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Heterogeneity Analysis of Human Capital's Income Effects Among Lifted-out-of-Poverty Households in the Yunnan-Guangxi-Guizhou Rocky Desertification Area

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SUMMARY: *Based on the microdata of 7432 households lifting themselves out of poverty, the study utilizes benchmark regression, heterogeneity analysis and quantile regression to systematically reveal the heterogeneous roles of education, health and other human capital elements on income growth. The study found that: the improvement of education level significantly drives the growth of wage income, but triggers the loss of agricultural labor force, and the business income of junior high school and high school and above groups declines by 25.6% and 64.5%, respectively, and low-income families are facing the trap of education conversion efficiency; health-impaired poverty-eradication families partially compensate for the loss of income through the enhancement of agricultural business, and the effect of health improvement of high-income groups on the increase of income is significantly higher than that of the low-income groups; Labor migration is significantly and positively associated with the wage income of poverty-stricken families, but leads to the loss of business income, and the return rate of migration for high-income groups is significantly higher than that of low-income groups; the coverage of technical training is low and has a weak impact on wage income, and the return rate of training for high-income groups exceeds that of low-income groups by a factor of 11, exposing the problem of mismatch between supply and demand. Accordingly, policy recommendations such as building a stepped human capital value-added system, implementing a subtype of health capital regeneration plan, creating differentiated labor allocation channels, and establishing a precise policy adaptation mechanism are put forward, with a view to providing precise decision-making references for the design of policies to promote the income increase of poverty-stricken households.*

KEYWORDS: *human capital; households out of poverty; heterogeneity*

1 Introduction

This paper takes Yunnan-Guizhou-Guizhou desertification area as the research field, focuses on the core issue of the heterogeneity of the human capital income-generating effect of poverty-stricken households, and based on the micro-data of 7,432 poverty-stricken households, applies the benchmark regression, heterogeneity analysis and quantile regression to systematically reveal the heterogeneity of the role of the human capital elements, such as education, health, labor migration, and technical training, in the income growth, with a view to providing precise decision-making suggestions for the design of the policy to promote the poverty-stricken households' income-generation. In order to provide precise decision-making

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suggestions for the policy design to promote the income increase of poverty-stricken households.

2 Data sources and research design

2.1 Data sources

The data for this study come from the official statistical database, covering detailed information on 32,687 people in Yunnan-Guizhou-Guizhou rocky desertification area in the year 2023. Since the basic information of all members of each household is recorded in the system, and the income data are for the whole household, the group processed the data, retained only the relevant data of the head of the household, and excluded the samples with obvious missing values or outliers, and finally obtained a valid sample of 7,432 households [1]. Since panel data cannot be obtained, this study uses cross-sectional data and focuses on analyzing the relationship between human capital and household income[2].

2.2 Description of variables

Given the low share of transfer income and property income in the income of poverty-eradicating households and their weak association with human capital, as well as the fact that schoolchildren have not completed human capital accumulation, they are not studied separately in this paper. The measurement of explanatory variables such as education, health, labor migration, and technical training are all household-specific[3]. Among them, the education variable draws on the view of relevant scholars] that the head of the household is the main body of the household's decision-making and source of income, i.e., the level of education of the head of the household is used as a proxy for the average level of education of the household. Per capita household wage income, per capita household business income, and per capita household net income were natural logarithmically transformed to reduce the skewed distribution of the data and to improve the goodness of fit of the model. The specific assignment methods of the explained variables, explanatory variables and control variables used in this paper are shown in Table 1[4].

Table 1: Description of variable assignment

Variable type	specified variable	variable assignment
explanatory variable	Ln_Household per capita wage income	Logarithmic household per capita wage income
	Ln_Household business income per capita	Logarithmic per capita household business income
	Ln_Net per capita household income	Logarithmic net household income per capita
explanatory variable	Education (head of household)	Illiterate or semi-literate = 0, Primary school = 1, Middle school = 2, High school = 3, College = 4, Bachelor's degree and above = 5
	well-being	Someone in the family is unhealthy (disabled/has a major illness/long term chronic illness) = 0, the whole family is healthy = 1
	labor migration	Household not working outside the home = 0, working outside the home = 1
	Technical training	No one in the household has skills = 0, at least 1 person has skills = 1
control variable	Family size	Number of persons in surveyed households
	Type of district	Non-national rural revitalization key helping counties = 0, national rural revitalization key helping counties = 1
	transport condition	Transportation backward = 1, transportation not backward = 0
	Self-Development Dynamics	Insufficient self-motivation for development = 1, sufficient self-motivation for development = 0
	resource endowment	Existence of shortage of any of the resources such as land, labor, capital = 1, no shortage of the above resources = 0

2.3 Model setup

In order to investigate the impact of human capital on the income growth of households out of poverty and its heterogeneous characteristics, the following model was constructed[5, 6]:

2.3.1 Benchmark regression model

The benchmark regression model aims to assess the impact of human capital elements such as education, health, labor migration and technical training on household income. The model is set up as follows:

$$\ln Y_i = \alpha + \beta HC_{\mathrm{i}} + \gamma X_i + \varepsilon_i \tag{1}$$

where: lnYi denotes the natural logarithm of per capita wage income, per capita business income, and per capita net income of household i. HCi denotes the human capital variables of household i, including the level of education, health, labor migration, and technical training. Xi denotes the control variables, including the household size, the type of district and county in which it is located, the transportation conditions, the dynamics of its own development, and

the resource endowment. α is the constant term, β and γ are the coefficients of the human capital variables and control variables, respectively. ϵi is the error term. are the coefficients of human capital variables and control variables, and ϵi is the error term[7].

2.3.2 Heterogeneity analysis models

This study further constructs a group regression model and introduces an interaction term to explore the effect of human capital on the heterogeneity of different groups. The model is set up as follows[8]:

$$\ln Y_i = \alpha + \beta HC_i + \delta\left(HC_i \times Group_i\right) + \gamma X_i + \varepsilon_i \tag{2}$$

where: groupi denotes grouping variables such as health status, education level, etc. δ is the coefficient of the interaction term, reflecting differences in the marginal effect of human capital on specific groups.

2.3.3 Quantile regression models

In this study, a quantile regression model was used to assess the impact of human capital on households in different net income quartiles, and the model was set up as follows:

$$Q_\tau\left(\ln Y_i |\ \mathrm{X_i}, HC_i\right) = \alpha_\tau + \beta_\tau HC_i + \gamma_\tau X_i \tag{3}$$

where: Q_τ denotes the conditional net income distribution at the τth quantile. α_τ, β_τ and γ_τ are the coefficients of the constant term, the human capital variable, and the control variables under the τ quartile, respectively[9].

3 Results and analysis

3.1 Descriptive statistics

As shown in Table 2, the human capital of poverty-eradicating households is characterized by multidimensional structured differences. Education dimension. The education level of the head of the household shows a pyramid distribution, with the elementary school and below group accounting for 68.3%, junior high school accounting for 29.6%, and senior high school and above accounting for only 2.2%, highlighting the coexistence of popularization of basic education and a serious lack of higher education. Wage income increased from 8,961.78 yuan in the illiterate group to 17,097.44 yuan in the undergraduate and above group, an increase of 90.7%. At the same time, the business income of the poverty-stricken households shows fluctuating characteristics, with the basic education stage from elementary school to high school showing an increasing characteristic, while the higher education group with college degree or above is completely detached from the agricultural business due to the occupational transition, forming an extreme low value of 51.85 yuan, which reflects the choice of survival strategy for the de-agriculturalization of the high-education group. The health dimension reveals the structural imbalance of the health capital of poverty-stricken families. Although 61.9% of the poverty-eradication households are fully healthy, 16.8% of the households have disabled members, 18.1% have chronic disease patients, and 3.3% suffer from major disease shocks. The wage income of healthy families is 12,635.76 yuan, which is 49.7% higher than that of disabled families, while the business income of the chronically ill group inversely

exceeds that of healthy families by 10.7%. Labor allocation is characterized by homogenization. 95.6% of households rely on labor migration for income, confirming the dominance of the labor economy, but the coverage rate of technical training is only 1.4%, revealing a serious obstruction of the channels for adding value to human capital. Transportation conditions are backward in 6.2% of households out of poverty, with per capita household wage income of RMB 12,741.18, business income of RMB 2,239.73, and net income of RMB 15,860.20, all higher than the sample average. 9.0% of households out of poverty have insufficient incentives for self-development, with wage income of RMB 12,340.31, business income of RMB 1,919.11, and net income of RMB 1,5787.7, all higher than the sample average. yuan, and net income of 15,787.23 yuan, all higher than the average level. 22.9% of the families have a shortage of resources such as land, labor and capital, and their per capita household wage income is 10,155.14 yuan, operating income is 1,259.63 yuan, and net income is 13,332.37 yuan, all lower than the average level, which reflects the limiting effect of the shortage of resources on the family's income[10].

