

Article

The Impact of Education Investment on Regional Poverty Alleviation, Dynamic Constraints, and Marginal Benefits: A Case Study of Yunnan's Poor Counties

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Abstract: This paper studied the impact of education investment on regional poverty alleviation of Yunnan's poor counties, especially the dynamic constraints and marginal benefits of education input. This paper takes 30 poor counties in Yunnan province from 2007 to 2020 as the research object. A double fixed effect model, a systematic GMM model, and a quantile regression model are used to study the effect of education investment on regional poverty alleviation from static and dynamic levels. The results show that education investment has a significant positive effect on regional poverty alleviation at both static and dynamic levels. At the same time, under different poverty levels, the effect of education investment on poverty alleviation shows a law of diminishing marginal effect. As for the current situation of poor counties in Yunnan Province, the effect of education investment on poverty alleviation is increasing at a decreasing rate. The research object of this paper has achieved the goal of getting rid of absolute poverty, so the conclusion of this paper has more reference value.

Keywords: regional poverty alleviation; education investment; diminishing marginal benefits; system GMM model; dynamic constraint



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1. Introduction

Poverty eradication is the common mission of mankind and remains the biggest global challenge facing the world today. Eradicating poverty and sharing development and prosperity is the common goal and mission of governments around the world and the international community. The 17 Sustainable Development Goals are a blueprint for a better and more sustainable future for all. The first of these is to end poverty in all its forms around the world by 2030. Globally, the percentage of people living in extreme poverty fell from 36 percent in 1990 to 10 percent in 2015. However, the pace of improvement is slowing, and the COVID-19 crisis threatens to reverse decades of progress in poverty eradication. For the first time in 30 years since 1990, the global poverty rate is likely to increase.¹

Since the 1990s, the global economic and social growth has significantly aided the decrease of human poverty and enhanced the quality of life for all people. However, imbalanced development, natural disasters, war, climate change, economic fluctuations, and other causes have severely hampered the global sustainable poverty reduction process and spawned a number of issues, such as hunger, over-exploitation of resources, regional conflicts, etc. Currently, the majority of the world's poor reside in rural regions. A household study conducted by the [World Bank Group \(2016\)](#) in 89 developing nations reveals that 80 percent of the world's poor reside in rural regions. China, the world's most populous developing country, achieved its 2020 target of eliminating absolute poverty. China is now the country with the greatest poverty reduction population and the major contributor to global poverty reduction ([Tang 2020](#)).

The China's practice and experience of poverty alleviation showed that "Poverty alleviation must nourish wisdom; cure the fool before the poor". Education, as one of the important measures of targeted poverty alleviation strategy, has increasingly become a consensus in China. "To ensure that all children from poor families can receive fair and quality education and prevent the transmission of poverty from generation to generation" is the strategic guiding ideology set out in the decision of the Communist Party of China Central Committee and the State Council on winning the tough battle against poverty. The targeted poverty alleviation in China has achieved remarkable success. For understanding of the important role of poverty alleviation through education, we should not only stay in poverty alleviation through education itself, nor should we be limited to the education cause. We should rationally understand the role and impact of education in supporting the poor from the perspective of modern social governance and sustainable development, so as to better promote the reform and development of poverty alleviation through education.

According to the "Poverty Monitoring Report of Rural China 2020" and the current Chinese rural poverty standards,² the number of rural poor in China in 2019 was 5.51 million, a decrease of 11.09 million over the previous year, and the incidence of poverty was 0.6%. More than half (58.7%) of the poor are still concentrated in the western region.³ The incidence of poverty is relatively high in the group with low education level in rural areas. According to the grouping of the education level of the head of household, the incidence of poverty is negatively correlated with the education level of the head of household, and the incidence of poverty is relatively high in the group with low education level of the head of household. Figure 1 illustrates the incidence of poverty among the group whose head of household has not attended school was 2.0% in 2019, the incidence of poverty among the group whose head of household has received primary school education was 0.9%, the incidence of poverty among the group whose head of household has received junior middle school education was 0.4%, and the incidence of poverty among the group whose head of household has received high school education or above was 0.2%.

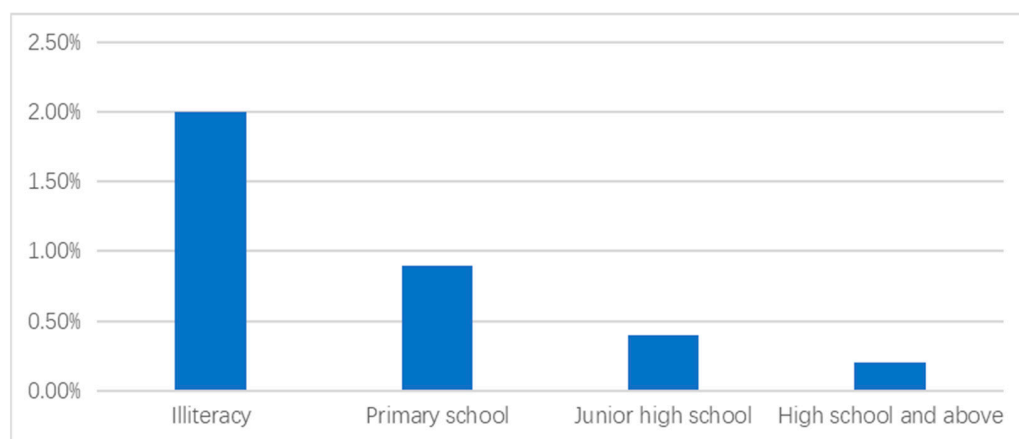


Figure 1. Incidence of rural poverty grouped by education level of household head in 2019 (Data source: Poverty Monitoring Report of rural China 2020).

As a typical region of deep poverty, Yunnan has 73 state-level poverty counties, and multidimensional poverty is very common. In 2019, Yunnan province had 560,000 rural poor people, with a poverty incidence rate of 2.2% in rural counties. Yunnan province has the largest number of poor people in China, and the poverty incidence rate is also the second highest in China. The work of alleviating poverty has been enormous and challenging for a very long time due to geographical environment, local illnesses, clean drinking-water, and other regional issues. Traditional handouts have had little effect, raising average incomes only in the short term, leading to poverty alleviation that is not sustainable and stable. Poverty alleviation through education aims to reduce the relative deprivation suffered by poor groups by improving their human capital level. To achieve poverty alleviation

through education, it is necessary to improve the will to study, the quality of education and the quality of employment of poor groups from the input, production and application of human capital, and the reconstruction of social relations. Table 1 illustrates the rural poor population and the incidence of rural poverty in Yunnan Province from 2012 to 2019.

