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Research on the Impact of Educational Investment on Regional Economic Growth

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Abstract

This paper aims to explore the impact of educational investment on regional economic growth. By applying econometric models and regression analysis methods, an in-depth analysis was conducted on the relationship between educational investment and economic growth in different regions. The research results show that the investment in education funds has a significant impact on regional economic growth, but this impact varies among different regions and at different levels of economic development. In addition, the investment in education funds affects regional economic growth in other forms through mediating effects. In the short term, it will lead to a slowdown in economic growth, but in the long term, it has a profound impact on economic growth. Moreover, this influence varies in different regions and at different levels of economic development. Therefore, the government should increase its investment in education, especially in backward areas, to promote balanced regional economic development.

Keywords

Educational Investment; Regional Economic Growth; Heterogeneity Analysis; Hausmann test; Fixed effect

1. Introduction

With the advent of the knowledge economy era, the role of education in regional economic development has become increasingly prominent. Educational investment, as an important means to enhance human capital and promote scientific and technological innovation, has received widespread attention for its contribution to regional economic growth. However, there is still controversy in the academic circle regarding the specific relationship between educational investment and regional economic growth. This article aims to review relevant literature to gain a deeper understanding of the impact of educational investment on regional economic growth.

2. Literature Review

2.1. New Economic Theory and Educational Investment

The new economic growth theory holds that the source of economic growth does not only come from the increase in the quantity of factors such as capital and labor, but also from the improvement in quality. Education, as an important means to enhance human capital, especially with the improvement of people's educational attainment, the impact of higher education on economic growth has drawn much attention.

2.2. Gross domestic Product

GDP, the full name of which is Gross Domestic Product, is the total market value of all final goods and services produced by residents and enterprises in a country or region over a period of time. Nowadays, GDP, as one of the main indicators for measuring a country's economic scale, has become a very intuitive and important indicator in global economic measurement and evaluation. As the world's second-largest economy, China's economic development holds significant reference value internationally. As a widely used indicator to measure the economic development of a region, China also uses GDP to measure the development of a region. Due to China's large area, wide span and diverse topography and landforms, there are significant regional differences in economic development among different regions of our country. [2]

This article collected data from 31 provinces in China (excluding Hong Kong, Macao and Taiwan) during the five years from 2017 to 2021. The main explanatory variable was regional GDP, and the main explanatory variable was local education expenditure. Other control variables were: the number of approved patents, the population at the end of the year, local general public budget expenditure, and the total amount of foreign investment. The data is sourced from the statistical yearbooks of various provinces from 2018 to 2022. The GDP of each province in China during these five years was analyzed using Stata software. Descriptive statistical analysis, correlation analysis, regression analysis and some tests were conducted using Stata analysis software.

Table 1. Total GDP of 31 Provinces and Regions in China from 2017 to 2021 (Billions of yuan)

Serial	Region	2017	2018	2019	2020	2021
1	Beijing	28014.94	30319.98	35371.28	36102.55	40269.60
2	Tianjin	18549.19	18809.64	14104.28	14083.73	15695.00
3	Hebei	34016.32	36010.27	35104.52	36206.89	40391.30
4	Shanxi	15528.42	16818.11	17026.68	17651.93	22590.20
5	Inner Mongolia	16096.21	17289.22	17212.53	17359.82	20514.20
6	Liaoning	23409.24	25315.35	24909.45	25114.96	27584.10
7	Ji Lin	14944.53	15074.62	11726.82	12311.32	13235.50

