901) \quad (0.405322) \quad (8.958018)$$
$$R^2=0.995794 \quad \bar{R}^2=0.994893 \quad F=1104.981$$

Hebei:

$$LNY = 0.217847063562*LNE + 0.495231304962*LNK - 0.204383092006*LNL + 12.5778392255$$
$$(4.035316) \quad (10.65990) \quad (-1.365857) \quad (11.53929)$$
$$R^2=0.996268 \quad \bar{R}^2=0.995468 \quad F=1245.718$$

According to the preliminary regression results, the values of R^2 in Tianjin and Hebei are both above 0.99, indicating that the regression models of Tianjin and Hebei are good. The t- statistic of LnL of both places is less than the critical value. The significance test is not passed. The F-statistic test of the regression model of the two places passes. The significance test of the variables and the

overall regression equation show the opposite results. In addition, the correlation coefficient of LnL in Hebei is negative, which is contrary to the theoretical assumptions. Therefore, there may be multicollinearity among the variables in Tianjin and Hebei.

3.5 Multicollinearity Test and Correction

From the results of correlation coefficient test in Tianjin (Table 3), the simple correlation coefficient between the variables of Tianjin is higher than 0.8, and the model has severe multicollinearity. According to results of the correlation coefficient test in Hebei, the correlation coefficient between LnE and LnK is higher than 0.95, and the model also has multicollinearity.

Table 3. Results of correlation coefficient test

Tianjin	LNE	LNK	LNL
LNE	1	0.984746	0.8026869
LNK	0.984746	1	0.8234887
LNL	0.8026869	0.8234887	1
Hebei	LNE	LNL	LNK
LNE	1	0.5304885	0.9589638
LNL	0.5304885	1	0.6527955
LNK	0.9589638	0.6527955	1

In this paper, the stepwise regression method is used to modify the multicollinearity of the model. After correction, the LnL was removed. The regression results of Tianjin and Hebei models are as follows:

Tianjin:

$$LNY = 0.251779394948*LNE + 0.585325310377*LNK + 9.76781183303$$
$$(2.474922) \quad (7.862924) \quad (12.05410)$$
$$R^2=0.995745 \quad \bar{R}^2=0.995178 \quad F=1755.178$$

Hebei:

$$LNY = 0.250639107719*LNE + 0.457193352824*LNK + 11.174278387$$
$$(5.040171) \quad (11.95506) \quad (29.89050)$$
$$R^2=0.995770 \quad \bar{R}^2=0.995207 \quad F=1765.753$$

It can be seen that the values of R^2 in both Tianjin and Hebei are above 0.99, indicating that the regression models of Tianjin and Hebei have good fit. All variables pass the t-statistic test, and the effect is significant. The value of F-statistic is higher than the critical value and the overall regression equation is also significant. The total social fixed assets investment and the educational expenditures of higher education in Tianjin and Hebei have a positive impact on the regional GDP.

3.6 Granger Causality Test

The Granger causality test is used to test whether the previous information of one variable affects the current information of another variable. The lag orders selected in this paper are 1, 2, 3, and 4. According to Granger causality test results (Table 4), when the lag order is 1 and the significance level is 10%, LnE of Beijing, Tianjin and Hebei is not the Granger cause of LnY. LnY of Beijing and Hebei is the Granger cause of LnE. When the lag order is 2, the LnE of Beijing, Tianjin and Hebei is not the Granger cause of LnY. And LnY is the Granger cause of LnE. When the lag order is 3, LnE in Beijing is not the Granger cause of LnY, and LnY is the Granger cause of LnE. LnY and LnE in Tianjin and Hebei are not the other Granger cause. When the lag order is 4, LnE in Beijing is the Granger cause of LnY. LnY is not the Granger cause of LnE. LnY and LnE in Tianjin and Hebei are not the other Granger cause.

Due to the limited data, the Granger test in this paper only lags behind four periods. The impact of higher education on economic growth is lagging behind. Beijing has concentrated many excellent institutions, which is sufficient in resources for higher education, sufficient funds, and rapid

transformation of scientific and technological achievements. In the fourth period of lag, the expenditure on education in higher education shows influences on the GDP of the region. Tianjin and Hebei have not yet shown the impact.