Table 1. The rural poor population and the incidence of rural poverty in Yunnan Province from 2012 to 2019.

Year	2012	2013	2014	2015	2016	2017	2018	2019
Rural poor population (10,000 people)	744	607	536	448	352	264	166	56
Incidence of rural poverty	26.70%	21.90%	20.30%	17.40%	13.70%	10.20%	6.40%	2.20%

Data source: Poverty Monitoring Report of rural China 2020.

It is clearly that education is an important means of enhancing human capital and improving the quality of the population; education is an important way to promote the development of individual freedom; education is an important tool to break the intergenerational transmission of poverty. For impoverished counties in Yunnan, the backward education level restricts local economic development and is also the main factor affecting farmers' poverty alleviation. It also provides a practical site for exploring the impact of education input on regional poverty alleviation. With the deepening of a number of education poverty alleviation policies, human, material, financial, and other educational resources are constantly tilted to the poverty-stricken counties, providing the possibility of local education poverty alleviation. Thus, what role has education investment played in poverty alleviation? What is the economic effect of poverty alleviation in the region? These are the questions about which this paper wants to study.

Furthermore, the region's persistent poverty will result in a lack of educational resources. In poor regions of Yunnan Province, for instance, skilled teachers are an exceptionally scarce resource. Because of the disparity between living conditions and earnings in impoverished areas and those in cities, teachers with extensive teaching experience are unwilling to work in disadvantaged areas. This factor has also contributed to the long-standing concentration of educational resources in developed cities. However, even if there are schools and other building amenities in impoverished communities, there is a severe dearth of instructional materials. How to properly utilize the government's investment in education to tackle the regional poverty issue is a valuable research topic.

For the above problems, this paper proposes the following hypothesis: education input has a significant role in promoting regional poverty alleviation, and the economic contribution of education input to regional poverty alleviation is dynamic, following the law of diminishing marginal benefits.

In previous research, researchers examined the impact of education in alleviating poverty. This study is novel in that it examines whether the role of education investment in the process of alleviating poverty follows the law of diminishing marginal returns. This inventive concept derives from three factors. First, the increased investment in education allows more children from low-income households to attend school and benefit from their education. However, within a certain length of time, the family labor force will diminish, resulting in a decline in family income and a consequent escalation of poverty. Secondly, if education is considered a consumption or investment behavior, the return on investment in education for impoverished regions is long-term. If the government continues to invest more in education, it may experience some financial hardship. Lastly, if education investment continues to expand in order to relieve regional poverty, it will lead to an undue reliance on government support for educational resources, making it hard to eradicate poverty entirely.

For Yunnan, the above problems also exist in some poor counties, which are more common in economically developed counties and cities. Especially in some counterpart support areas, the infrastructure construction of schools has reached a high level. However, for many reasons, local governments still enjoy rich external funding. From the phase of

poverty alleviation, the scale of poverty is relatively constant, which means that the resource input in the base period often has higher output efficiency. However, with the solution of poverty, the continuous increase of resources shows a more obvious phenomenon of efficiency decline, which also leads to the problems of resource waste and efficiency decline in some poor counties.

This paper will take 30 poor counties in Yunnan Province as the research object, using the fixed effects model of general linear panel data to analyze the impact of education input on regional poverty alleviation and at the same time, using the system GMM model to analyze the short-term and long-term effects of education investment. Further, based on the idea of quantile regression, this paper analyzes the educational effectiveness of comprehensive poverty alleviation degree at different levels, so as to judge the dynamic characteristics of the impact of educational investment on poverty alleviation. Based on previous scholars' research on education and poverty, this paper uses a new perspective to verify whether there is a marginal effect on the impact of education investment on poverty relief.

2. Literature Review

Poverty is not only a single economic phenomenon, but the product of many factors. Poverty is accompanied by social development, which is historical, dynamic, and multi-dimensional. Poverty takes many forms. In many studies, scholars have found that education is one of the important factors affecting poverty, and the role of education in poverty alleviation can be reflected in many aspects.

On the one hand, education is an important component to improve the quality of human capital and the human population. During the 1960s, scholars studied the economic effects of education. They found that educational investment contributed to the country's economic growth and employment. [Schultz \(1961\)](#) noted that education's positive effects on the country's economic growth were evidenced by the average return on educational investment. In addition, education's higher economic contribution rate than that of other traditional factors has been acknowledged by Schultz. He explained that human capital is the main component of modern economic development. Thus, "education is the largest and easiest part of human capital, so education is the appropriate representative of investment in human". The link between education and economic development is evidenced by the increasing number of countries that promote higher education. The concept of the human capital theory states that education is very important for improving the quality of human capital and reducing poverty.

Some scholars, however, questioned whether education really has a direct impact on economic growth. For instance, [Hanushek \(1996\)](#) noted that real spending per pupil has grown at a rate of 3.5 percent in a century. [Wolf \(2002\)](#) pointed out that "education is important, but in the current form and organization, education is not necessarily a guarantee of economic success". Alison Wolf's book is sharp, brave, and well-documented, explaining in detail what has gone wrong in many education systems, particularly in the UK, but also in other countries. For example, the number of students in higher education has increased explosively, so the available resources per participant have decreased significantly and the student/teacher ratio has deteriorated. In Alison Wolf's book, many facts are presented to show that increased spending on education in many countries has failed to reduce social disparities. Such a conclusion is of great reference value to both developed and developing countries.

As [Chen \(2007\)](#) argued, the lack of human capital is one of the main factors that affect China's economic growth. They found that the level of education of Chinese farmers has a significant impact on their income. [Xin and Wang \(2007\)](#) used the Granger causality test to analyze the influence of farmers' education level on farmers' income and concluded that the level of education of Chinese farmers has a long-term stable relationship with the income of the farmers. [Du and Liu \(2010\)](#) carried out an empirical study on the influence of various agricultural economic growth factors, including human capital investment, and pointed out that human capital investment has become an important part of farmers' living

expenses. Among human capital factors, educational investment has the greatest influence. [Cheng et al. \(2016\)](#) constructed an extended income function containing human capital elements, and calculated that the contribution rate of basic education to farmers' income reached 13.97%, which was second only to health (18.15%) in importance.