8	Heilongjiang	15902.68	16361.62	13612.68	13698.50	14879.20
9	Shanghai	30632.99	32679.87	38155.32	38700.58	43214.90
10	Jiangsu	85869.76	92595.40	99631.52	102718.98	116364.20
11	Zhejiang	51768.26	56197.15	62351.74	64613.34	73515.80
12	Anhui	27018.00	30006.82	37113.98	38680.63	42959.20
13	Fujian	32182.09	35804.04	42395.00	43903.89	48810.40
14	Jiangxi	20006.31	21984.78	24757.50	25691.50	29619.70
15	Shandong	72634.15	76469.67	71067.53	73129.00	83095.90
16	Henan	44552.83	48055.86	54259.20	54997.07	58887.40
17	Hubei	35478.09	39366.55	45828.31	43443.46	50012.90
18	Hunan	33902.96	36425.78	39752.12	41781.49	46063.10
19	Guangdong	89705.23	97277.77	107671.07	110760.94	124369.70
20	Guangxi	18523.26	20352.51	21237.14	22156.69	24740.90
21	Hainan	4462.54	4832.05	5308.93	5532.39	6475.20
22	Chongqing	19424.73	20363.19	23605.77	25002.79	27894.00
23	Sichuan	36980.22	40678.13	46615.82	48598.76	53850.80
24	Guizhou	13540.83	14806.45	16769.34	17826.56	19586.40
25	Yunnan	16376.34	17881.12	23223.75	24521.90	27146.80
26	Xizang	1310.92	1477.63	1697.82	1902.74	2080.20
27	Shaanxi	21898.81	24438.32	25793.17	26181.86	29801.00
28	Gansu	7459.90	8246.07	8718.30	9016.70	10243.30
29	Qinghai	2624.83	2865.23	2965.95	3005.92	3346.60
30	Ningxia	3443.56	3705.18	3748.48	3920.55	4522.30
31	Xinjiang	10881.96	12199.08	13597.11	13797.58	15983.60

2.3. Research on the Impact of Educational Funding Input on Regional Economy

There are two main viewpoints in the academic circle regarding the impact of educational investment on the regional economy. One view holds that educational investment has a direct driving effect on regional economic growth by enhancing labor productivity, promoting industrial upgrading and optimizing resource allocation. Another viewpoint emphasizes the external effects of educational investment, arguing that education not only boosts personal income and social welfare but also attracts talents, promotes innovation and enhances regional competitiveness. [3]

2.4. Eastern, central and western provinces (excluding Hong Kong, Macao and Taiwan)

The eastern region includes 10 provinces (municipalities) : Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan. [4]
The central region includes six provinces: Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan.
The western region includes 12 provinces (autonomous regions and municipalities), namely Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Xizang, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang.
The Northeast region includes Liaoning, Jilin and Heilongjiang.

3. Research Design

3.1. The explained variable

The total regional development value of each province is an important indicator for evaluating the market value created by a region in the economy. It can objectively reflect the economic development level of a region. Therefore, in this paper, it is taken as the explained variable of the model and represented by GDP.

3.2. Explanatory variables

3.2.1. Local Education Expenditure(EDU)

Education has an impact on the quality of the labor force. In regions where more investment is made in education, the average quality of the labor force is higher than that in regions where less investment is made. The quality of the labor force directly affects the amount of value created by labor. Therefore, we choose local education expenditure as the explanatory variable. [5]

3.2.2. Number of patent applications granted (PAT) by domestic applicants

Technology can have a huge impact on the economic development of a region, and the number of patent applications authorized by domestic applicants in a region can reflect the development of technology and the region's emphasis on it from the side. Therefore, this indicator is selected as the main explanatory variable to measure the impact of technological development on the GDP value.

3.2.3. Annual Population size (PER)

The creation of GDP cannot do without a large amount of labor force, so areas with a higher labor force density will produce higher economic value. [6]

3.2.4. Local general public budget Expenditure (PAY)

Most of the general public budget expenditure is used for the construction of infrastructure and other facilities. Regions with a larger general public budget usually have a better economic situation. Therefore, this data is selected to describe the degree of improvement of regional infrastructure. [7]

3.2.5. Total Foreign Investment (INV)

In many regions of our country, there are a large number of foreign-funded enterprises, which can generate a lot of economic value for the regions. At the same time, foreign investors will also choose regions with better infrastructure, policies and market conditions when making investments. It can be used as a reference for analyzing the economic development situation.

