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Impact of Education on Multidimensional Poverty Reduction at the Post-Poverty Alleviation Era in Xinjiang

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The multidimensional poverty index is an indicator system established for defining and evaluating poverty, to understand poverty in dimensions beyond just monetary scarcity. Based on income, education, health, living standards, and social dimensions, this article measures and analyzes the level of multidimensional poverty in Xinjiang using the Alkire-Foster method, with cross-sectional data obtained from a 2022 survey. Probit model is constructed for regression analysis, further considering the impact of education on enhancing feasible capabilities and alleviating multidimensional poverty at the post-poverty alleviation era. The data shows that many people still face significant challenges from the perspective of multidimensional poverty; the decomposition results of each dimension show that education contributes more to the multidimensional poverty; the regression analysis results show that the higher the education level, the lower the multidimensional poverty; heterogeneity analysis revealed that the inhibitory effect of education on multidimensional poverty is greater for females than males, and the poverty reduction effect of education mainly concentrates on middle-aged and older individuals. This article is meaningful for exploring strategies to alleviate multidimensional poverty in ethnic minority regions in frontier areas in the new era, accelerating regional economic development, and achieving shared prosperity.

Keywords: Multidimensional Poverty, Education, Alkire-Foster Method, Poverty Alleviation

JEL Classification: I24, I32, O15

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I. Introduction

The issue of poverty has always been a widespread social phenomenon in the development process of human society. Reducing poverty is a basic requirement for a country's progress, and eliminating poverty is a key goal for human society to achieve long-term development. In recent years, China has achieved great poverty reduction in its development history. It proclaimed to have comprehensively eradicated absolute poverty in 2020, based on the current China's standards, which set the poverty line at 2,300 Chinese yuan per person per year (at 2010 constant prices) equivalent to approximately $2.2 per day when calculated using purchasing power parity (Chong et al., 2022). This marks the beginning of a new stage in poverty alleviation work, namely the post-poverty alleviation era. However, the development disparities among different regions in China suggest that relatively disadvantaged issues will still exist. For example, in 2020, the ratio of per capita disposable income between the eastern and western regions of China was 1.62, and the ratio of per capita disposable income between urban and rural residents was 2.56 (Zheng et al., 2021). Xinjiang Uygur Autonomous Region (hereinafter referred to as Xinjiang) is located in the inland region of northwest China. In the past, it not only had the characteristics of deep poverty and high poverty incidence rate, but also had its unique poverty features, such as the generally lower education level of rural residents and the lower proficiency in Mandarin of some ethnic minorities. The comprehensive popularization and development of education is an important pathway to improve income levels and alleviating absolute poverty (Lavell et al., 2023). In the post-poverty alleviation era, the role of education in alleviating multidimensional poverty will continue to be demonstrated.

The Multidimensional Poverty Index (MPI) is utilized in this study as an indicator system to define and evaluate poverty precisely. This article expands on the three dimensions (income, education, and infrastructure) set by the global MPI. Building upon the dimensions of income, education, health, living standards, and social factors, it further selects ten specific indicators to construct a multidimensional poverty index system. Using the Alkire-Foster (A-F) method (Alkire and Foster, 2011), the article measures the extent of multidimensional poverty in the Xinjiang region and conducts a research analysis on its multidimensional poverty situation. Based on the results of the multidimensional poverty measurement, Probit model is constructed for regression analysis. This study validates that education is a significant determinant of multidimensional poverty and further confirms its role in enhancing capabilities

and alleviating multidimensional poverty at the individual level. The findings have implications for policymakers in Xinjiang and other regions facing similar challenges, emphasizing the need to prioritize education as a key strategy for poverty reduction.

II. Literature Review

1. Multidimensional Poverty Theory

In the late 20th century, Sen (1976) creatively proposed the concept of capability, which is described as the ability to do what one wants to do and to live in an environment that corresponds to one's ideals. The capability theory is the key factor that prompts a fundamental reflection on poverty concepts, particularly in the broad field of economics (Jenkins and Micklewright, 2007). The capability concept eventually saw human progress as progress in human freedom and capability to live the kind of lives that people have reason to value (Drèze and Sen, 2013).

Sen (2001) extended a multidimensional poverty theory based on the capability theory, which indicated that individuals' welfare rights should receive more attention, rather than just focusing on their survival capabilities. Since then, a measure of poverty that considers individual welfare, capabilities, and social inclusiveness was developed (Tiwari, 2007), and multidimensional poverty analysis has become an increasing important component of poverty research worldwide.

Afterward, researchers from the Oxford Poverty and Human Development Initiative and the United Nations Development Programme (UNDP) established a systematic indicator for measuring multidimensional poverty that included education, health, and standard of living, based on Amartya Sen's capability theory, which is the global MPI (Alkire and Foster, 2011). The Global MPI uses three dimensions of health, education, and living standards, and assigns equal weights to them, which has been adopted by many studies.

2. Education and Poverty

According to Bhorat (1999), relying solely on the income index cannot provide strong evidence to analyze the overall poverty situation. Only through multidimensional research and analysis, such as education and health, can the poverty situation of a regional population be fully reflected. Education is not only a dimension of

multidimensional poverty, but also an important resource for integrating humans into the labor market and society's main sectors (Sen and Anand, 1997).

Ram (2021) suggested that when investigating the poverty situation in rural China, the higher the education level of a family's labor force, the more likely the poor family is to escape poverty. Faggio et al. (2010) studied the correlation between poverty-stricken areas and education believe that improvement in educational attainment is one of the fundamental channels for reducing poverty in impoverished regions. Therefore, education and poverty alleviation should also have intricate connections.

