

## Estimation of the Rate of Return to Higher Education Based on Least Squares Method and Mincer Equation Model

Peng Weng<sup>1</sup>, Ling Yuan<sup>2</sup>, Chaonan Li<sup>1</sup>, Cong Yi<sup>1</sup>, Yin Zhang<sup>1</sup>

<sup>1</sup>Department of Architecture and Environmental Engineering, Changzhou University Huaide College  
Jingjiang Jiangsu, China

<sup>2</sup>Department of Economics and Management, Changzhou University Huaide College Jingjiang Jiangsu,  
China

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**Abstract:** The rate of return to higher education, also called the return on investment of higher education, is an indicator reflecting the economic benefits of higher education investment from the perspective of human capital theory; its size reflects the advantages and disadvantages of higher education investment to a considerable extent, and then provides investment decisions of higher education investment for individuals and society. Therefore, the study of the rate of return to higher education can not only analyze the residents' demand for higher education, but also help to correctly estimate the willingness of individuals and families to pay for higher education; at the same time, it is also an important means to analyze the demand and supply of higher education funds. On the basis of summarizing and analyzing previous related studies, this paper expounds the theoretical framework, policy connotation, current situation and existing problems of the rate of return study of higher education, proposes the investment return rate calculation model based on least square method and Mincer equation, and estimate the rate of return of higher education in selected regions and countries. The results of this paper provide a reference for the individual, society or country to make investment decisions on higher education or to further develop the theoretical research on the return on investment of higher education.

### 1. Introduction

The rate of return to higher education is an indicator of the economic benefits of higher education investment, and its size reflects the advantages and disadvantages of higher education investment to a considerable extent, thus providing a decision-making reference for individuals and society to invest in higher education. The study of investment return to education is a relatively mature research method widely used in the study of education cost-benefit and even the whole field of educational economics; it not only becomes an important basis for other theories in educational economics, but also provides theoretical guidance of the educational decision-making activity for many governments. International research on the rate of return to education began in the late 1950s; at the time, numerous studies of the rate of return to education were used to demonstrate the assumptions of human capital theory that education can increase individual labor productivity and become developed and developing countries. In the 1960s, the theoretical basis for expanding the scale of education, promoting national economic growth, reducing poverty, and narrowing the gap between the rich and the poor, and then the study of the rate of return to education was enduring and becoming an basic analytical tool to make education investment for different countries, organizations, groups and individuals [1].

In general, there are two main methods for studying the rate of return to education: the Mincer earnings equation, called the Mincer rate of return and the internal rate of return based on the elaborate method. The Mincer rate of return is the percentage of income growth that a person can receive for one year of higher education, which mainly focuses on the marginal benefit of higher education; the internal rate of return is the rate of return to financial accounting taking into account

the time value of money, which is the discount between the present value of the higher education cost and the present value of the expected return rate. Investment in education should flow to sectors with high returns, but the investment in education funds is fundamentally an investment behavior, which is accompanied by corresponding risk factors [2]. The investment return period of education is longer, and there are more uncertain factors in the longer time span, for example, the previous researchers have concluded that the personal income rate of higher education is much higher than that of the social education rate. The result of a decline in personal education income from the sharp decline in the salary level of university graduates is contrary to this result. Therefore, education investment decisions, especially the private sector, should have a dynamic perspective on education investment decisions, rather than simply relying on a series of static indicators such as yield [3].

On the basis of summarizing and analyzing previous related studies, this paper expounds the theoretical framework, policy connotation, current situation and existing problems of the rate of return study of higher education, proposes the investment return rate calculation model based on least square method and Mincer equation, and estimate the rate of return of higher education in selected regions and countries; the results of this paper provide a reference for the individual, society or country to make investment decisions on higher education or to further develop the theoretical research on the return on investment of higher education. The detailed chapters are organized as follows: Section 2 introduces the least squares method and the Mincer equation model; Section 3 proposes the higher education return estimation based on the least squares method and the Mincer equation model; Section 4 is the conclusion.

## 2. Least Squares Method and Mincer Equation Model

Educational income can be divided into social income and personal income; social income refers to the part attributed to national education investment; personal income refers to the part of personal income growth that can be attributed to individual education investment. Education costs refer to the sum of all direct and indirect labor inputs attributable to the educational process. The direct costs of education include the cost of education spent by the state and the cost of education by the individual or family of the educated. The indirect cost of education, also known as the opportunity cost, refers to the loss of production and income to the society and individuals due to the education of the educated, thus losing the opportunity to engage in productive activities during the education period [4].