According to [Sen's \(1982\)](#) definition based on survivability, poverty reduction can be understood as improving nutrition, health status, and education level. The extent to which poverty is reduced depends on two basic factors: rising income levels and narrowing income gaps. Therefore, from the dual perspectives of income growth and gap narrowing, the link between education and rural poverty reduction is a basic idea that draws attention to the issue of income inequality. [Yao and Wang \(2010\)](#) point out that human capital of different dimensions can effectively alleviate relative poverty in Chinese cities. [He et al. \(2018\)](#) believe that the improvement of human capital is the only way to reduce poverty in rural areas, and the expenditure on training is the most effective way to reduce poverty in rural areas.

On the other hand, education is also a form of investment, and the investment of educational resources also has expected returns. The research of [Chen \(2008\)](#) points out that education investment is risky. As for a family, they may not get corresponding returns if all is spent on their children to receive education, especially higher education. [Romano and Tampieri \(2016\)](#) took students' investment in courses as an example and argued that due to the lack of investigation of the work environment, students' investment in teaching courses did not achieve the expected economic benefits, but exacerbated the short-term economic stress. [Zhang \(2017\)](#) pointed out that in the short term, the education of family children not only needs investment, but also reduces the number of family labor force and family income. In addition, there is a crowding out effect on family life consumption, and even in some cases, it causes the embarrassment of family monetary expenditure, that is, the phenomenon of "poverty caused by education" in the social sense. By analyzing the predicted return rates of various types of education, [Wang et al. \(2019\)](#) concluded that vocational education's income-increasing effect is not optimal. As time goes by, the employment difficulties and low-income problems faced by individuals with only vocational education degrees will become more obvious. By examining the relationship between leverage ratio and family education expenditure, according to [Wei et al. \(2021\)](#), a greater leverage ratio can reduce family spending on children's education, and this effect can be amplified when families invest.

According to [Awan et al. \(2011\)](#), the likelihood of a person in Pakistan not being poor improves as their degree of education rises. Nevertheless, [Tilak \(2010\)](#) discovered that although the impact of higher education on development is relatively substantial, many developing countries do not give it sufficient attention. The research of [Iheonu and Urama \(2019\)](#) demonstrates that the Nigerian poverty problem may be significantly mitigated by increasing the education budget allocation to enable individuals to obtain the necessary skills and by investing extensively in quality education. However, according to the research conducted by [Spaull \(2015\)](#), low-quality education investments created a poverty trap for the majority of learners in South Africa. According to the research of [Nawaz and Iqbal \(2016\)](#), the lack of education in Pakistan was a significant source of poverty, and the lack of enough funding for education was the greatest challenge for impoverished households. Oppositely, [Efendi et al. \(2019\)](#) showed that education investment has a negative and insignificant impact on Indonesia's poverty level.

Comparing the aforementioned papers reveals that the influence of education investment on poverty alleviation varies among countries and regions and even generates contradictory findings. To summarize the results of the literature review and our research, the authors concluded that the effect of education investment on poverty alleviation follows the law of diminishing marginal returns. Various researchers have recognized the role and process of education in alleviating poverty. Education may reduce poverty effectively. However, reducing poverty cannot be accomplished merely by increasing government investment in education. At present, the research on the effect of education investment on poverty alleviation uses national or provincial data as the analysis object. The study

object in this work is panel data from 30 poor counties in Yunnan Province, which precisely depicts the true situation in poor counties and leads to a more compelling conclusion.

The existing studies draw conclusions when countries or regions are experiencing poverty. In February 2021, China completely lifted itself out of absolute poverty. Yunnan Province is one of the provinces with the largest number of poor people in China. Under the background of comprehensively getting rid of absolute poverty, this paper has more research value and representativeness on the effect of education investment in poor counties in Yunnan Province on regional poverty alleviation, and whether the economic contribution of education investment to regional poverty alleviation follows the law of diminishing marginal returns.

3. Empirical Specification and Methodology

The goal of poverty alleviation is to provide adequate food, water, and clothing. This includes the protection of children from unsafe living conditions. Aside from food, water, and clothing, these are also key factors that determine the effectiveness of various policies designed to improve living conditions for the poor. This paper chooses to build a model to measure the degree of poverty alleviation from five perspectives: “poverty alleviation through production, relocation, ecological compensation, education, and social security.” This is in accordance with the primary means proposed by the Chinese government for achieving the goal of poverty alleviation (Lu and Liu 2015). On the basis of Yunnan’s existing conditions and available data, acceptable explanatory factors are developed. The core idea of this paper is to use the econometric model to analyze the impact of education input on the improvement of comprehensive poverty alleviation, so as to objectively show the economic effect of education input on regional poverty alleviation and its dynamic characteristics. Specifically, at the static level, the general linear panel data model is used to examine the influence of education input on regional poverty reduction at the static level. At the dynamic level, the short-term and long-term effects are analyzed using the system GMM model. Furthermore, based on quantile regression, the effectiveness of comprehensive education under different poverty alleviation levels is analyzed to judge the dynamic characteristics of the impact of education input on poverty alleviation.

3.1. Empirical Specification

The basic poverty alleviation goal of “adequate food and adequate clothing” and “guaranteed compulsory education, safe housing and basic medical care” is the comprehensive embodiment of multidimensional poverty alleviation (Zeng 2012). The academic circle has carried out research on multidimensional poverty, mainly discussing related aspects such as economy, education, health, and medical treatment. For instance, Wang and Alkire (2009) redefined the critical value of multidimensional poverty index in the United Nations Millennium Development Goals based on China’s reality, and proposed a measurement system of multidimensional poverty index suitable for China. Yang and Wang (2015) continued to enrich the number of indicators and incorporated income and assets into the multidimensional poverty evaluation system. Zhang et al. (2017) also explored the construction of multidimensional poverty indicator system from experience and theory. By comparing poverty indicator systems of various countries, Wang and Feng (2020) proposed constructing a multidimensional poverty indicator system based on economic, social, and environmental components. The economic dimension includes income and employment, the social development dimension includes education, health, social security, and access to information and other indicators, and the ecological environment includes drinking water safety, sanitation facilities, fuel, and garbage and sewage treatment.

Poverty in Yunnan is complex and diverse. In addition to deep poverty at the level of farmers and families, regional poverty is also common. Among the 14 contiguous poverty-stricken areas in China, Yunnan province has the largest number of 91 counties in four districts⁴. The poor natural ecological environment and closed traffic location lead to the

chronic poverty in many aspects such as life, medical treatment, and production, which is difficult to eradicate for a long time.