3. Poverty in Xinjiang

The four southern prefectures of Xinjiang have characteristics such as being remote and inland, multiculturalism, and underdevelopment. As a result, scholars studying multidimensional poverty in Xinjiang's local field tend to focus on the four southern prefectures when measuring multidimensional poverty and studying its spatiotemporal evolution and influencing factors (Chen et al., 2022; Yao and Wang, 2021), investigating the degree and characteristics of multidimensional poverty among the main ethnic groups in contiguous extremely poor areas in Xinjiang. For example, Chen et al. (2022) studied the spatial distribution and regional differences of poverty in Southern Xinjiang based on a multidimensional poverty identification index system. In addition, scholars have respectively argued that information asymmetry (Yao and Wang, 2021), health conditions (Zhang and Zhao, 2021), natural disasters (Ullah et al., 2020), or water scarcity (Wang et al., 2023) are significant issues contributing to poverty in Xinjiang. Yao and Wang (2021) suggest that anti-poverty work needs to fully consider the multidimensionality and diversity of poverty among various ethnic groups in Xinjiang to enhance the endogenous development capabilities of impoverished populations. Some studies have separately explored the relationship between inclusive finance (Li et al., 2022), tourism development (Yang et al., 2021), improved public health (An and Zhang, 2022; Uskoković, 2023) increased agricultural efficiency (Mi et al., 2020), or ecological environment construction (Jiang et al., 2021), and household income, and further examine the potential effects of these factors in reducing poverty in Xinjiang.

In summary, previous studies mainly focused on limited dimensions or limited areas in Xinjiang, while this study is the result of multidimensional poverty research in Xinjiang. In addition, based on the three dimensions of the global MPI and the actual

poverty situation in Xinjiang, this study selected corresponding multidimensional poverty indicators to calculate the MPI. Through the decomposition and empirical analysis of MPI, the mechanism of multidimensional poverty formation is explored, emphasizing the importance of education in improving individual quality of life and reducing poverty. This provides a reference for achieving targeted poverty alleviation and consolidating poverty alleviation work.

III. Multidimensional Poverty Analysis

1. Multidimensional Poverty Measurement Methods

(1) Alkire-Foster method

The A-F method is a flexible approach that can adapt to various situations by selecting different dimensions (such as education), poverty indicators within each dimension (such as a person's educational attainment), and poverty cutoffs (such as considering education levels below compulsory education as deprivation). This method has been widely applied to empirical research on multidimensional poverty at the micro level, which is a systematic multidimensional poverty measurement method. Therefore, this study uses the A-F method to measure the multidimensional poverty status of residents in Xinjiang, and analyzes the multidimensional poverty situation in the region using the MPI. This method consists of three stages: poverty identification, poverty aggregation, and poverty decomposition.

A-F method applies two critical values to identify poverty. One critical value is used to measure each indicator for each sample to assess whether the indicator of the sample belongs to poverty. If the overall dimension surpasses the threshold value, then poverty is increased by a dimension. For example, for a single income dimension, if the average annual income is less than 2,300 yuan (unless otherwise specified, all amounts are in Chinese yuan), it is identified as one-dimensional poverty. The other critical value is used as the threshold for the number of dimensions that define multidimensional poverty. For example, when the threshold is set to 3, if the total of deprivation scores exceeds 3, it will be considered as a situation of multidimensional poverty. After determining the critical values, the established multidimensional poverty indicator system is used to measure and comprehensively identify poverty. Finally, the MPI is calculated through three-level aggregation to determine individuals' multidimensional poverty status.

The uniqueness of the A-F method lies in its ability to differentiate, for example, a group of poor individuals who on average experience two episodes of deprivation from a group of poor individuals who on average experience five episodes of deprivation, by measuring intensity. The A-F method can be used to create national, regional, or international measures of poverty or well-being by incorporating dimensions and indicators that are suitable for specific circumstances. While the A-F method provides a single poverty headline measure, it can also be decomposed and analyzed in a powerful way to provide information for policy-making.

(2) Identification of multidimensional poverty

When identifying multidimensional poverty, first assume that n samples are selected, and m indicators are used to identify their poverty status. Therefore, the $n \times m$ matrix $X = [x_{ij}]$ represents the matrix composed of all samples. The row vector x_i represents the value of sample i in each dimension, and the column vector x_j represents the value of all samples in dimension j. x_{ij} corresponds to the value of individual i in dimension j. The row vector $Z = [Z_j]$ represents the poverty threshold of the selected dimension, which is used to determine whether an individual is deprived in dimension j. The process of identifying multidimensional poverty consists of the following two steps:

The first step is to determine whether sample i is in poverty in dimension j, and the deprivation matrix $g = [g_{ij}]$ is used to represent the result. The calculation formula is shown in Equation (1):

$$g_{ij} = \begin{cases} 1, & x_{ij} < Z_j \\ 0, & x_{ij} \geq Z_j \end{cases} \tag{1}$$

The second step is to determine whether an individual is in a state of multidimensional poverty. Assuming that individual i has a deprivation score $C_{i(k)} = \sum_{j=1}^{m} \omega_j g_{ij}$ in all dimensions, where the weight vector $\omega = (\omega_1, \omega_2, \ldots, \omega_m)$, $0 < \omega_j \leq 1$, and ω_j is the weight coefficient on dimension j, reflecting the relative importance of dimension j. When individual i is in poverty in at least k dimensions, $C_{i(k)} = \sum_{j=1}^{m} \omega_j g_{ij}$; otherwise, $C_{i(k)} = 0$.

