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Analysis on Influence of Stock of Education Capital and Fixed Assets on GDP Based on Three Types of Regression Model

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ABSTRACT

The investment of education capital and fixed assets play an important role in the economic growth of one country, while traditional regression analysis may underestimate or overestimate the contribution of the investment of education capital and fixed assets on economic growth. In this paper, simple regression, bivariate regression and quantile regression methods are adopted to analyze the relation between the stock of fixed assets and education capital and gross domestic product (GDP). It is shown by research result that: the stock of fixed assets and education capital obviously impacts GDP, and the impact effect of the stock of education capital is larger than that of stock of fixed assets. It can be found through quantile regression that if linear regression is adopted to estimate the impact of the stock of education capital and fixed assets on GDP, the research may be anamorphic.

Keywords: linear regression, quantile regression, stock of fixed assets, stock of education capital, GDP

INTRODUCTION

Currently, China is implementing the strategy that innovation drives development, so technological innovation plays an important role on economic growth, and the competition among countries is turning into the competition of technological innovation ability; however, the competition of technology is the competition of talents ultimately. In recent years, China continuously enlarge the investment on education, and it is shown by statistical data that the overall investment in education nationwide was 3.6 trillion Yuan in 2015, an increase of 10.13% compared with previous year; among them, the national budgetary funds for education was 2.9 trillion Yuan, an increase of 10.6% compared with 2.6 trillion Yuan in previous year. The national budgetary funds for education accounted for 4.26%

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State of the literature

- There are many research results on the impact of fixed assets and educational capital on economic growth. Podrecca and Carmeci (2001) examined the issue of causality between investment shares and economic growth. Glewwe and Jacoby (2004) studied the relationship between household resources and the demand for education using recent household survey data from Vietnam. Fu Chuanrui (2007) utilized conditional quantile regression method to audit the relativity between intellectual capital and corporate performance. Liu Shenglong (2008) used quantile regression and censored quantile regression technology to study and found the positive effect of education and experience on income of Chinese residents. Ljungberg and Nilsson (2009) found that after 1975, the growth of human capital has not been able to match the demands of the third industrial revolution. Fleisher, et al. (2010) found that human capital positively affects output per worker and productivity growth. Sun Xiaofang (2010) adopted multiple linear regression to analyze the route of education capital transformation of surplus labor in rural area. Liu Jun (2012) analyzed and discussed the influence of investment in education capital on economic growth in Taiwan. In addition, some scholars use quantile regression method. Soukiazis and Antunes (2012)'s research showed that the inclusion of human capital, external trade and interaction terms between them have significant effects on growth. Ilegbinosa, et al. (2015) examined the impact of domestic investment on economic growth in Nigeria using annual time-series data from 1970-2013.

Contribution of this paper to the literature

- In summary, linear regression is mainly adopted in the research of investment of education capital and fixed assets on economic growth, while nonlinear data cannot be fitted; therefore, the analysis on impact effect may be overestimated or underestimated. Thus, quantile regression analysis method is planned to be adopted in this paper, and results of simple regression, bivariate regression and quantile regression methods will be compared to evaluate the impact effect of the stock of education capital and fixed assets on economic growth in a more objective aspect.

of GDP, with an increase of 0.16% compared with 4.10% in previous year. The emphasis on education is beneficial for cultivating high-quality talents and providing new energy for enterprise so as to promote the economic development. On the other hand, the investment in fixed assets in China also keeps stable growth, which provides important safeguard for realizing the target of "the 13th Five-year Plan". In 2016, the investment in fixed assets in the whole society was 60.6466 trillion Yuan, an increase of 7.9% of previous year, and the actual increase was 8.6% after deducting the price factor. However, what is the contribution of investment of education capital and fixed assets on economic growth in fact? Whether it is underestimated or overestimated? In this research, simple regression, bivariate regression and quantile regression methods are adopted to analyze the relation between GDP and the stock of fixed assets and education capital to expand current research.

RESEARCH METHOD

Empirical Model

Single linear regression model

For the population regression model, $y = f(x) + u$ specially, when $f(x) = \beta_0 + \beta_1 x$, that

$$y = \beta_0 + \beta_1 x + u \tag{1}$$

In the equation, β_0 and β_1 are two undetermined parameters; β_0 is the intercept of straight line; β_1 is the gradient of straight line. This equation is the single linear population regression mode.