3.1.1. Measurement of Poverty

In terms of dimensions and indicators, the Multidimensional Poverty Index of Human Development Report 2020 (Baumann 2021) released by the United Nations Development Program adopts three dimensions: health, education and living standards. Ten indicators are selected under the three dimensions: nutrition, child mortality, years of adult education, children's enrollment rate, whether to use electricity, sanitation facilities, safe drinking water, indoor ground, cooking fuel, and assets. Considering the actual development of poverty counties in Yunnan, based on the Multidimensional Poverty Index of Human Development Report 2020, a comprehensive poverty alleviation evaluation system was constructed, which includes five dimensions: life poverty alleviation, education poverty alleviation, economic poverty alleviation, medical poverty alleviation, and social security poverty alleviation. When calculating multi-dimensional poverty, the same weight is given to each index by referring to the method of Yang and Wang (2015), with a weight of 1 to reflect the comprehensive poverty alleviation level. The specific indicators are shown in Table 2.

Table 2. Evaluation indicators of comprehensive poverty alleviation degree.

Dimensions	Level Indicators	The Secondary Indicators
Economic Poverty Alleviation (0.2)	Poverty Level	Poverty population; Poverty headcount ratio
	Macroeconomic	Regional GDP; Financial self-sufficiency rate; Local fiscal revenue.
	Income level	Per capita disposable income of farmers; Wages of urban employees.
	Consumption and savings	Resident deposit balance; Total retail sales of social consumer goods.
Live Poverty Alleviation (0.2)	Food and clothing conditions	Grain, meat and cotton production.
	Living conditions	Number of landline subscribers; Investment in fixed assets.
Education Poverty Alleviation (0.2)	Educational scale	Number of students in ordinary secondary schools; Number of primary school students.
	Educational structure	Proportion of middle school students in all students.
	Population structure	Proportion of middle school students per 10,000 population; Growth rate of primary school students.
Medical Poverty Alleviation (0.2)	Medical scale	Number of beds in hospitals and health centers; Number of doctors per thousand population; Number of beds in social welfare homes.
Social Security Poverty Alleviation (0.2)	Security Scale	Number of urban and rural residents covered by medical insurance.

Note: the numbers in brackets are the weights of each dimension.

3.1.2. Educational Investment

As a part of the strategy to improve the living conditions of the poor, education is also expected to play a leading role in the development of deep poverty-stricken regions in Yunnan. The development of education has become an important component of the strategy to get rid of poverty. It is expected to improve the living conditions of the poor and provide special care for children. The input of various resources is a tool for poverty alleviation through education, and getting rid of poverty and becoming rich is the ultimate

goal. From the perspective of resource allocation, this paper takes education financial expenditure as an index to reflect the level of education investment.

3.1.3. Production Level

From the perspective of urban–rural differences, the poverty problem in Yunnan is mainly distributed in rural areas, mainly manifested in the low agricultural productivity, which is also the key factor restricting the increase of farmers' income. From the perspective of improving rural productivity or promoting farmers' income, it is very important to improve rural production conditions, which is also the basic condition and realistic representation of the development of production. This paper comprehensively investigated the current situation of productivity development in poor counties from the aspects of total sowing area of crops, grain yield, total power of agricultural machinery, and amount of chemical fertilizer.

3.1.4. Ecological Compensation

Yunnan is a frontier province located in the west of Yunnan–Guizhou Plateau. It is the source and upstream of six major river systems such as the Yangtze River, Pearl River, Lancang River, and Nujiang River. In the northwest, the topography is high, while in the southeast, it is flat. The landscape changes dramatically. Mountains cover 94 percent of the province's entire land area. The climate types are complex and diverse. Yunnan Province is one of the provinces with serious soil erosion in China. Soil erosion has become an important factor restricting social and economic development. Ecological compensation is one of the important measures to get rid of poverty in the new era. It is not only conducive to the restoration of local ecological environment, but also an important way to solve the employment of poor people. In particular, large-scale afforestation activities have given birth to many posts such as foresters and forest rangers, which has opened up a new path for the poor to increase their income while protecting the ecological environment. This paper measures the level of ecological compensation from the total afforestation area.

3.1.5. Employment

Employment is not only a direct factor affecting the increase of farmers' income, but also a basic guarantee for stable poverty alleviation. For a long time, the self-sufficient small-scale peasant economy has been the main cause of rural poverty in Xinjiang. Land constraints not only inhibit the increase of farmers' income, but also aggravate the risk of intergenerational transmission of poverty. Yunnan Province has put forward a number of targeted employment and poverty alleviation measures such as labor export and skill training, which has created more opportunities for the poor to increase their income, and the employed population in rural areas has increased significantly. This paper measures the effect of employment on poverty alleviation by the number of employed people.

3.1.6. Industrial Level

Industrial backwardness is an important factor leading to slow economic growth in poor counties. The high proportion of agriculture weakens the society's ability to absorb surplus labor force and delays the poverty alleviation process of poor people. Developing industry mainly refers to developing the secondary industry, improving the industrialization and service development level of poor counties, developing Yunnan's rich mineral, energy, and other natural resources, continuously absorbing social surplus labor force while optimizing the local industrial structure, and promoting the coordinated development of employment and industry. This study utilizes the added value of secondary industry to indicate the degree of industrial growth in poor counties, which is the major direction of industrial development in poor counties. Table 3 illustrates the definition and description of explanatory variables.

Table 3. Definition and description of explanatory variables.

	Explanatory Variable	Index
Core explanatory variable	Education	Total financial expenditure on education (10,000 Yuan)
	Production level	Total sown area of crops; grain production; fertilizer consumption (10,000 tons)
Control variable	Industrial level	Added value of secondary industry (10,000 Yuan)
	Employment	Number of employees (10,000 people)
	Ecological	Annual precipitation (millimeters)

3.2. Methodology

3.2.1. Panel Data Fixed Effect Model

In the research on poverty, scholars have found that there are many factors leading to poverty and alleviating poverty. When regression analysis is used to analyze the factors affecting the effect of poverty alleviation, some unobservable random variables are often related to explanatory variables. At this time, the fixed effect model is used to analyze the panel data to obtain a consistent estimator. Peng (2019) investigated the effects of education investment on impoverished people's income growth using a panel data fixed effect model. Wei et al. (2021) examined the aforementioned concerns using a panel fixed effect regression model.