After introducing the critical value k for multidimensional poverty, $Q = [q_i(k)]$ is used to determine whether the sample is in a state of multidimensional poverty. The multidimensional poverty $q_i(k)$ can be calculated using the following formula:

$$q_i(k) = \begin{cases} 1, & C_{i(k)} \neq 0 \\ 0, & C_{i(k)} = 0 \end{cases} \tag{2}$$

$C_{i(k)}$ represents the poverty level, which is a continuous variable. If $C_{i(k)}$ is not equal to 0, it is identified as poverty, and if $C_{i(k)}$ is equal to 0, it is identified as non-poverty. $q_i(k)$ represents the dummy variable indicating whether it is poverty.

(3) Aggregation of multidimensional poverty

The most common method of measuring poverty is by calculating the percentage of the population living in poverty, known as the headcount ratio (H). Once the identification of who is poor has been determined, the A-F method generates a unique class of poverty measures (M_0, MPI) that go beyond simple headcount ratios. This measure reflects both the incidence of poverty (percentage of the population living in poverty) and the intensity of poverty (percentage of poverty experienced by each individual or household). M_0 is calculated by multiplying the incidence (H) by the intensity (A).

$$M_0 = H \times A$$

Multidimensional poverty incidence (H): The multidimensional poverty incidence can express the proportion of the population in multidimensional poverty. Assuming the total sample size is n and the number of individuals in multidimensional poverty is q, the calculation formula for multidimensional poverty incidence is as follows:

$$H = \frac{q}{n} = \frac{\sum_{i=1}^{n} q_i(k)}{n} \tag{3}$$

Multidimensional poverty incidence can reflect poverty coverage at the macro level, but cannot reflect the share of deprivation of the poor.

Average deprivation gap (A): The average deprivation gap can represent the intensity of poverty, i.e., the ratio of the number of times multidimensionally poor

households or individuals are deprived to the total number of poor people. The calculation formula is as follows:

$$A = \frac{\sum_{i=1}^{n} c_i(k)}{q} \tag{4}$$

In Equation (4), $c_i(k)$ represents the number of indicators in which household or individual i is deprived when the poverty threshold is k, and $q_{ij}(k)$ represents the number of multidimensionally poor people when the poverty threshold is k.

MPI (M_0) represents the overall level of multidimensional poverty and is also known as the aggregated multidimensional poverty incidence. The MPI is composed of the product of multidimensional poverty incidence and average deprivation gap, and the calculation formula is as follows:

$$M_0 = H \times A = \frac{\sum_{i=1}^{n} c_i(k)}{n} \tag{5}$$

The size of M_0 can reflect both the distribution of poverty and the severity of deprivation.

It should be noted that MPI aims to capture multiple dimensions of poverty simultaneously, providing a comprehensive understanding of poverty beyond income-based measurements. Cutoff criteria (for H and A) are used to define thresholds for each dimension, indicating whether a person is deprived in that particular dimension. While cutoff standards may involve some subjectivity, the MPI framework strives to reduce this subjectivity by referencing literature in the field of poverty measurement, analyzing existing data on poverty indicators, considering social and economic backgrounds, and aligning with internationally recognized poverty measurement standards. The goal is to enhance the transparency and credibility of the multidimensional poverty index.

2. Data Source and Indicator Setting

(1) Source of data

The data used in this study was obtained through a questionnaire survey. Firstly, considering that answering poverty-related questions may involve personal dignity, using real-name questionnaires may lead to biased data collection, while using anonymous systems can protect the privacy of respondents and make it easier to obtain their true personal information. Secondly, as some poor areas or poor families may have difficulties in using networks or smart devices, conducting surveys only through the internet may result in selection bias. We also distributed a large number of (bilingual) questionnaires when promoting research in impoverished areas. Finally, due to the impact of the COVID-19 pandemic in recent years, on-site investigations have become more difficult, and survey costs are limited. Therefore, this study collected data through a combination of on-site surveys, online surveys, and commissioned surveys, each accounting for approximately one-third of the total data.

In addition, taking into account the overall situation of population in Xinjiang in terms of ethnicity, age, gender, marital status, and region, efforts were made to distribute the questionnaires using a stratified sampling method to enhance the representativeness of the samples and reduce biases as much as possible. The survey period was conducted in January 2022, with a total of 1200 questionnaires distributed, covering all 14 prefectures in Xinjiang. After screening the collected questionnaires, a total of 976 valid questionnaires were obtained. Among them, the gender ratio of the sample is approximately 1:1, and the proportion of ethnic minorities to Han Chinese is approximately 2:1. As Xinjiang has always been an autonomous region of ethnic minorities, the proportion of ethnic minorities to Han Chinese in the total population is also close to 2:1.