4. Model design

This paper intends to use econometric models to analyze the influencing factors of regional GDP in 31 provinces of China. Set the linear model.

$$GDP_t = \beta_0 + \beta_1 + \beta_2 EDU + \beta_3 PAT + \beta_4 PER + \beta_5 PAY + \beta_6 INV + \mu_i + \varepsilon_i$$

Among them, GDP represents the regional gross domestic product (in billions of yuan), EDU represents local education expenditure (in billions of yuan),PAT represents the number of patent applications authorized by domestic applicants (in hundreds),PER represents population density (in ten thousand people),PAY represents general public budget expenditure (in billions of yuan), and INV represents the total amount of foreign investment (in billions of US dollars). [8]

5. Empirical analysis

5.1. Descriptive statistical analysis and correlation analysis

Descriptive statistics is a summary of a class of statistical methods, providing support for people to have a general understanding of data tables. Descriptive statistics can be used to obtain the statistical characteristics of the research population. Through the data of this descriptive statistics, the distribution status and development trend of the population can also be discovered, which is convenient for conducting more in-depth research. Regarding the GDP of each province from 2017 to 2021 and its influencing factors, Overall descriptive statistical analysis and correlation analysis were conducted using the Stata model. The specific results obtained are shown in Figures 1.

Variable	Obs	Mean	Std. dev.	Min	Max
gdp	155	31595.74	25727.37	1310.92	124369.7
edu	155	1333.69	907.726	84.6209	5386.956
pat	155	931.4147	1365.167	4.2	8722.09
per	155	4528.761	2993.926	349	12684
pay	155	6363.706	3350.952	1372.78	18247.01
inv	155	3555.748	5943.513	26	45272

Figure 1. Descriptive statistics

Based on the above data selection, a correlation analysis was conducted on each variable. As shown in the following figure, the impact coefficient of education on

GDP is 0.916, and there is a significant positive correlation between the number of domestic patent applications authorized and GDP, with a coefficient of 0.892. And both passed the significance test at the 1% level. In addition, regional general public budget expenditure can significantly increase the GDP level. The population size at the end of the year and foreign direct investment can also boost the GDP level, but not significantly.

	gdp	edu	pat	per	pay	inv
gdp	1.000					
edu	0.916***	1.000				
pat	0.892***	0.870***	1.000			
per	0.863***	0.872***	0.655***	1.000		
pay	0.942***	0.946***	0.829***	0.901***	1.000	
inv	0.532***	0.501***	0.614***	0.329***	0.476***	1.000

Figure 2. Correlation Analysis (a)

Source	SS	df	MS	Number of obs	=	155
				F(5, 149)	=	525.42
Model	9.6461e+10	5	1.9292e+10	Prob > F	=	0.0000
Residual	5.4710e+09	149	36718023.3	R-squared	=	0.9463
				Adj R-squared	=	0.9445
Total	1.0193e+11	154	661897694	Root MSE	=	6059.5

gdp	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
edu	-7.821121	2.043312	-3.83	0.000	-11.85873	-3.78351
pat	9.786171	.8912065	10.98	0.000	8.025136	11.54721
per	3.195562	.4440577	7.20	0.000	2.318098	4.073026
pay	3.267964	.5363416	6.09	0.000	2.208145	4.327782
inv	.1132367	.1050214	1.08	0.283	-.094287	.3207605
_cons	-2759.233	1427.22	-1.93	0.055	-5579.439	60.97201

Figure 3. Correlation Analysis (b)