This paper uses panel data fixed effect model to analyze the impact of education investment on regional poverty alleviation at the static level. Ordinary least squares (OLS) regression and individual fixed effect estimation will cause the estimation results to ignore the additional impact caused by period fluctuation. In fact, there are not only cross-sectional differences in the development level between counties, but also obvious period characteristics. To account for the impact of macroeconomic conditions on each county's poverty alleviation effect, a double fixed effect model is developed by adding time dummy variables to the individual fixed effect model, as indicated in Equation (1):

$$y_{it} = \alpha EDU_{it} + \beta X'_{it} + \delta_t + \mu_i + \varepsilon_{it} \quad (1)$$

where i denotes the county, t denotes the period (year), y denotes the explained variable, y_i represents the comprehensive poverty alleviation degree of county i , and y_{it} represents the comprehensive poverty alleviation degree of county i in period t . EDU (education investment) represents the main explanatory variable, X' represents a set of control variables, ε is an interference item, μ for individual effects, δ is a dummy variable representing the time effect, and α and β are the coefficients to be estimated.

3.2.2. System GMM Model

This article analyzes the short- and long-term impacts of education investment on regional poverty reduction using a systematic Gaussian Mixture Model (GMM) model. Poverty is often a continuous process, and the degree of poverty in the previous period often has an impact on the degree of poverty in the current period. Therefore, when the poverty level is taken as the explained variable, the explanatory variable should include the poverty level of the previous period. This leads to the endogenous problem of explanatory variables in the model. The general panel data model mainly reflect the static relationship between variables. Affected by missing variables and other factors, the endogenous problem of panel data model is difficult to deal with, resulting in biased estimation results. The System GMM estimation method proposed by Arellano and Bover (1995) and Blundell and Bond (1998) had better effect in dealing with endogeneity, and can reflect the dynamic adjustment process between variables. A fundamental premise of the System GMM technique is that the interference term lacks sequence correlation. Generally speaking, the interference term after difference generally has the problem of first-order autocorrelation. Therefore,

the interference term does not have sequence correlation of second-order or higher-order, which shows that this assumption is reasonable.

In the research of poverty alleviation, the System GMM model has been widely used. Xiao (2016) analyzed the relationship between poverty rate, innovation potential, and economic growth in China's province, and estimated it by GMM method on the basis of controlling cross regional and cross time heterogeneity and endogeneity. He and Xiao (2017) examined the effect of people's livelihood finance on poverty alleviation in western rural areas using panel data from ten provinces and cities in western China from 2002 to 2014. They used the dynamic panel GMM estimation method and the dual structure characteristics of people's livelihood finance to examine the effect of people's livelihood finance on poverty alleviation in western rural areas. Xu and Yan (2017) constructed a mathematical model of the relationship between compulsory education equalization and rural poverty using provincial panel data from 2004 to 2015 and investigated the relationship between urban and rural mandatory education equalization and rural poverty using the systematic GMM estimation method. Su (2018) built a systematic GMM model using dynamic panel data from 31 Chinese provinces, cities, municipalities, and autonomous regions from 2008 to 2015 to examine the economic assistance effect of fiscal policy on the poor following the introduction of the "targeted poverty alleviation" policy.

The basic setting form of System GMM model is as follows:

$$\ln y_{it} = \alpha \ln y_{i,t-1} + \beta \ln EDU_{it} + \theta \ln X_{it} + \delta_i + \mu_i + \varepsilon_{it} \quad (2)$$

$$\Delta \ln y_{it} = \alpha \Delta \ln y_{i,t-1} + \beta \Delta \ln EDU_{it} + \theta \Delta \ln X_{it} + \Delta \delta_i + \Delta \varepsilon_{it} \quad (3)$$

From Equation (2), it can be seen that the System GMM model contains a lag period of the explained variable, $y_{i,t-1}$, which represents the comprehensive poverty alleviation degree in the initial stage, and y_{it} represents the comprehensive poverty alleviation degree in the target period (usually the current period). The term "ln" means to take the natural logarithm of the variable. Obviously, the adjustment level of the comprehensive poverty alleviation degree in the initial stage will affect the poverty alleviation speed in the current period. The adjustment speed of comprehensive poverty alleviation level in the target period depends on the coefficient α . When $\alpha = 0$, it indicates that the poverty reduction adjustment speed in the target period is 0, $\alpha > 0$ indicates that the poverty reduction in the early stage is low, $\alpha < 0$ indicates that the poverty reduction in the early stage is good. In order to maintain the steady-state poverty alleviation effect, the resource investment needs to be dynamically adjusted at a rate of $(1 - \alpha)$. In addition, long-term effects can be expressed by $\left(\frac{1}{1-\alpha}\right)$.

3.2.3. Quantile Regression

The marginal income effect of education investment on regional poverty reduction is examined in this research using quantile regression. Quantile regression was performed using the method proposed by Koenker and Bassett (1978) by judging the role of education investment under different quantiles of comprehensive poverty alleviation degree and testing the nonlinear relationship between them. The quantile regression model is expressed as follows:

$$Q_p(y | X) = X' \beta(p) \quad (4)$$

Q_p is the comprehensive poverty alleviation degree at the p quantile. $\beta(p)$ is the coefficient to be estimated of the explanatory variable at the p quantile. According to the change of p , it can more objectively reflect the impact and multi-stage change of education investment under different poverty alleviation degrees. When $p = 0.5$, it is the median regression.

3.3. Data

This paper takes 30 poverty-stricken counties in Yunnan province from 2007 to 2020 as the research object. The statistics for this article were mostly derived from Yunnan Statistical Yearbook; China Statistical Yearbook (County-Level); Poverty Monitoring Report of Rural China; and government work report and government work summary issued by Yunnan cities (autonomous prefectures). The data on education expenditure are from the Yunnan Provincial Department of Finance. After sorting and summarizing, the panel data required for the research were formed ($i = 30, t = 14$).

When constructing the indicators of comprehensive poverty alleviation degree (CPAD) of each county, all indicators were standardized. Figure 2 shows the comprehensive poverty alleviation degree of 30 counties from 2007 to 2020. With the passage of time, the comprehensive poverty alleviation degree of each county improved, which means that the poverty problem was gradually solved, but the degree and speed of poverty alleviation in each county are different.