Table 4. Results of Granger causality test

Region: Beijing		
Null Hypothesis	Lag Order	P-Value
LNE does not Granger Cause LNY	1	0.3302
LNY does not Granger Cause LNE	1	0.0078
LNE does not Granger Cause LNY	2	0.203
LNY does not Granger Cause LNE	2	0.0837
LNE does not Granger Cause LNY	3	0.4942
LNY does not Granger Cause LNE	3	0.0892
LNE does not Granger Cause LNY	4	0.0923
LNY does not Granger Cause LNE	4	0.1885
Region: Tianjin		
LNE does not Granger Cause LNY	1	0.1525
LNY does not Granger Cause LNE	1	0.1944
LNE does not Granger Cause LNY	2	0.681
LNY does not Granger Cause LNE	2	0.0976
LNE does not Granger Cause LNY	3	0.6712
LNY does not Granger Cause LNE	3	0.2199
LNE does not Granger Cause LNY	4	0.6194
LNY does not Granger Cause LNE	4	0.3409
Region: Hebei		
LNE does not Granger Cause LNY	1	0.2376
LNY does not Granger Cause LNE	1	0.0712
LNE does not Granger Cause LNY	2	0.4143
LNY does not Granger Cause LNE	2	0.0316
LNE does not Granger Cause LNY	3	0.6201
LNY does not Granger Cause LNE	3	0.1711
LNE does not Granger Cause LNY	4	0.7751
LNY does not Granger Cause LNE	4	0.1019

3.7 Conclusion

According to the estimation equation, the long-term elasticity of LnE to LnY in Beijing is 0.323. From 1999 to 2016, for every 1 percentage point increase of educational expenditures of ordinary colleges and universities in Beijing, the regional GDP will increase by 0.323 percentage points. The long-term flexibility of LnE to LnY in Tianjin is 0.252. For every 1 percentage point increase of educational expenditures of ordinary colleges and universities in Tianjin, the regional GDP will increase by 0.252 percentage points. The long-term elasticity of LnE to LnY in Hebei is 0.251. For every 1 percentage point increase of educational expenditures of ordinary colleges and universities in Hebei, the regional GDP will increase by 0.251percentage points.

4. Comparative Analysis of Development Status of Higher Education in Beijing, Tianjin and Hebei

From the results of empirical analysis, it can be seen that the educational expenditures of colleges and universities in Beijing, Tianjin and Hebei have a positive impact on the regional GDP. Among them, the positive impact in Beijing and Tianjin is stronger than that in Hebei. This paper selects the

number and level of ordinary colleges and universities, the number of students and the level of higher education, the number and the level of full-time teachers, as indicators to measure the level of higher education [4] and compare the development status of higher education in the three places. Try to find out why the impact of Hebei's higher education on economic growth is weaker than that of Beijing and Tianjin.

4.1 Number and Level of Ordinary Colleges and Universities

Judging from the number of ordinary colleges and universities (Fig. 1), there are 91 colleges and universities in Beijing, including 66 undergraduate colleges and 25 higher vocational colleges. There are 55 colleges and universities in Tianjin, including 30 undergraduate colleges and 25 higher vocational colleges. The number of higher vocational colleges is the same as that of Beijing. There are 120 colleges and universities in Hebei Province, including 61 undergraduate colleges and 59 higher vocational colleges. The number of higher vocational colleges is the highest among the three places.

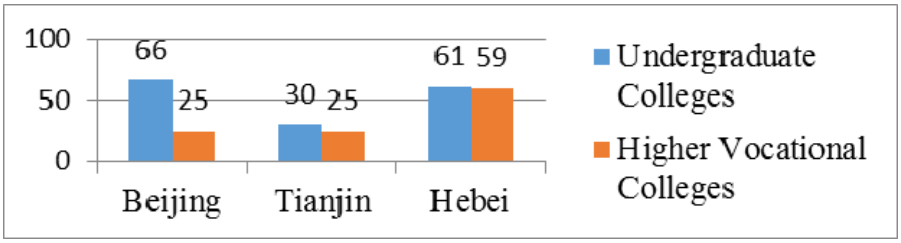

Fig. 1 Number of ordinary colleges and universities

In terms of the level of ordinary higher education (Table 5), Beijing has eight “985” engineering colleges, accounting for 20.5% of the thirty-nine “985” engineering colleges in the country. Compared with Tianjin and Hebei, the amount is the largest. There are two in Tianjin. Hebei Province does not have a “985” engineering school. In terms of the number of “211” engineering colleges, Beijing has 26, which is the largest. Tianjin has 3 and Hebei has only one. In 2017, the list of “double-class” colleges and universities were finalized. In terms of the number of first-class university building colleges, Beijing has the largest number of eight, and there are two in Tianjin. There are no schools in Hebei. In terms of the number of first-class disciplines building colleges, 26 colleges and universities in Beijing are selected, three universities in Tianjin are selected, and only one in Hebei. It can be seen that the higher education institutions in Hebei Province are lower in level and lack of key universities. There is a big gap among Beijing, Tianjin and Hebei.