5.2. Heteroscedasticity test and processing

5.2.1. Draw a scatter plot

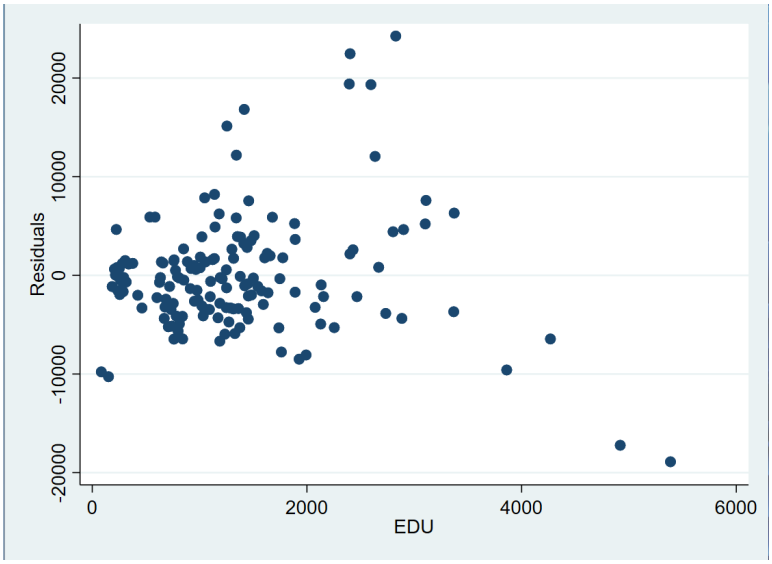

Figure 4. Scatter plot

As shown in Figure 4. above, the Y-axis represents the residuals obtained from the regression, and the X-axis represents the regional gross domestic product (GDP). It can be seen that as the value increases, the fluctuation of the residuals also begins to increase, and there may be a problem of heteroscedasticity. Therefore, heteroscedasticity tests are conducted subsequently.

5.2.2. Heteroscedasticity test

The white test is adopted to examine whether the variance of the dependent variable changes with the variation of the independent variable, that is, whether there is an autocorrelation. The test results are shown in Figure 5. as follows:

Source	chi2	df	p
Heteroskedasticity	**51.98**	**20**	**0.0001**
Skewness	**10.06**	**5**	**0.0735**
Kurtosis	**6.99**	**1**	**0.0082**
Total	**69.02**	**26**	**0.0000**

Figure 5. The result of the inspection

The results of the White test show that p is less than 0.05, significantly rejecting the null hypothesis, indicating the existence of heteroscedasticity. Therefore, heteroscedasticity will be dealt with in the subsequent steps.

5.2.3. Heteroscedasticity processing

Here, heteroscedasticity robust standard errors are adopted for processing, and the regression results are shown in Figure 6. below.

Linear regression

Number of obs	= 155
F(5, 149)	= 253.03
Prob > F	= 0.0000
R-squared	= 0.9463
Root MSE	= 6059.5

gdp	Coefficient	Robust std. err.	t	P>|t|	[95% conf.	interval]
edu	-7.821121	2.412897	-3.24	0.001	-12.58904	-3.053205
pat	9.786171	1.15704	8.46	0.000	7.499844	12.0725
per	3.195562	.3917744	8.16	0.000	2.42141	3.969713
pay	3.267964	.6047007	5.40	0.000	2.073067	4.46286
inv	.1132367	.0675661	1.68	0.096	-.0202748	.2467483
_cons	-2759.233	1301.48	-2.12	0.036	-5330.974	-187.4926

Figure 6. Regression result

It can be seen from the regression results that there is still a significant negative correlation between the core explanatory variable local education expenditure EDU and the explained variable GDP, with a coefficient of -7.821121, indicating that for each increase of one unit, GDP will decrease by 7.821121 units. In addition, there is a significant positive correlation between the number of domestic patent applications authorized, the population at the end of the year, general public budget expenditure and economic growth.

5.3. Principal regression model

At present, the main panel data regression models mainly include the following three types: random effects, fixed effects and mixed effects models. In this paper, the Hausman test is adopted, and the test result is: Prob>chi2 = 0.0000, with a p value less than 0.05. Therefore, the fixed effects model should be used for analysis.

The double fixed effects model was used to regression the above variables, and the results are shown in Table 2. below. Judging from the goodness of fit R2, its fitting value is relatively high. Model shows the regression results without adding control variables. It is not difficult to see that the increase in local education expenditure has a significant positive correlation with GDP, with a coefficient of 5.8, indicating that for every 1% increase in local education expenditure, it positively drives economic growth by 5.8%. Regression is the result of the regression after adding control variables. Both the PAT of patent application authorizations and the PAY of general public budget expenditures are significant at the 1% level, indicating that for every 1% increase in the PAT of patent application authorizations, GDP will grow by 3.93%, and for every 1% increase in general public budget expenditures, it will positively drive economic growth by 2.74%. The correlation between population density and total foreign investment is significant at the 5% level. The regression results of the correlation between population density show that for every 1% increase in popula-

tion density, GDP will increase by 4.424%, and for every 1% increase in total foreign investment, GDP will decrease by 0.086%.