The basic statistical information of the sample is shown in Table 1:

Table 1. Frequency Analysis of Basic Information of Samples

Grouping	Options		Frequency	Percentage
Nationality	Han nationality		286	29.30
	Uygur nationality		411	42.11
	Other ethnic minorities		279	25.59
Age	Under 20		180	18.44
	20-35		492	50.41
	35-50		174	17.83
	Over 50		130	13.32
Gender	Male		492	50.41
	Female		484	49.59
Marital status	Married		634	64.96
	Unmarried		232	23.77
	Divorced or widowed		110	11.27
Income	Less than 2,800 RMB		241	24.69
	2800-3500 RMB		330	33.81
	3500-4500 RMB		278	28.48
	More than 4500 RMB		127	13.01
Education	No education		91	9.32
	Primary school		290	29.71
	Junior high school		243	24.90
	High school or secondary school		205	21.00
	Higher education		147	15.06
Health	Workforce health	All family members are healthy	583	59.73
		At least one family member is sick	393	40.27
	Medical insurance	Joined the cooperative medical insurance	799	81.86
		Not joined the cooperative medical insurance	177	18.14
Life	Housing condition	Made of thatch, wood, or stone structures	603	61.78
		Made of brick, tile, or reinforced concrete structure	343	35.14
	Drinking water condition	Tap water and bottled water	447	45.80
		Well water and river-lake water	529	54.20
	Energy condition	Firewood	223	22.85
		Coal, liquefied petroleum gas, or natural gas	753	77.15
	Information condition	Have a cell phone, telephone or television	976	100
		No cell phones, telephones or televisions	0	0
	Traffic condition	National road, provincial road, or township road	746	76.43
		Dirt road or no road	230	23.57
Social	Able to receive assistance from relatives and friends		505	51.71
	Unable to receive assistance from relatives and friends		471	48.26
Total			976	100

According to the results of Table 1, it is known that the majority of the survey subjects in this study are Uyghurs, accounting for 42.11%, while the proportions of Han and other ethnic minorities are 29.3% and 25.59%, respectively. The high proportion of Uyghurs is related to the surveyed region, and the diversity of ethnicities among the survey subjects is beneficial to ensuring the reliability of the empirical estimation results. From the age distribution, the survey subjects of all age groups are included in this study, which can also ensure the universality of the empirical estimation results. In terms of gender, the proportion of female survey subjects is close to that of male, indicating that there is no obvious gender bias in the empirical sample of this study. In terms of marital status, most of the respondents are married. In addition, t-tests indicate that there are no significant differences between the sample and the population in terms of ethnic, age, gender, and marital status distributions, which strengthens the argument for the representativeness of the sample.

(2) Description of indicators

In the process of designing indicators, not only the poverty characteristics of the targeted population need to be considered, but also the core needs of poverty alleviation in China. Based on the global MPI and the actual situation in Xinjiang, this article selects five dimensions: income, education, health, living standards, and social factors.

- **Income:** In the income dimension, because per capita annual income is an important factor in measuring individual income status, this article takes per capita annual income as the standard for measuring income.
- **Education**: In the education dimension, the key indicator for measurement is the level of education received.
- **Health**: This dimension is mainly measured by whether family members participate in basic medical insurance and the health status of the labor force in the family. Because the health status of the labor force will directly determine whether they have the ability to live and work, whether family members participate in insurance is a key guarantee to ensure that individuals can receive timely medical treatment and obtain medical insurance subsidies when they are ill, thereby preventing poverty caused by illness.
- **Life:** In the life dimension, the selected indicators mainly include five aspects: housing conditions, living energy conditions, transportation conditions, drinking water conditions, and information conditions.

- **Social:** In the social dimension, social relationships are considered one of the indicators for measuring the self-development ability of impoverished households or individuals.

(3) Weight of each dimension and determination of critical value

Equal weighting is a method that assigns equal weights to each dimension included in a multidimensional poverty system, and further assigns equal weights to each indicator within the same dimension based on the weights of each dimension. This article uses an equal weighting method to measure poverty, which is the same as the method used by most scholars when conducting related research. The main reasons are: 1) Multidimensional poverty indices are relatively stable. Authoritative research has conducted a correlation analysis of MPI under different weights and found that there is a high correlation between multidimensional poverty indicators, and even with different weights, the impact will not be significant. This research result shows that MPI is robust under different weights. 2) Equal weighting method is currently the most commonly used method in multidimensional poverty research. Therefore, it is reasonable to assume that the impact of each dimension on multidimensional poverty is equally important. Some dimensions contain sub-indicators, which are also given the same weight. Based on this, the MPI constructed in this article is shown in Table 2 below:

Table 2. Multidimensional Poverty Indicator System

Dimensions	Indicators	Indicator critical value	Weight
Income	Per capita annual income	Less than 2800 yuan is assigned a value of 1	0.2
Education	Educational level	Value is 1 if the education level of the main labor force is below junior high school or school-age children cannot be supported until the end of compulsory education	0.2
Health	Workforce health	Value is 1 if a family member has a serious or chronic disease*	0.1
	Medical insurance	Value is 1 if one or more family members are not covered by any health insurance	0.1

Table 2. Continued

Dimensions	Indicators	Indicator critical value	Weight
Life	Housing condition	Value is 1 if the housing structure is unsafe or if the housing structure is wood, stone or adobe	0.04
	Drinking water condition	Value is 1 if the drinking water source is not tap water	0.04
	Energy condition	Value is 1 if only firewood can be used as fuel	0.04
	Information condition	Value is 1 if there is no TV or mobile phone in the home	0.04
	Traffic condition	Value is 1 if the place of residence is not accessible by road or by road that is not accessible by car	0.04
Social	Funding condition	Value is 1 if they cannot get support or help from relatives and friends	0.2

Notes: *The Chinese government has a set of criteria for the classification of serious diseases and chronic diseases. For example, serious diseases include 28 types such as malignant tumors, while chronic diseases encompass 35 types including hypertension and diabetes.