Table 5. Number of key universities and colleges

	“985” Engineering College	“211” Engineering College	First-class University Building College	First-class Discipline Construction College
Beijing	8	26	8	26
Tianjin	2	3	2	3
Hebei	0	1	0	1

4.2 Number of Students and the Level of Higher Education

In terms of the number of students in colleges and universities, due to the different population bases of the Beijing-Tianjin-Hebei region, this paper does not compare the absolute number of students, but uses the average number of students in higher education per 100,000 people to compare and analyze. In 2016, the average number of students in higher education per 100,000 people in Beijing was 5,028, ranking first, about 2.5 times that of Hebei Province. The number of Tianjin was 4,058, ranking second, about twice that of Hebei Province. The number of Hebei was the lowest, only 2,191. It can be seen that the number of people receiving higher education in Hebei is small and the proportion in the total population is low.

In Hebei, the number of students enrolled in colleges and universities, the number of students in school, estimated number of graduates, and the number of graduate students are always the largest. Beijing is the second, and Tianjin is the third.

In terms of the number of graduate students enrolled in colleges and universities, Hebei is the smallest and Beijing is the largest. It is nearly 9 times that of Hebei Province. Tianjin ranks second, which is 1.5 times that of Hebei. Considering that the population of Beijing and Tianjin is much smaller than that of Hebei, it can be seen that Hebei has a low level of academic education.

From the analysis of the differences in postgraduate education, the number of all indicators in Beijing is the largest. Tianjin ranks the second and Hebei is the third. In terms of the number of doctoral students (Table 6), the number of doctoral students enrolled in Beijing was 20,793 and the number of graduate students was 30,366 in 2016, while the number of doctoral students enrolled in Hebei was 654 and the number of graduate students was 424. The gap is very large. It can be seen from the above analysis that graduate education in Hebei Province is lagging behind and doctoral education is seriously inadequate.

Table 6. Doctoral students in colleges and universities

	Beijing	Tianjin	Hebei
Enrollment Number	20793	2193	654
Number Of Students In School	88360	9052	2893
Number Of Graduates	15738	1685	424
Estimated Number Of Graduates	36366	3882	1636

4.3 Number and Level of Full-Time Teachers in Ordinary Colleges and Universities

In terms of the number of full-time teachers in colleges and universities, Hebei has the largest number of 70,400 people, followed by Beijing with 70,000 people. Tianjin has the least number of only 30,600. It is due to the number of colleges and universities in the three places.

In terms of the level of the faculty (Table 7), Beijing ranks first in the number of senior and deputy senior full-time teachers. Hebei ranks second and Tianjin is the third. Among them, the number of full-time teachers in Beijing with senior titles is about twice that of Hebei. Hebei has the largest number of intermediate professional full-time and non-professional full-time teachers, followed by Beijing and Tianjin. In terms of the number of junior full-time teachers, Hebei is the first. Tianjin is the second and Beijing is the third. It reflects the high level of Beijing's full-time teachers and the structure of the faculty has great advantages. Due to the small scale of colleges and universities in Tianjin, the number of full-time teachers at all levels is relatively small. But it can still be seen that the teachers are relatively powerful. Hebei has more teachers with intermediate, junior and untitled titles than Beijing and Tianjin. There are fewer teachers with senior titles. It can be seen that the level of full-time teachers in Hebei is generally low.

Table 7. Distribution of teachers' titles in colleges and universities

	Beijing	Tianjin	Hebei
Senior Title	19900	4700	10000
Deputy Senior Title	24200	9800	21300
Intermediate Title	21800	12200	28300
Junior Title	2400	2500	7300
No Title	1600	1300	3500

5. Summary

It can be seen from the above analysis that there is a clear gap of higher education in Hebei, Beijing and Tianjin. The level of Beijing's higher education is high and large, followed by Tianjin. Hebei's higher education is large but not powerful. To some extent, it explains why Hebei's higher education

has weaker impact on economic growth. Economic development requires not only the amount of higher education, but also the quality of higher education. Therefore, continue increasing government spending, expand the sources of funding for higher education and establish diversified investment channels [5]. Besides, improve the quality of higher education and achieve connotative development, including planning the construction of colleges and universities and strengthen the construction of the full-time teachers.

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