Table 2: Descriptive statistics

variant	brochure	minimum value	maximum values	average value	Per capita household wage income (yuan/year)	Per capita household business income (yuan/year)	Per capita net family income (yuan/year)
educational level	7432	0	5	1.250	11469.54	1417.04	14404.35
Illiterate or semi-literate	725	0	1	0.098	8961.78	888.04	13563.80
secondary schools	4341	0	1	0.584	11311.65	1495.36	14274.07
junior high school	2198	0	1	0.296	12408.02	1410.69	14738.65
congrats! (on passing an exam)	128	0	1	0.017	13197.02	2084.48	16353.37
three-year college	31	0	1	0.004	16920.99	910.73	19549.90
Undergraduate and above	9	0	1	0.001	17097.44	51.85	17867.67
well-being	4597	0	1	0.619	12635.76	1355.64	14937.41
deformity	1246	0	1	0.168	8436.21	1459.38	13214.85
serious illness	246	0	1	0.033	10306.35	1892.24	14210.25
Long-term chronic diseases	1343	0	1	0.181	10504.95	1500.85	13718.88
labor migration	7432	0	1	0.956			
Technical training	7432	0	1	0.014			
Family size	7432	1	15	4.216			
Type of district in which it is located	7432	0	1	0.743			
transport condition	458	0	1	0.062	12741.18	2239.73	15860.20
Self-Development Dynamics	672	0	1	0.090	12340.31	1919.11	15787.23
resource endowment	1702	0	1	0.229	10155.14	1259.63	13332.37

Note: 1) Net household income refers to the remaining part of the total household income including wage income, business income, property income, etc., minus productive expenditures; 2) Transportation conditions, own development dynamics, and resource endowment are all based on the assessment of village cadres, and the subject group follows the labeling of the data system for statistical purposes.

3.2 Benchmark regressions with different income structures

Prior to the benchmark regression, the variance inflation factor (VIF) method was used to test for multicollinearity for the four explanatory variables of educational status, health level, labor migration, and technical training. The results show that the VIF values of all variables are less than 5, there is no significant multicollinearity problem, and the model setting is reliable[11].

Table 3: Benchmark regressions for different income structures

variant	Ln_Household per capita wage income	Ln_Household business income per capita	Ln_Net per capita household income
(1) Education	0.128*** (0.021)	-0.199*** (0.061)	0.033*** (0.005)
(2) Health	0.364*** (0.031)	-0.474*** (0.087)	0.051*** (0.007)
(3) Labor migration	7.318*** (0.197)	-0.965*** (0.241)	0.193*** (0.018)
(4) Technical training	0.100*(0.061)	-0.457 (0.395)	0.113*** (0.039)
(5) Family size	0.008 (0.009)	0.217*** (0.024)	-0.066*** (0.002)
(6) Type of district	-0.099** (0.040)	-1.668*** (0.114)	-0.084*** (0.010)
(7) Transportation conditions	0.095* (0.050)	-0.248 (0.193)	0.026* (0.016)
(8) Self-development dynamics	0.099* (0.052)	-0.398** (0.165)	-0.012 (0.014)
(9) Resource endowment	-0.218*** (0.036)	-0.577*** (0.102)	-0.060*** (0.008)
sample size	7432	7432	7432

Note: 1) Values in parentheses indicate standard errors of regression coefficients; 2) * indicates level of statistical significance (*p<0.1, **p<0.05, ***p<0.01)

3.2.1 Impact of explanatory variables on income

(1) Educational attainment shows a significant correlation with the differentiation effect of household income structure. The results in row 1 of Table 3 show that per capita household wage income increases by an average of 12.8 percent for each level of education of the head of the household that escapes poverty. At the same time, education level is negatively associated with household per capita business income, reflecting the fact that households with higher education tiers are more inclined to reduce their participation in agricultural production. This phenomenon may stem from the fact that with higher levels of education, the labor force is more likely to have access to non-farm employment opportunities, thus reducing its dependence on household business activities. Further, the coefficient of the effect of education level on net household income per capita is 0.033, suggesting that an increase in wage income may partially offset a decrease in business income, which is consistent with the finding of a non-farming bias in the returns to rural education in existing studies[12].

(2) Characteristics of the association between health status and income structure. The results in row 2 of Table 3 show that the average per capita wage income of healthy households out of poverty is 36.4 percent higher than that of non-healthy households, but health status is negatively associated with per capita household business income. This pattern may indicate that laborers with better health status are more inclined to move to non-agricultural fields, thus reducing their participation in household business activities. Nonetheless, the positive association between health status and net household income per capita suggests that improved health may have a net gain effect on the household income of households moving out of poverty through the non-farm employment channel[13].

(3) Analysis of the association between labor migration and income changes. The results in row 3 of Table 3 show that labor migration is strongly and positively associated with per capita household wage income, while it is significantly and negatively associated with business income. This pattern may reflect the substitution effect of the labor economy on traditional agricultural business in the context of large-scale non-farm transfer of rural labor, which is consistent with the typical phenomenon of industrial transformation in the process of rural "hollowing out". Despite the risk of agricultural labor loss, labor migration is still associated with positive changes in per capita net household income, underscoring the centrality of nonfarm employment to the livelihood strategies of households that are currently moving out of poverty[14, 15].