(4) Reliability and validity

As the questionnaire data is used in this article, in order to improve the reliability of the survey questionnaire data, this article further analyzed the reliability and validity of the relevant questionnaires to determine the reliability of the empirical analysis results.

The reliability analysis is mainly used to test the stability and reliability of data. Usually, Cronbach's Alpha coefficient can be used to determine it. The larger the value of this coefficient, the stronger the stability and consistency between the data. Scholars have established a clear threshold for the coefficient. Only when the α coefficient is greater than 0.7, the sample is stable and consistent. In this article, Stata is used for reliability analysis, and the corresponding results are shown in Table 3. It can be found that the α coefficient is greater than 0.7, indicating that the sample data estimated in this article is stable and consistent.

Table 3. Reliability Test Results

	α coefficient	Number of items
$Poverty$	0.826	976

Note: $Poverty$ is a dummy variable of multidimensional poverty.

In addition, this article conducted a validity analysis. Generally speaking, the validity analysis of questionnaires can reflect the accuracy of data characteristics. The effectiveness of a measurement tool is better when it has a higher validity, otherwise it indicates that the validity of the measurement tool needs improvement. In this article, the common practice of existing literature and structural validity are selected to analyze the measuring tool used in this article, and the corresponding validity test results are shown in Table 4. It can be found that the KMO value is greater than 0.6, so the validity test results are also reasonable.

Table 4. Validity Test Results

	KMO	Approximate chi-square	Df	sg
Poverty	0.725	1149.572	10	0.000

3. Multidimensional Poverty Result Analysis

(1) Measures of multidimensional poverty

The breadth, intensity, and degree of multidimensional poverty are expressed by H, A and M_0. If the deprivation threshold set is different, the corresponding M_0 value will also be different in the calculation process. The identification of multidimensional poverty mainly depends on the choice of threshold value. Typically, the range of k, which represents the threshold value, is between 1 and 10. The results are shown in Table 5.

Table 5. Multidimensional Poverty Measurement Results

k	Incidence of poverty (H)	Share of poverty deprivation (A)	MPI (M_0)
1	0.83	0.31	0.257
2	0.67	0.36	0.241
3	0.51	0.44	0.224
4	0.36	0.55	0.198
5	0.21	0.61	0.128
6	0.12	0.70	0.084
7	0.03	0.77	0.023
8	0	-	0
	…		…

The measurement results in Table 5 show that as the value of k increases, the poverty deprivation share continues to increase, while the poverty incidence and MPI decrease. When $k = 1$, the poverty incidence is 83%, and the MPI reaches 25.71%, indicating a higher poverty incidence when one indicator is deprived. UNDP has set $k = 3$ as the criterion for multidimensional poverty, which has been widely applied by scholars in various countries in recent years. Based on this criterion, this article mainly takes $k = 3$ as the standard for judging the existence of multidimensional poverty, and conducts corresponding measurements and analysis. When the threshold value for deprivation is set at $k = 3$, the poverty incidence and MPI are 51% and 22.44%, respectively. According to international standards, these figures indicate that half of the individuals experience multidimensional poverty when the threshold value is three. As the poverty threshold value increases, H and M_0 continue to decrease. When the threshold value reaches 8, both the MPI and poverty incidence drop to zero. This indicates that there are no individuals that are deprived of 8 or more indicators, and there is no multidimensional poverty when $k \geq 8$.

(2) Decomposition of MPI

In order to explore the main poverty factors of multidimensional poverty, analyze the poverty depth, this article decomposes each dimension indicator established in the article one by one. The formula for decomposing the MPI by indicator is as follows:

$$M_j = \frac{q_j w_j}{n} \tag{6}$$

As in the previous section, q_j represents the total number of multidimensionally deprived individuals in dimension j, w_j represents the weight of dimension j, and n represents the total number of individuals. Therefore, the contribution rate of multidimensional poverty for each dimension (P_j) can be deduced as:

$$P_j = \frac{M_j}{M_o} = \frac{q_j w_j / n}{\sum_{i=1}^{n} c_i(k)/n} \tag{7}$$

The results of multidimensional poverty contribution rates of each dimension are shown in Table 6.

Table 6. Contribution Rate of Each Dimension under Different k Values

k	M_0	Income	Education	Healthy	Insurance	Housing	Drink water	Energy	Information	Traffic	Subsidize
1	0.257	0.181	0.246	0.175	0.062	0.138	0.033	0.076	0.045	0.025	0.020
2	0.241	0.180	0.235	0.176	0.053	0.143	0.037	0.071	0.049	0.027	0.101
3	0.224	0.180	0.234	0.179	0.046	0.148	0.032	0.069	0.041	0.022	0.050
4	0.198	0.154	0.224	0.155	0.048	0.144	0.029	0.070	0.039	0.210	0.106
5	0.128	0.160	0.250	0.158	0.038	0.144	0.028	0.064	0.037	0.016	0.106
6	0.084	0.146	0.238	0.144	0.029	0.135	0.024	0.063	0.034	0.015	0.172
7	0.023	0.140	0.211	0.141	0.024	0.155	0.026	0.059	0.034	0.014	0.191

Table 6 shows that when $k = 1$, the contribution rate of the education dimension to MPI is greater than its weight of 20%, at 24.56%; while the contribution rate of the income dimension is 18.14%, which is less than its weight of 20%. This indicates that currently, income may not be the key factor contributing to multidimensional poverty among residents in Xinjiang. When $k = 3$, although the multidimensional poverty incidence under each indicator has decreased, the data results show that deprivation is still severe, with a multidimensional poverty incidence of 22.44%. This suggests that although all impoverished families in the region have escaped poverty based on income measurement, multidimensional poverty still exists, and major issues such as education still need to be addressed. From the data in the table, when $k = 7$, the contribution rate of the education level is as high as 21.05%, still exceeding its weight. This indicates that the education dimension is an important component of the multidimensional poverty of Xinjiang residents. This finding can help us adopt more targeted strategies for poverty alleviation and prevention of relapse in Xinjiang during the post-poverty era.