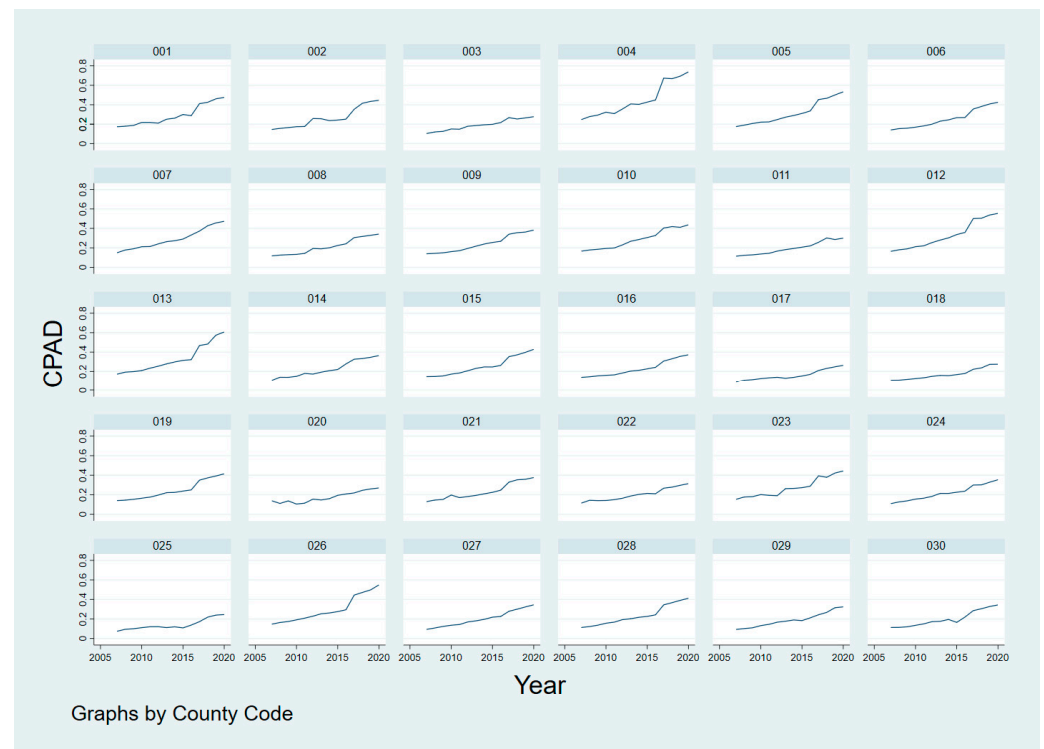


Figure 2. Comprehensive poverty alleviation degree of 30 poverty-stricken counties in Yunnan Province from 2007 to 2020.

In this paper, the panel data fixed effect model, the system GMM model, and the quantile regression model were used. Table 4 shows the mean of the variables used in the different models over different years. From the distribution of the data in different years, it can be roughly seen that the comprehensive poverty alleviation degree of the poverty-stricken counties in Yunnan is increasing year by year, and at the same time, the “education investment” also has an obvious upward trend year by year. However, between 2018 and 2019, “education investment” shifted and showed a downward trend.

Table 4. The mean value of each variable.

Year	CPAD	Education	Production	Industrial	Employment	Ecological
2007	0.1337	5339	33,952.21	56,100.97	130,895	120.63
2008	0.1468	6695	35,583.70	66,981.63	126,153	136.70
2009	0.1552	8987	37,328.61	76,422.87	134,775	176.40
2010	0.1692	11,638	38,098.16	96,793.33	137,038	176.40
2011	0.1761	15,448	43,898.79	128,388.50	139,132	176.40
2012	0.1988	19,614	44,702.96	160,383.40	139,739	166.67
2013	0.2716	21,034	48,606.41	187,420.80	139,253	166.67
2014	0.2282	22,299	49,879.21	188,781.50	140,755	153.57
2015	0.2414	26,232	50,600.63	167,601.40	141,510	151.77
2016	0.2594	30,519	51,357.55	183,087.10	142,927	153.87
2017	0.3403	34,519	51,871.54	205,615.40	143,696	147.87
2018	0.3594	37,790	48,315.38	223,834.30	143,393	143.33
2019	0.3832	34,236	48,845.21	23,484.31	142,300	180.80
2020	0.4028	36,363	49,488.40	12,069.42	142,300	153.60

In order to avoid the appearance of “spurious regression” and ensure the validity of the estimated results, it is usually necessary to perform stationarity analysis on panel data, that is, to test whether the data process is stationary through unit root test. In the unit root test of each variable, taking into account the corresponding characteristics of the panel data, the method of [Im et al. \(2003\)](#) (abbreviated as IPS) was adopted. In addition to the unit root test of each variable itself, the IPS test was also carried out on the first-order difference form of each variable. The results are shown in Table 5. The unit root test results show that the two variables “Employment” and “Ecological” passed the significance test in the original series, and the unit root test of other variables cannot reject the null hypothesis, so there is still a unit root problem. Therefore, the first-order difference calculation was performed on all variables. After the first-order difference, all variables passed the significance test and were significant at the 1% level. It shows that all variables are integrated of order 1. The data meet the basic requirements of panel analysis.

Table 5. The unit root test.

Variables	Original	First Order Difference
CPAD	0.5676 (0.7148)	−12.1733 *** (0.0000)
Education	−0.5161 (0.3029)	−7.2305 *** (0.0000)
Production	2.9682 (0.9985)	−11.5961 *** (0.0000)
Industrial	6.0015 (1.0000)	−8.6278 *** (0.0000)
Employment	−7.6094 *** (0.0000)	−24.1675 *** (0.0000)
Ecological	−7.6333 *** (0.0000)	−17.3525 *** (0.0000)

Note: The value in the first row of the table is the W-t-bar statistics, and the *p* value is listed in parentheses; *** indicates the significant level at 1% level.

4. Results and Discussion

This section provides the estimated results in several subsections. Firstly, it provides the estimation results of static panel analysis using the double fixed effect model. The results show the impact of education investment on regional poverty in static panel data is positively significant. Secondly, it provides the estimation results of the dynamic panel model. The results show that the impact of education investment and poverty degree in the

previous period on regional poverty in dynamic panel data is also positively significant. Lastly, it provides the estimation results of quantile regression. The results show the impact of education investment on regional poverty in different levels of comprehensive poverty alleviation degree is positively significant.

4.1. Static Panel Model Estimation

OLS regression model, fixed effect model, and random effect model can be used to analyze panel data. When selecting the analysis model, Wald-F and LM tests are needed to determine whether the OLS regression model is adopted. The Hausman test is then utilized to pick between the fixed effect model and the random effect model. The estimation results of OLS estimation, the double fixed effect model, and the random effect model are provided in Table 6 (1)–(3) for comparison. The Wald-F test, the LM test, and the Hausman test all rejected the null hypothesis at the 1% significance level, demonstrating that the double fixed effect model provides more accurate estimates than the OLS model and the random effect model. In this study, just the estimation results of model (2) are discussed. The coefficients in models (1)–(3) are the coefficients after controlling heteroscedasticity. By comparing the adjusted R-square, it is also possible to determine that model (2) provides the greatest goodness of fit. In the static panel model study, the most accurate model is the time individual double fixed effect model. The findings of the time fixed effect analysis in model (2) indicate that nine of the fourteen coefficients are statistically significant.