Bivariate linear regression

The equation of bivariate linear regression is listed below:

$$y = a + b_1 x_1 + b_2 x_2 + \mu \tag{2}$$

In the equation, x_1 and x_2 are independent variables; y is dependent variable; a, b1 and b2 are parameters to be estimated.

(3) Quantile regression

It is supposed that (y_i, x_1) represent explained variable and explaining variable respectively, $i = 1, 2, \ldots, n$ and θ is fraction. In the observed value of one sample, ϵ is residual value and β is estimated parameter. The quantile regression model is listed below:

$$y_i = x_i\beta_\theta + \epsilon_i \tag{3}$$
$$Quant_\theta(y_i|x_i) = x_i\beta_\theta$$

Among it, $Quant_\theta(y_i|x_i)$ is the quantile of y_i at the θ condition; in addition, $0 < \theta < 1$ and it shall conform to $Quant_\theta(\epsilon_{\theta i}|x_i)$=0. The object function synthesized by minimized absolute value of residual can be expressed by the following equation:

$$\min_\beta \left(\sum_{y_i \geq x_i\beta} \theta|y_i - x_i\beta| + \sum_{y_i \geq x_i\beta} (1-\theta)|y_i - x_i\beta| \right) \tag{4}$$

The following equation can be gotten through linear programming for minimization process:

$$Q_{\theta,n}(\beta) = \frac{1}{\mathrm{n}} \left(\sum_{y_i \geq x_i\beta} \theta|y_i - x_i\beta| + \sum_{y_i \geq x_i\beta} (1-\theta)|y_i - x_i\beta| \right) = \frac{1}{n}\sum_{i=1}^{n} \lambda_\theta(\epsilon_i) \tag{5}$$

Among it, the test function is listed below:

$$\lambda_0(\epsilon_i) = \begin{cases} \theta_\epsilon, if\ \epsilon \geq 0 \\ \theta_{\epsilon-1}, if\ \epsilon < 0 \end{cases} \tag{6}$$

In the test function, the meaning of estimated parameter value β_θ is: when x_i is changed to one unit, thequantile is changed withunits.

Variable Declaration and Data Source

Dependent variable: The GDP from 1982 to 2007 in China is regarded as explained variable, due to GDP is the important index to weigh economic and social development in China. Data are from China Statistical Yearbook.

Independent variable: Stock of education capital and fixed assets in China are regarded as explaining variables in this paper. Major literature mainly gain data of education capital flow and fixed assets flow, while the influence of investment of education capital and fixed assets on economy is long-term; therefore, it is more suitable to get stock data of education capital and fixed assets. Stock of education capital is estimated by referring to the calculation method of Cui Binlong (2010), which is the same as major researches; stock of fixed assets adopts data of stock of fixed assets in 1952-2009 calculated by Zhang Jun.

EMPIRICAL RESULT AND ANALYSIS

We use Eviews6.0 software to evaluate single and bivariate regression model; in addition, we use stata to program quantile regression model. Specific regression result can be seen in **Table 1.**

Model (1) and (2) in **Table 1** verify the impact effect of stock of education capital and fixed assets on GDP. It can be seen from the regression result that stock of education capital and fixed assets passes 1% significance level test, and the coefficient is positive, showing that stock of education capital and fixed assets is closely related to GDP, and the investment on education capital and fixed assets can obviously promote GDP in China; therefore, the result and theoretical analysis is the same as expectation.

Table 1. Regression Estimation Results of All Samples

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant term	-13606.98*** (2150.428)	-2592.674 (2094.268)	-8888.621*** (2750.808)	-12921.45*** (1687.975)	-11145.45*** (1416.595)	2450.542*** (2450.542)	-7882.267 (7563.88)	-9524.548 (11061.38)
H	5.790*** (0.114)	-	3.216*** (1.059)	1.229*** (0.246)	1.272*** (0 .278)	1.143** (0.493)	0.680 (0.944)	-0.228 (1.249)
K	-	1.792*** (0.037)	0.801** (0.328)	1.894** (0.796)	1.729* (0.871)	2.100 (1.540)	3.693 (3.004)	6.758 (4.028)
R-squared	0.991	0.989	0.992	0.9133	0.9169	0.9202	0.9164	0.9246

Note: ***, ** and *1%, 5%, 10% significance level; number in brackets is standard deviation of corresponding coefficient.