The Mincer return model has become the cornerstone of empirical economics. This model is used to estimate the impact of school education and the impact of school quality on the return on education. It is also used to measure the impact of work experience on wage differentials between men and women, and is the basis for economic research on education in developing countries [5]. The opportunity cost of higher education is calculated by the income of undergraduates working for high school graduates during their studies, which underestimates the opportunity cost of higher education investment, thus underestimating the cost of higher education investment. In this case, the estimated internal rate of return of higher education is higher than the actual value. When discussing the benefits of higher education investment, the indirect benefits of higher education investment are neglected. By adopting this method, the income of higher education investment must be underestimated, and the estimated internal rate of return of higher education is also inevitable.

The basic formula for the cost-benefit method of higher educational return is [6]:

$$\sum_{t=E}^G [E_0(t) + C(t)](1+r)^{-t} = \sum_{t=G}^R [E_1(t) - E_0(t)](1+r)^{-t} \quad (1)$$

Where,  $E_0(t)$  is the income abandoned due to education, that is, the opportunity cost of education;  $C(t)$  indicates the direct education cost;  $E_1(t) - E_0(t)$  indicates the net brought by the higher education. The amount of income;  $E$  and  $G$  respectively indicate the entrance and graduation time of the education at that level, that is, the time required for  $G - E$  to indicate the level of education;  $R$  is the retirement time;  $r$  is the rate of return on education.

When estimating the specific rate of return on education, a more general linear form, the classic Mincer return function is usually used [7]:

$$\ln wage = \beta_1 + \beta_2 Educ + \beta_3 EXP + \beta_4 EXP^2 + \varepsilon \quad (2)$$

In the formula, the explanatory variables Educ, EXP, and  $EXP^2$  represent the years of education, work experience, and educational human capital, respectively; and the estimated coefficient of education ( $\beta_2$ ) is the percentage of the labor that receives more than one year of education.

Model the entire sample according to whether it enters the labor market and obtains wage income, and establish a binary variable  $\lambda$ :

$$\lambda = \frac{\varphi\left(\frac{-Z_i\gamma}{v_0}\right)}{1 - \Phi\left(\frac{-Z_i\gamma}{v_0}\right)} = \frac{\varphi\left(\frac{-Z_i\gamma}{v_0}\right)}{\Phi\left(\frac{Z_i\gamma}{v_0}\right)} \quad (3)$$

In the formula,  $\varphi$  is the density function under the standard positive distribution,  $\Phi$  is the distribution function, and the inverse ratio  $\lambda$  is obtained by the parameter estimation values of  $\gamma$  and  $\theta$ . If  $\lambda$  passes the significance test, it indicates that there is sample selection bias in the equation and the education return estimate under the ordinary least squares method fails.

### 3. Estimation of Rate of Return to Higher Education

Comparing the educational rate of return of the ordinary least squares estimation under the income equation with the educational rate of return of the sample selection under the selection equation, it is found that the educational returns of the least squares estimation exist the phenomenon of partial estimation in both the non-control group and the control group. In the selection equation, the work experience and the empirically squared parameter estimate are opposite to each other. The influence of the primary term on the income level is positive and the quadratic term is negative, which verifies the relationship between wage income and work experience under the Mincer return function. When using the ordinary least squares method and the two-stage sample selection model to estimate samples, there is also an estimated bias in the rate of return on education, which is shown as an upward bias in the non-control group and downward in the control group [7]. The basic idea of studying the rate of return on education through cost-benefit analysis is that education can benefit both individuals and society. If we can calculate the specific contribution of higher education to personal income and the national economy, derive the investment return rate of individuals and society for higher education can be derived.

From the perspective of economics, the rate of return to higher education is an indicator of the economic benefits of higher education investment. It can reflect the amount of income that can be earned in higher education, and can judge higher education according to the rate of higher education. Whether investing is of value or not, so the valuation of higher education returns can be used to provide a reference for social and individual investment in higher education [8]. Higher education can improve people's labor productivity, and thus increase personal wage income and social income, which is the basic view of human capital theory. The demand for labor in enterprises depends mainly on the marginal product value of labor, while the value of marginal products is equal to the product of marginal production and marginal revenue. Under the conditions of technical level, capital quantity, labor input, etc., education and training are the main human capital investment increases, the marginal production of labor increases, the value of marginal products increases, and the demand for labor in enterprises increases, resulting in an increase in the equilibrium wage income in the labor market [9].