Table 6. Static panel model estimation results.

Variables	(1)	(2)	(3)
Education	0.0666 *** (0.000)	0.0380 *** (0.000)	0.0759 *** (0.000)
Production	0.0140 ** (0.037)	0.0170 *** (0.000)	0.0051 (0.102)
Industrial	−0.0024 *** (0.000)	−0.0016 *** (0.000)	−0.0027 *** (0.000)
Employment	0.0008 (0.643)	0.0014 (0.195)	−0.0003 (0.822)
Ecological	0.4150 (0.259)	−0.0863 (0.589)	−0.2330 (0.293)
Constant	447.8097 *** (0.001)	469.9299 ** (0.044)	947.4784 *** (0.000)
Time			
2008		77.34 ***	
2009		50.78 **	
2010		106.74 **	
2011		−18.54	
2012		86.23	
2013		199.19 *	
2014		233.89 **	
2015		168.52	
2016		195.99	
2017		879.53 ***	
2018		1036.71 ***	
2019		1080.31 ***	
2020		1163.968 ***	
R-sq	0.8595	0.9483	0.9241
Adj. R-sq	0.8578	0.9418	0.9174
F	195.77 ***	379.06 ***	11.290 ***

Note: The p value is listed in parentheses; *, **, *** indicates the significant level at 10%, 5%, and 1% level, respectively.

In model (2), the coefficients of “Education”, “Production”, and “Industrial” are significant at the 1% level. The coefficient of “Education” is 0.0380, which indicates that when the regional education investment is increased by 10,000 CNY, the regional comprehensive poverty alleviation degree (CPAD) can be increased by 0.038 points. This demonstrates that education expenditure has a considerable beneficial impact on reducing regional poverty. For the variable of agricultural productivity, the coefficient is 0.0170. This also shows that increasing regional agricultural output is one solution to the issue of poverty. As for the impact of industrial level on reducing poverty in Yunnan Province, an unexpected result was discovered. The coefficient of “Industrial” is -0.0016 , which indicates that the poor counties will get poorer as the value generated by industry increases. The reason for this phenomenon may be that the industrial development of poor counties in Yunnan has been severely constrained by natural environment and geographical conditions; at the same time, the increase of industrial output value cannot play a significant role in poverty alleviation due to the backward level of industrialization.

In the static panel model study, the most appropriate double fixed effect model is selected, and it is determined that education investment has a positive and important role in alleviating poverty in poor counties in Yunnan Province. Nevertheless, given the clear intergenerational impact of poverty, dynamic panel analysis should be utilized to further examine it.

4.2. Dynamic Panel Model Estimation

To better comprehend the dynamic impact of education investment on the elimination of poverty in impoverished counties of Yunnan Province, System GMM is used to develop models (1) and (2) in the following table. Models (1) and (2) provide the estimated regression coefficients for the core explanatory variables when the first and second lag periods of the explained variables are included in the equation. The coefficients in models (1) and (2) are the coefficients after controlling heteroscedasticity. The second-order sequence correlation tests of models (1) and (2) accept the null hypothesis, and the results of the Sargan P and Hansen P tests indicate that there is no substantial issue with weak instrumental variables. Table 7 illustrates the dynamic panel model estimation results.

The System GMM estimate results reveal that the first-order lag of the explained variable in model (1) is significant at 1% level, with a coefficient of 0.5097; the explanatory variable “education investment” is significant at the 5% level, with a coefficient of 0.0735; the explanatory variable “production” is significant at the 5% level, with a coefficient of 0.0984; the explanatory variable “employment” is significant at the 10% level, with a coefficient of 0.0593. In model (2), the first and second-order lags of the explained variable are not statistically significant; there are three explanatory variables are significant at 5% level, which are “education investment”, “production”, and “employment”. On the whole, the short-term effect of regional comprehensive poverty is 1.1933 times that of the long-term effect ($1 - (-0.2318 + 0.0385)$). This shows that the output effect of poverty alleviation resources has the characteristics of diminishing marginal return on the whole.

Whether in model (1) or model (2), “education investment” as an explanatory variable is significant at 5% level. In terms of coefficient significance, the estimate result of model (1) may more accurately reflect the actual change law of dynamic panel data. The following discussion will center on model (1). Through system GMM analysis of dynamic panel data, it is determined that “education investment” plays a significant positive role in alleviating regional poverty; “production level” and “employment” also showed a significant poverty alleviation effect; the coefficient of “industrial level” is the same as the result of static panel analysis, indicating a negative value (not statistically significant). This result conforms to expectations.

Table 7. Dynamic panel model estimation results.

Variables	(1)	(2)
L.CPAD	0.5097 *** (0.000)	−0.2318 (−0.407)
L2.CPAD		0.0385 (0.746)
Education	0.0735 ** (0.022)	0.0599 ** (0.012)
Production	0.0984 ** (0.023)	0.0834 ** (0.012)
Industrial	−0.0308 (0.909)	−0.0365 (0.876)
Employment	0.0593 * (0.066)	0.1717 ** (0.036)
Ecological	0.0028 (0.453)	0.0025 (0.484)
Constant	0.8124 (0.808)	0.8062 (0.785)
AR(1)	(0.007)	(0.149)
AR(2)	(0.563)	(0.789)
Sargan P	0.018	0.000
Hansen P	1.000	1.000

Note: L.CPAD and L2.CPAD indicate the variables with the first and second lag periods, respectively. *, **, *** indicates the significant level at 10%, 5%, and 1% level, respectively.

4.3. Quantile Regression Estimation

Quantile regression analysis is required to further comprehend the impact of “education investment” on regional poverty alleviation at varying degrees of poverty. As shown in Table 8, the coefficient of “education investment” stays significant and exhibits an upward trend between the quantiles 0.05–0.95. However, the rate of change of this coefficient is gradually decreasing. Between 0.05 and 0.75 quantiles, the coefficient of “industrial level” is significant and subsequently increases with a negative value. Except for the coefficients of the above two variables, the coefficients of other explanatory variables are not significant. Within the quantile range of 0.05 to 0.95, the coefficients of variables “production” and “ecological” show a decreasing trend. The variable “employment” shows an increasing trend with decreasing rate of speed.

Table 8. Quantile regression estimation.