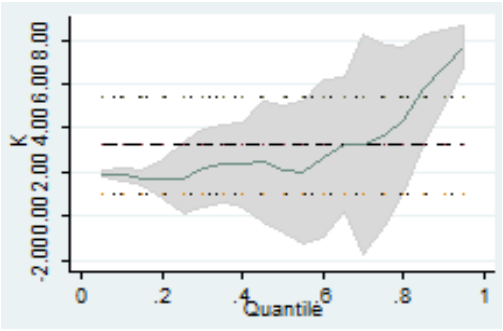

Figure 1. Quantile Regression Change of Stock of Fixed Assets on GDP in Different Quantiles

Model (3) is used to inspect impact effect of stock of education capital and fixed assets on GDP in China. It can be seen from the regression result that stock of education capital passes 1% significance level test, and stock of fixed assets passes 5% significance level test; in addition, their coefficients are positive, showing that stock of education capital and fixed assets is closely related to GDP, and it should be noticed that the impact effect of education capital on GDP may be larger; in other words, investment on education capital and fixed assets can obviously promote GDP in China.

Model (4) - (8) are impact effects of stock of education capital and fixed assets on GDP in China at 0.1, 0.25, 0.5, 0.75 and 0.9 quantile regression models. In medium and low quantile regression model, stock of education capital and fixed assets is closely related to GDP in China, showing that when education capital and fixed assets are invested in small amount, the investment of education capital and fixed assets can greatly promote GDP. In high quantile regression model, there is little connection between stock of education capital and fixed assets and GDP in China, showing that when education capital and fixed assets are invested in large amount, the investment of education capital and fixed assets cannot greatly promote GDP, which is may be the result due to diminishing marginal utility.

It can be known from **Figure 1** that in medium and low quantile, confidence interval of quantile regression of fixed assets stock on GDP is partially overlapped with confidence interval of linear regression model; in high quantile, the influence of stock of fixed assets on GDP in China may be underestimated if linear regression is adopted.

It can be known from **Figure 2** that in medium and low quantile, confidence interval of quantile regression of education capital stock on GDP is partially overlapped with confidence interval of linear regression model; in high quantile, the influence of stock of education capital on GDP in China may be overestimated if linear regression is adopted.

All in all, linear regression and quantile regression are marginal effects by using linear coefficient to explain variable, but explanatory meanings of them are different: linear regression represents estimated value of dependent variable, while quantile regression is the marginal effect of independent variable on dependent variable in certain specialized quantile regression. When sample is allocated symmetrically, the estimation result of linear

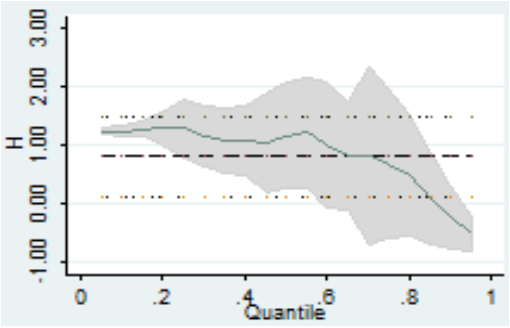

Figure 2. Quantile Regression Change of Stock of Education Capital on GDP in Different Quantiles

regression and quantile regression is the same; when sample is allocated asymmetrically, the estimation result of linear regression and quantile regression is not same; therefore, the result gotten by quantile regression can better explain marginal effect under different quantile conditions.

CONCLUSION

In this paper, single regression, bivariate regression and quantile regression are used to analyze the relation between GDP and stock of fixed assets and education capital to mainly know the influence of stock of fixed assets and education capital on GDP. It can be seen from single linear regression that the stock of fixed assets and education capital is positive correlated with GDP that the larger investment in education capital, the higher GDP; while it can be seen from bivariate linear regression that investment of stock of fixed assets and education capital will influence the change of GDP; meanwhile, the influence of education capital stock on GDP is stronger than that of fixed assets stock on GDP. It can be seen from the quantile linear research that the research on the influence of stock of fixed assets and education capital on GDP will be an amorphic if linear regression is used. Therefore, the government shall increase the investment of stock of fixed assets and education capital, especially in the stock of education capital to promote further increase of GDP; in addition, it is suggested that related institutions should use quantile regression to research in the future.

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