Under the condition that the enrollment scale of higher education has not expanded, the education level and labor market income of different time groups have natural changes with time. This natural trend can be controlled by adding low-order polynomials of time groups to the model. The exogenous impact of the higher education enrollment policy as an external event that is

difficult for individuals to control will lead to the deviation of the education level and labor market income of different time groups from the original natural trend, and there is additional growth or attenuation [10]. From the above characteristics of the economic benefits of higher education investment, this particular socio-economic system is complex in space and time, and is integrated with other economic factors. Therefore, the structural analysis modeling method should be used to establish a qualitative economic model to find out the trajectory of the economic benefits of higher education investment. Figure 1 shows the rate of return of general higher education, applied higher education, adult higher education, higher education self-study exam and remote network education in target area.

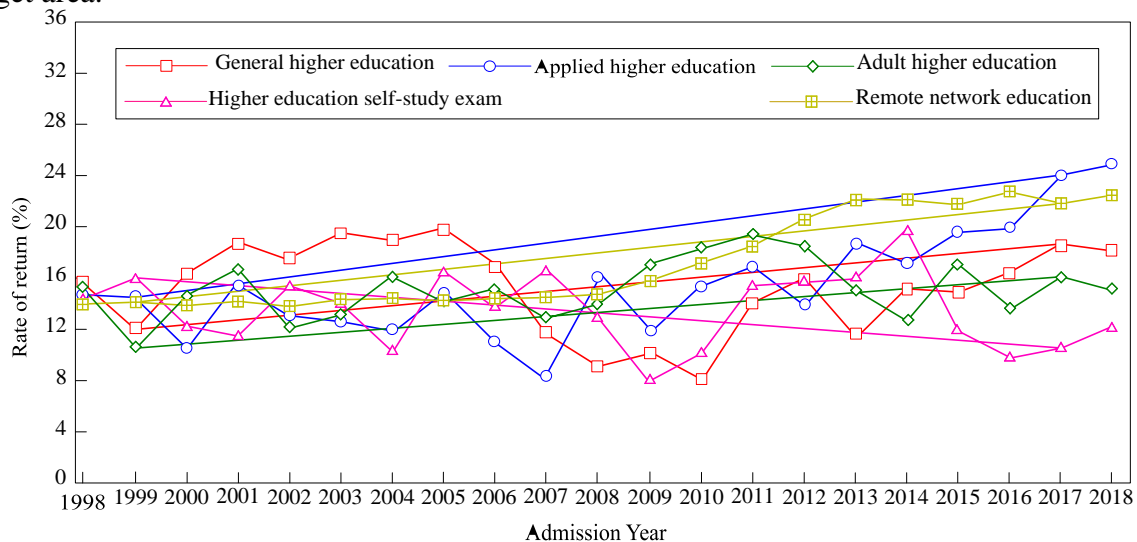


Figure 1 Rate of return of various type of higher education in target area

The investment cost of higher education refers to the value of the educational resources that colleges and universities use to cultivate students, which can be measured in monetary terms, and is the cost of financial or actual payment of money. Different from the cost of enterprise products, the ratio of income to education costs is different. There is a clear gender wage difference in the higher education labor market; in the context of higher education, higher education will lead to an increase in the rate of return to education, and the overall rate of return to education will increase as the level of education increases; The rate of return on education found that the average annual rate of return on education in college education was higher than that of men. The average annual rate of return on education for undergraduate education was higher than that of women. With the improvement of higher education level, the rate of return of higher education for men was higher than that of women. The income period of education is the number of years of lifelong employment, and the period of cost is the number of years of education. Moreover, the accounting contents of the two are different. The education cost is calculated to reflect the public product attributes of education, and should include the accounting of educational opportunity costs [11].

#### 4. Conclusions

The rate of return to higher education is an indicator of the economic benefits of higher education investment, and its size reflects the advantages and disadvantages of higher education investment to a considerable extent, thus providing decision-making reference to invest in higher education for individuals and society. Based on the summary and analysis of previous research results, this paper proposes an investment return rate calculation model based on least squares method and Mincer equation, and finally estimates the rate of return to higher education in selected regions and countries. The Mincer return model has become the cornerstone of empirical economics, and his model is used to estimate the impact of school education and the impact of school quality on the return on education; it is also used to measure the impact of work experience on wage differentials between men and women. Whether investing is of value or not, so the valuation of

higher education returns can be used to provide a reference for society and individuals to invest in higher education. Comparing the educational rate of return of the ordinary least squares estimation under the income equation with the educational rate of return of the sample selection under the selection equation, it is found that the educational returns of the least squares estimation exist the phenomenon of partial estimation in both the non-control group and the control group. From the perspective of economics, the rate of return to higher education is an indicator of the economic benefits of higher education investment, and it can reflect the amount of income that can be earned in higher education, and can judge higher education according to the rate of higher education.

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