IV. Empirical Analysis of Education on Poverty Reduction

1. Model Construction

To examine the impact of education on multidimensional poverty, this paper conducts an analysis by building an econometric model. Considering that the dependent variable is a dummy variable, a Probit model is constructed for estimation. In the

robustness section, the econometric model is replaced to ensure the reliability of the estimation results. The corresponding econometric model is as follows:

$$\Pr(poverty_i = 1) = \beta_0 + \beta_1 Edu_{i,c} + \beta_2 Controls + \varepsilon_{i,c} \quad (8)$$

Where $poverty_i$ indicates whether individual i is in multidimensional poverty, $Edu_{i,c}$ represents the education investment level of the region c where individual i is located, $Controls$ is a set of control variables used to control for other factors that may affect multidimensional poverty, $\varepsilon_{i,c}$ is the random disturbance term representing other factors that may affect multidimensional poverty but have not yet been controlled. β is the parameter to be estimated.

2. Variable Selection

(1) Explained variable

The dependent variable focused on in this paper is multidimensional poverty ($Poverty$). Its identification method is as follows: when an individual is in multidimensional poverty, the variable takes a value of 1, otherwise the variable takes a value of 0. The corresponding dimensions of poverty are as shown in the previous text.

(2) Explanatory variable

The education level (Edu) uses an individual's level of education as a proxy variable, with a value of 1 if the individual's education level is high school or secondary school or above, and 0 otherwise.

(3) Control variables

This article mainly studies the impact of education on multidimensional poverty in Xinjiang. Considering that there are many factors that affect multidimensional poverty, in order to avoid the interference of other factors on the regression estimation results, this article further controls for relevant individual characteristic variables in the regression model, including ethnicity, gender, family size, marital status and age. The specific variable definitions are shown in Table 7.

Table 7. Variables Meaning

Variables	Specific indicators	Code	Specific definition
Explained variable	Multidimensional poverty	$Poverty$	If the individual is in multidimensional poverty, the value is 1; otherwise, the value is 0
Explanatory variable	Educational level	Edu	If the individual's education level is high school or above, the value is 1; otherwise, the value is 0
Control variables	Ethnic group	$Race$	If the individual belongs to the Uygur nationality, the value is 0, the value of other ethnic minorities is 1, and the value of Han nationality is 2
	Gender	Sex	The value is 1 if the individual is male and 0 if the individual is female
	Household size	$Family$	If the number of household members is greater than 3, the value is 1; otherwise, the value is 0
	Marital status	$Marriage$	Married takes the value 0, unmarried takes the value 1, and divorced or widowed takes the value 2
	Age	Age	If the age is less than 20, the value is 0; if the age is between 20 and 35, the value is 1; if the age is between 35 and 50, the value is 2; and if the age is over 50, the value is 3

Table 8 shows the descriptive statistics of the variables. It can be found that the mean value of multidimensional poverty is 0.753, indicating that a large proportion of individuals in the sample are in a state of multidimensional poverty.

Table 8. Descriptive Statistics

Variables	Mean	p50	SD	Min	Max	N
$Poverty$	0.753	1	0.431	0	1	976
Edu	0.567	0	0.657	0	1	976
$Race$	0.872	1	0.836	0	2	976
Sex	0.504	1	0.500	0	1	976
$Family$	0.461	0	0.499	0	1	976
$Marriage$	0.463	0	0.689	0	2	976
Age	1.260	1	0.910	0	3	976

3. Analysis of empirical results

(1) Regression analysis

To analyze the influence of education on individuals' multidimensional poverty, a Probit model is used for estimation, and the corresponding regression estimates are

shown in Table 9. The first column shows the estimation results with only the core explanatory variable included, and the regression coefficient of education is -0.147, which is significant at the 1% level. This indicates that there is a negative correlation between education level and the probability of multidimensional poverty at the individual level, consistent with the theoretical analysis in the previous section. The second and third columns add corresponding control variables, and it can be found that the regression coefficient of education is still significantly negative after adding control variables, indicating that the addition of control variables does not directly affect the estimation direction of this article. The higher the level of education, the higher an individual's potential income capacity (Glyn and Salverda, 2000). Therefore, selecting to encourage education is a way to help the most disadvantaged families and promote long-term economic growth.

Table 9. Benchmark Regression Results

Variables	$Poverty$		
	(1)	(2)	(3)
Edu	-0.147***	-0.150***	-0.151***
	(0.050)	(0.050)	(0.050)
1.$Race$		-0.000	-0.011
		(0.108)	(0.109)
2.$Race$		-0.111	-0.119
		(0.105)	(0.106)
Sex		-0.219**	-0.216**
		(0.089)	(0.089)
$Family$		0.148*	0.143
		(0.089)	(0.090)
1.$Marriage$			-0.026
			(0.107)
2.$Marriage$			-0.051
			(0.142)
1.Age			-0.374***
			(0.129)
2.Age			-0.440***
			(0.152)
3.Age			-0.220
			(0.168)
Constant term	1.269***	1.364***	1.689***
	(0.205)	(0.227)	(0.254)
Observation	976	976	976

Notes: *, ** and *** indicate significance at the levels of 10%, 5% and 1%, respectively. Standard errors are in parentheses.