Table 2. Regression result

	(1)	(2)
	gdp	gdp
edu	5.800*	-0.898
	(1.876)	(-0.639)
pat		3.930***
		(6.030)
per		4.424**
		(2.146)
pay		2.740***
		(3.628)
inv		-0.086**
		(-2.593)
_cons	23859.846***	-8032.677
	(5.684)	(-0.811)
N	155	155
R2	0.988	0.995
Adj. R2	0.985	0.993

5.4. Heterogeneity analysis

China has a vast territory, and there are significant regional differences among different regions in terms of local education expenditure, the number of patent applications authorized, and the population at the end of the year. Theoretically speaking, the impact of local education levels on GDP varies in different geographical areas, which is related to the development conditions of different regions. Therefore, this paper conducts a heterogeneity analysis based on the division of the eastern, central, western and northeastern regions by the National Bureau of Statistics of China. The regression results are shown in the following.

HDFE Linear regression
Absorbing 2 HDFE groups

Number of obs	50
F(5, 31)	39.62
Prob > F	0.0000
R-squared	0.9954
Adj R-squared	0.9927
Within R-sq.	0.7125
Root MSE	2809.7135

gdp	Coefficient	Robust std. err.	t	P>|t|	[95% conf.	interval]
edu	-2.861236	1.113093	-2.57	0.015	-5.131405	-.5910666
pat	4.680477	1.068539	4.38	0.000	2.501176	6.859777
per	15.70157	7.290185	2.15	0.039	.8331357	30.56999
pay	.7629295	1.10628	0.69	0.496	-1.493343	3.019202
inv	-.09652	.0516858	-1.87	0.071	-.201934	.008894
_cons	-46447.43	40012.85	-1.16	0.255	-128054.2	35159.31

Absorbed degrees of freedom:

Absorbed FE	Categories	- Redundant	= Num. Coefs
id	10	0	10
year	5	1	4

Figure 7. Return to the eastern region

HDFE Linear regression
Absorbing 2 HDFE groups

Number of obs	30
F(5, 15)	7.05
Prob > F	0.0014
R-squared	0.9953
Adj R-squared	0.9909
Within R-sq.	0.6580
Root MSE	1191.2754

gdp	Coefficient	Robust std. err.	t	P>|t|	[95% conf.	interval]
edu	.3233888	.5328344	0.61	0.553	-.8123209	1.459099
pat	6.926492	1.87426	3.70	0.002	2.931601	10.92138
per	16.74281	4.970557	3.37	0.004	6.148323	27.33731
pay	2.096382	1.21393	1.73	0.105	-.4910479	4.683812
inv	1.456751	.5726287	2.54	0.022	.2362218	2.67728
_cons	-89093.46	32052.81	-2.78	0.014	-157412.4	-20774.5

Absorbed degrees of freedom:

Absorbed FE	Categories	- Redundant	= Num. Coefs
id	6	0	6
year	5	1	4

Figure 8. Return to the central region

HDFE Linear regression
Absorbing 2 HDFE groups

Number of obs	60
F(5, 39)	44.36
Prob > F	0.0000
R-squared	0.9945
Adj R-squared	0.9918
Within R-sq.	0.7160
Root MSE	1099.1535

gdp	Coefficient	Robust std. err.	t	P>|t|	[95% conf.	interval]
edu	1.710982	1.839329	0.93	0.358	-2.009412	5.431376
pat	8.187446	3.057378	2.68	0.011	2.003315	14.37158
per	1.217093	11.36099	0.11	0.915	-21.76269	24.19687
pay	3.113749	.986147	3.16	0.003	1.119078	5.108419
inv	.0711172	.1507808	0.47	0.640	-.2338658	.3761002
_cons	-5827.534	33919.34	-0.17	0.864	-74435.87	62780.8

Absorbed degrees of freedom:

Absorbed FE	Categories	- Redundant	= Num. Coefs
id	12	0	12
year	5	1	4

Figure 9. Return to the western regions

HDFE Linear regression
Absorbing 2 HDFE groups

Number of obs	15
F(5, 3)	11.93
Prob > F	0.0340
R-squared	0.9974
Adj R-squared	0.9879
Within R-sq.	0.9166
Root MSE	616.8961

gdp	Coefficient	Robust std. err.	t	P>|t|	[95% conf.	interval]
edu	-30.26154	21.521	-1.41	0.254	-98.75097	38.2279
pat	19.64139	8.555824	2.30	0.105	-7.587061	46.86984
per	1.414702	.9776781	1.45	0.244	-1.696706	4.52611
pay	1.19032	3.199917	0.37	0.735	-8.993243	11.37388
inv	2.356974	1.916076	1.23	0.306	-3.740834	8.454783
_cons	21937.26	17914.87	1.22	0.308	-35075.86	78950.38

Absorbed degrees of freedom:

Absorbed FE	Categories	- Redundant	= Num. Coefs
id	3	0	3
year	5	1	4

Figure 10. Return to the Northeast region

According to the results of the heterogeneity test, there are significant differences in the impact of each variable on GDP in different regions. In terms of the core explanation EDU, in the four regions of the east, central, west and northeast, the invest-

ment in education funds in the eastern region has a significant effect on GDP, with a regression coefficient of -2.861, that is, the investment in education funds has a negative impact on GDP. The number of patent application authorizations is significant in the eastern, central and western regions. In the eastern and central regions, at the 1% level, the coefficients are 4.680 and 6.926 respectively, while in the western region, at the 5% level, the coefficient is 8.187. That is, the overall impact of the number of patent authorizations on GDP is significant and obvious. The population size at the end of the year was significant in the eastern and central regions. In the eastern region, at a level of 5%, the coefficient was 15.702, and in the central region, at a level of 1%, the coefficient was 16.743. That is, the impact on GDP is relatively significant and even more obvious. The impact of general public budget expenditure on GDP in the western region is significant. At the 1% level, the coefficient is 3.114. The total amount of foreign investment is significant in the eastern region. At the 10% level, the coefficient is -0.097, which has a negative impact, but the impact is not significant. It is significant in the central region. At the 5% level, the coefficient is 1.457.

Table 3. Regression result

	(1)	(2)	(3)	(4)
	gdp	gdp	gdp	gdp
edu	-2.861**	0.323	1.711	-30.262
	(-2.571)	(0.607)	(0.930)	(-1.406)
pat	4.680***	6.926***	8.187**	19.641
	(4.380)	(3.696)	(2.678)	(2.296)
per	15.702**	16.743***	1.217	1.415
	(2.154)	(3.368)	(0.107)	(1.447)
pay	0.763	2.096	3.114***	1.190
	(0.690)	(1.727)	(3.157)	(0.372)
inv	-0.097*	1.457**	0.071	2.357
	(-1.867)	(2.544)	(0.472)	(1.230)
_cons	-4.64e+04	-8.91e+04**	-5827.534	21937.260
	(-1.161)	(-2.780)	(-0.172)	(1.225)
N	50	30	60	15
R2	0.995	0.995	0.995	0.997
Adj. R2	0.993	0.991	0.992	0.988

6. Conclusions and Suggestions

Since the reform and opening up, education has had many influences on the quality of China's population and the development of its economy and society. This study only conducted an empirical analysis from the perspective of the impact of higher education on the national economic output. The empirical results show that education has a positive effect on China's economic output. Although educational investment does not directly promote the growth of the gross domestic product, it can be transformed into forms such as patent applications to promote the growth of the gross domestic product through an intermediary effect. [9]

Utilize educational investment to sow the seeds for economic growth. China should increase its investment in education at all levels and of all types, with particular emphasis on the central government's financial inclination and support for educa-

tion in the central, western, northeastern and economically underdeveloped regions. It is necessary to improve the rationality of the regional distribution of educational resources, reduce the imbalance in the allocation of educational resources in the eastern, central, western and northeastern regions, and continuously amplify the economic growth effect of educational investment. Improve the utilization rate of educational expenditure in infrastructure construction, enhance educational investment through the shaping of human capital, and exert an indirect impact on economic growth. When the central government earnestly assumes the public function of financial transfer payments for education in economically underdeveloped regions, it should support, encourage and guide private capital and foreign capital from economically developed regions to enter the education field at the policy level, stimulate the willingness of non-governmental sectors to invest in education, serve as an effective supplement to public education investment, and better play the role of education in promoting economic growth.

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