Quantile	Education	Production	Industrial	Employment	Ecological
0.05	0.5161 *** (0.000)	0.1127 (0.596)	−1.2281 *** (0.000)	−0.0450 (0.564)	−0.0076 (0.691)
0.1	0.5193 *** (0.000)	0.1043 (0.550)	−1.2017 *** (0.000)	−0.0329 (0.607)	−0.0079 (0.613)
0.25	0.5278 *** (0.000)	0.0827 (0.440)	−1.1334 *** (0.000)	−0.0016 (0.967)	−0.0088 (0.361)
0.5	0.5394 *** (0.000)	0.0533 (0.759)	−1.0403 *** (0.000)	0.0410 (0.520)	−0.0100 (0.524)
0.75	0.5554 *** (0.000)	0.0125 (0.973)	−0.9111 ** (0.026)	0.1003 (0.466)	−0.0116 (0.732)

Table 8. Cont.

Quantile	Education	Production	Industrial	Employment	Ecological
0.9	0.5648 *** (0.000)	−0.0116 (0.982)	−0.8350 (0.128)	0.1351 (0.463)	−0.0125 (0.782)
0.95	0.5683 *** (0.000)	−0.0205 (0.970)	−0.8069 (0.179)	0.1480 (0.462)	−0.0129 (0.795)

Note: **, *** indicates the significant level at 5%, and 1% level, respectively.

According to the result of quantile regression, all explanatory variables adhere to the law of diminishing marginal effect as poverty level decrease. When the poverty problem is severe (the comprehensive poverty alleviation degree is low), the coefficient value for the main explanatory variable “education investment” is likewise low; when comprehensive poverty alleviation improves, the coefficient value increases, but the growth rate decreases.

4.4. Discussion

Static panel estimation yields a fair estimation result. As the primary explanatory variable, the coefficient of “education investment” remains significant, indicating that, at the static level, education investment plays a crucial role in the alleviation of regional poverty. Human capital has increased in impoverished regions as a result of a rise in education expenditures, resulting in a rise in work productivity. Therefore, education is one of the most essential means of combating poverty. Increasing education spending may dramatically alleviate poverty in impoverished regions. Increasing the government’s educational expenditures can not only increase the quality of education, but also enable children from low-income households to obtain free educational resources throughout compulsory schooling. However, education investment and output cannot be reflected at a static level, and education’s return has an obvious lag. The use of static analysis to examine the effect of education expenditures on regional poverty eradication is therefore inadequate.

The results of dynamic panel estimate indicate that education investment has both short- and long-term effects on the elimination of regional poverty. In addition, the findings of quantile regression indicate that when the quantile increases, the coefficient of the education investment likewise increases, although at a slower rate. This demonstrates that the anti-poverty effect of education investment is stable and long-lasting. The human capital of inhabitants in disadvantaged regions has progressively grown over a lengthy period of time due to a rise in education spending. Moreover, the accumulation of human capital has the characteristics of intergenerational transmission, which gives education investment a crucial role in eradicating poverty. As a result of society’s requirement to judge the benefits of education primarily on the level of academic education, the return on investment in education is commonly lagging. After completing their formal education, students learn the market-required labor skills in order to increase productivity. In terms of family income, students are unable to work during their academic education; hence, they cannot increase family revenue.

From the results of quantile regression, we can see that with the improvement of comprehensive poverty alleviation, the effect of education investment on regional poverty alleviation conforms to the trend of diminishing marginal effect, but it has not reached the highest level, and there is no reduction. At the same time, the effect of other poverty alleviation assets on poverty eradication also shows a decreasing trend of marginal effect. However, the effect of different explanatory variables on poverty eradication is at different stages.

5. Conclusions

This paper analyzes panel data for 30 impoverished counties in Yunnan province of China from 2007 to 2020. This study examined the static and dynamic effects of education investment on regional poverty alleviation. The results indicate that education has a considerable beneficial effect on reducing poverty through the accumulation of human capital, and that this effect adheres to the law of diminishing marginal effect. Moreover, this study indicated that the effect of education expenditure on poverty alleviation in 30 poor counties of Yunnan Province is still increasing, has not yet hit its peak, and there are no indications of a downturn. In light of the fact that all poverty-stricken counties in Yunnan have eliminated absolute poverty by the year 2020, the research findings indicate that as poverty declines, the poverty alleviation effect of education investment becomes increasingly evident. Even if absolute poverty is eradicated, education investment remains an essential method for alleviating relative poverty. If we intend to achieve our objective of eradicating poverty by expanding educational investment, we must consider the long-term influence of education on poverty alleviation and the judicious deployment of educational resources. In the absence of equitable educational investment distribution, the role of education in relieving poverty will be diminished.

According to the findings of this paper, the following education investment suggestions may be made from the standpoint of reducing poverty:

Firstly, after the regional poverty has been alleviated to a certain extent, the return on poverty alleviation of education investment gradually decreases. The government should better plan the use of financial investment in education to guarantee that education investment plays a substantial role in the long-term alleviation of poverty.

Secondly, maximize the utilization of education expenditures in accordance with the characteristics of impoverished regions. In poor counties of Yunnan, for instance, the majority of education spending is allocated to the building of instructional facilities, while subsidies and guarantees for teachers are quite inadequate. Increase the guarantee and training of teachers to enhance the quality of education and make education investment a key factor in reducing poverty.

The research subject of this paper is 30 impoverished counties in Yunnan Province, and the results may have limits. Different results may be formed in various nations or regions due to the varying causes of poverty and socioeconomic situations at the most fundamental level. Based on this paper, future research should further investigate the role of various investment structures in education in eradicating poverty and identify the most effective education poverty alleviation strategy, or, from the micro level, investigate the marginal relationship between education investment and return from the perspective of individuals or families and determine the most effective decision-making basis for various families' or individuals' education investment. Simultaneously, future study might also investigate the mechanism of the quality of education in reducing poverty.⁵

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Notes

- 1 The United Nations, Shared Responsibility, Global Solidarity: Responding to the Socio-Economic Impacts of COVID-19. https://www.un.org/sites/un2.un.org/files/sg_report_socio-economic_impact_of_covid19.pdf (accessed on 20 December 2022).
- 2 China's current rural poverty standard line is set in 2019: the annual income per person is 3218 Yuan.
- 3 The western region includes 12 provinces: Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang.
- 4 There are four concentrated contiguous areas of extreme poverty in Yunnan province: the border mountainous area in the west of Yunnan province, the Wumeng mountainous area, the Tibetan area in Diqing, and the rocky desertification area. See the website of the Central People's Government of the People's Republic of China for more details: http://www.gov.cn/jrzq/2013-09/09/content_2484232.htm (accessed on 20 December 2022).
- 5 This paper is a part of Xiaowen Xie's Ph.D. thesis at the Graduate School of Development Economics, National Institute of Development Administration.

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