Observing the control variables, it can be found that: Firstly, the relationship between ethnicity and poverty is not significant, indicating that poverty alleviation in Xinjiang is well-managed, and the concept of ethnic unity and integration in China has been well-reflected in poverty alleviation work. Secondly, the probability of male poverty is smaller than that of females. From domestic to global, females have more unpaid household and caregiving work, earn lower wages when working outside, may lack the right to participate in land allocation and inheritance in some rural areas, and have lower average levels of education and labor skills compared with males. These features are closely related to female poverty. Then, the impact of family size and marital status on poverty is not significant. This shows that individuals can achieve relatively autonomous development in work and life, and whether they are in poverty mainly depends on their personal efforts. Finally, there is a U-shaped relationship between age and poverty incidence. A universal income guarantee and welfare system should be established, with a focus on protecting adolescents and the elderly.

(2) Robustness analysis

Although the Probit regression shows a negative correlation between the increasing education level and the probability of multidimensional poverty for individuals, and a series of control variables have been added to the model for analysis, the estimation results of this article may still be biased. In order to improve the reliability of the estimation results, empirical analysis is conducted through replacement of econometric models, changing the dependent variable measurement method, adding independent variables, and instrumental variable (IV) tests. The results are shown in Table 10. Firstly, to examine whether different deprivation cutoff values may lead to different results, a robustness test is conducted by setting $Poverty$ with $k = 6$ as the dependent variable. The results are shown in column (1). Secondly, the Logit model is used for estimation, and the corresponding estimation results are shown in the column (2). Thirdly, Ordinary least square method (OLS) model regression is conducted using the natural logarithm of continuous variable MPI as the dependent variable, and whether to accept 9-year compulsory education ($Edu9$) and high school, secondary school, and above education (Edu) as independent variables. The corresponding results are shown in columns (3) and (4).

In addition, Probit is used again with $Poverty$ excluding the dimension of education as the dependent variable, to examine whether the level of education still has a positive impact on the poverty index. The results are shown in columns (5) and (6) of Table 10.

In the case of reverse causality, where individuals lacking resources may be unable to afford higher levels of education, education becomes endogenous. Therefore, the presence of higher education institutions in the respondent's location is used as the IV for education, and the $Poverty$ without the education dimension is used as the dependent variable for IV regression. The existence of local higher education institutions reflects the availability of certain educational resources in the local area, which is strongly correlated with the education level of the respondents, especially those from poor families, satisfying instrument relevance. The presence of local higher education institutions in the respondents' location is not strongly correlation with their abilities and talents, nor is it closely related to the $Poverty$ without the education dimension, satisfying IV exogeneity. The results of the IV validity tests consistently demonstrate that the IV used in this study is reasonable and effective. Further discussion on this topic will not be elaborated upon here.

Table 10. Robustness Test Results

Variables	$Poverty\ (k=6)$	$Poverty$	$\ln MPI$		$Poverty$ (Excluding Education)	
	(1)	(2)	(3)	(4)	(5)	(6)
	Probit	Logit	OLS		Probit	IV-Probit
Edu	-0.058*	-0.266***	-0.044***		-0.122*	-2.087***
	(0.034)	(0.089)	(0.014)		(0.073)	(0.048)
$Edu9$				-0.139***		
				(0.049)		
Constant term	1.685***	2.994***	1.060***	1.372***	0.586***	0.726***
	(0.139)	(0.456)	(0.073)	(0.050)	(0.089)	(0.082)
Observation	976	976	965	965	976	976

Notes: *, ** and *** indicate significance at the levels of 10%, 5% and 1%, respectively. Standard errors are in parentheses. Regression results for the control variables are omitted and available upon request.

By examining Table 10, it can be seen that even after a series of robustness and endogeneity tests, the regression coefficient of education level remains significantly negative. This indicates that the empirical regression results are reliable, meaning that education has an inhibitory effect on multidimensional poverty.

(3) Heterogeneity analysis

It is worth discussing whether there are differences in the impact effects for individuals with different characteristics. This article will conduct empirical analysis from two

aspects: gender and age. Firstly, grouping regression by gender, the corresponding regression estimation results are shown in Table 11. It can be found that the regression coefficient of female education level in the sample is -0.2, which is significant at the 5% level, while the regression coefficient of education level in male samples is -0.138, also significant at the 5% level. This indicates that the inhibitory effect of education on multidimensional poverty is higher for women than for men. Women are more likely to be poor than men mainly because they lack education and resources to help them get out of poverty. As China attaches great importance to the development of education, women in ethnic areas have increasingly more opportunities to receive high school and higher education. Education increases women's employment opportunities and income, which has been demonstrated significantly in China's ethnic areas.

Table 11. Gender Heterogeneity

Variables	(1) Female	(2) Male
Edu	-0.200**	-0.138**
	(0.084)	(0.064)
1.$Race$	0.117	-0.120
	(0.162)	(0.150)
2.$Race$	-0.137	-0.078
	(0.154)	(0.149)
$Family$	0.242*	0.047
	(0.134)	(0.123)
1.$Marriage$	-0.127	-0.221*
	(0.142)	(0.132)
2.$Marriage$	-0.109	-0.128
	(0.205)	(0.206)
1.Age	-0.290	-0.450**
	(0.189)	(0.179)
2.Age	-0.414*	-0.479**
	(0.222)	(0.210)
3.Age	-0.399*	-0.012
	(0.237)	(0.241)
Constant term	1.847***	1.597***
	(0.399)	(0.329)
Observation	484	492

Notes: *, ** and *** indicate significance at the levels of 10%, 5% and 1%, respectively. Standard errors are in parentheses.

Furthermore, considering the differences in work ability at different age groups, this article further divided the sample into two groups based on age: under 35 and over 35. The corresponding regression estimation results are shown in Table 12. It can be found that the regression coefficient of education level is negative but not significant in the sample under 35, while it is significantly negative in the sample over 35, indicating that the poverty reduction effect of education mainly focuses on the sample over 35. One possible reason is that the widespread implementation of compulsory education and the expansion of higher education opportunities in China after the reform and opening-up period have reduced educational disparities among young people, allowing other socio-economic factors to play a more significant role in their poverty status. For those under 35, interventions should focus on early education for disadvantaged youth, while ensuring access to quality education resources and skills training to improve their employment prospects. For those over 35, emphasis should be placed on lifelong learning opportunities, career transitions, and retraining to prevent poverty due to obsolete skills.

Table 12. Age Heterogeneity

Variables	(1) Below 35	(2) Above 35
Edu	-0.092	-0.275***
	(0.062)	(0.097)
1.$Race$	0.034	-0.069
	(0.130)	(0.200)
2.$Race$	-0.061	-0.203
	(0.130)	(0.187)
Sex	-0.298***	-0.048
	(0.108)	(0.159)
$Family$	0.231**	-0.052
	(0.109)	(0.160)
1.$Marriage$	-0.090	-0.258
	(0.117)	(0.175)
2.$Marriage$	-0.109	-0.081
	(0.182)	(0.240)
Constant term	1.181***	1.984***
	(0.287)	(0.441)
Observation	672	304

Notes: *, ** and *** indicate significance at the levels of 10%, 5% and 1%, respectively. Standard errors are in parentheses.

V. Conclusions

Based on research on relevant theories and existing literature, this article uses the A-F method to measure and analyze the multidimensional poverty status of residents in Xinjiang, providing a more comprehensive and realistic reflection of the multidimensional poverty situation of residents in the region. On this basis, a Probit model is established to further analyze the degree of education's impact on multidimensional poverty, thus deeply exploring the continued poverty alleviation role of education in the post-poverty era from a multidimensional poverty perspective. The specific research results of this article are as follows: 1) The phenomenon of multidimensional poverty is prominent. When the critical deprivation threshold $k = 3$, the MPI is 22.44%, and the incidence of multidimensional poverty is 51%. This further illustrates that after breaking away from income-based absolute poverty, the problem of multidimensional poverty is still severe, and there is significant pressure for returning to poverty in Xinjiang, which deserves attention from all sectors of society. 2) Education has a profound impact on curbing multidimensional poverty. The regression result shows that the regression coefficient of education level is -0.147 and it is significant at the 1% level, indicating that individuals with higher education levels have a lower probability of experiencing multidimensional poverty. Analyzing individuals with different characteristics, it is found that the inhibitory effect of education level on multidimensional poverty is higher for females than for males. By dividing the sample into two groups, those under 35 and those over 35, it is found that the regression coefficient of education level is negative but not significant in the sample below 35, and the regression coefficient of education level is significantly negative in the sample over 35, indicating that the poverty reduction effect of education mainly concentrates on middle-aged and older people.

The research findings indicate that education is an important factor influencing the multidimensional poverty index, and also recognize the significance of education in poverty reduction. These findings are generally consistent with studies conducted in various countries. By emphasizing the significance of education in enhancing feasible capabilities and addressing multidimensional poverty, this research provides valuable insights for exploring strategies to alleviate poverty in ethnic minority regions, particularly in frontier areas like Xinjiang. The findings further underscore the potential of education in accelerating regional economic development and achieving shared prosperity in the new era. This article proposes the following suggestions:

Firstly, strengthen skills training to enhance the intrinsic development motivation of the multidimensional poor population; Secondly, continue to do well in ensuring compulsory education, and improve the dropout prevention and dynamic monitoring mechanisms; Thirdly, continue to increase public investment in education to ensure high-quality development of the entire region's educational undertakings; Fourthly, fully leverage the advantages of poverty alleviation teams as the main body to activate the endogenous motivation of multidimensional poor populations through educational assistance. Fifthly, based on the characteristics of different age groups, targeted policy recommendations should be proposed to more effectively utilize education resources, promote poverty reduction, and achieve the goals of eliminating poverty and ensuring social stability.

In conclusion, it is important to acknowledge a limitation in our study regarding the chosen tipping points for measuring deprivation in different dimensions. The selection of these thresholds may have an impact on the conclusions drawn about the relationship between education and poverty alleviation. Different thresholds could potentially yield different results, thus influencing the overall understanding of the role of education in addressing poverty. Furthermore, the research relied on available data sources and methodologies, which may have inherent limitations and potential inaccuracies. Despite efforts to ensure data validity and reliability, there may exist gaps or inconsistencies that could impact the robustness of the findings. Future research should aim to address these limitations and explore additional perspectives to further enhance our understanding of this complex issue.

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