(4) Characteristics of the association between technical training and income structure. The results in row 4 of Table 3 show that receiving technical training is positively associated with an increase in per capita wage income of poverty-eradicating households, suggesting that technical training may enhance the competitiveness of the labor force in non-agricultural employment through the value-added effect of skills. At the same time, technical training is also positively associated with per capita net income of poverty-eradicating households, but the association with business income fails the statistical significance test. Combined with the reality that the coverage rate of technical training is only 1.4%, this reflects that there is a mismatch between supply and demand in the current training in Dian-Guizhou-Qianxian desertification area, where the training content may deviate from the needs of local industries or lack of complementary resources to support the skills on the ground, which has led to the fact that the effect of technical training on business income has not yet been brought into full play.

3.2.2 Effects of control variables

(1) Family size effect. The results in row 5 of Table 3 show that the size of the household size of a poverty-eradicating household is positively associated with the per capita business income of the household, and each unit increase in the size of the poverty-eradicating household is associated with a significant increase of 21.7 percent in the per capita business income of the household, suggesting that an increase in the supply of labor in the household may enhance the participation in business activities. However, an increase in household size is negatively associated with net income per capita, suggesting that labor gains may be offset by per capita resource dilution and increased consumption expenditures.

(2) Regional policy effects. The results in row 6 of Table 3 show that, compared with non-National Rural Revitalization Priority Support Counties, the three types of income of households lifting themselves out of poverty in the National Rural Revitalization Priority Support Counties are all significantly lower, with wage income being 9.9% lower, business income being 166.8% lower, and net income being 8.4% lower. This difference may be related to the fact that most of the counties in the National Rural Revitalization Priority Support Counties are concentrated in formerly deeply impoverished areas, with structural constraints such as a weak foundation for economic development and limited non-farm employment opportunities.

(3) Marginal effects of transportation conditions. The results in row 7 of Table 3 show that poor transportation conditions are positively associated with per capita household wage income, but the association with business income fails the statistical significance test. This finding may reflect the fact that the geographical isolation of poverty alleviation areas with poor transportation conditions makes it difficult to develop on-farm industries, forcing laborers to migrate to earn off-farm income, but also accelerating the loss of agricultural labor.

(4) The pattern of association between own development motivation and income structure. The results in row 8 of Table 3 show that the wage income of the poverty-eradicating households with insufficient self-development motivation is significantly higher than that of the control group, but the business income is significantly lower, and the net income does not show any significant difference. Combined with the results of descriptive statistics, this anomaly may stem from the fact that local governments prioritize the inclusion of such families in public welfare jobs and other policy employment programs in order to reach the assessment target of assistance, resulting in a passive increase in their wage income. In addition, the label of insufficient self-motivation for development may have been misused to mark the target of policy support, and their high net income is actually a function of transfer payments rather than an expression of endogenous development capacity.

(5) Resource endowment constraint effect. The results in row 9 of Table 3 show that there is a negative correlation between the lack of land, labor or capital on the income of households escaping poverty, with wage income about 21.8 percent lower than that of resource-sufficient households, business income about 57.7 percent lower, and net income about 6.0 percent lower. This reflects the deep-rooted constraints of the lack of factors of production on non-farm employment and agricultural operations; the combined effect of the lack of land, labor and capital has led to a shrinking of household income sources, highlighting the fundamental constraints of resource endowment on household income growth.

3.3 Heterogeneity analysis of the income-enhancing effects of human capital

Human capital education and health classified indicators were regressed in groups to examine the size of the correlation between differences in the level of human capital on the per capita household wage income and other forms of income, which were combined because only 2.2% of poverty-eradicating households had high school or higher education levels. Education level is regressed in groups with labor migration and technical training, and labor migration is regressed in groups with type of county and district, and own development motivation, respectively. In order to make the results more concise, the regression results are consolidated in one table and only the results of the categorical independent variable indicators are retained, see Table 4 for details.

Table 4: Heterogeneity analysis of human capital on income growth

variant	Ln_Household per capita wage income	Ln_Household business income per capita	Ln_Net per capita household income
(1) Illiterate or semi-literate	0 (zero)	0 (zero)	0 (zero)
(2) Primary Schools	0.246*** (0.062)	0.010 (0.145)	0.009 (0.012)
(3) Junior High School	0.338*** (0.063)	-0.256*(0.154)	0.045*** (0.012)
(4) High school and above	0.356*** (0.096)	-0.645** (0.308)	0.115*** (0.027)
(5) Health	0 (zero)	0 (zero)	0 (zero)
(6) Disability	-0.490*** (0.044)	0.281** (0.116)	-0.068*** (0.009)
(7) Suffering from a serious illness	-0.380*** (0.087)	0.385 (0.237)	-0.062*** (0.009)
(8) Long-term chronic diseases	-0.239*** (0.035)	0.684*** (0.109)	-0.036*** (0.009)
(9) Labor Migration	7.266*** (0.199)	-1.053*** (0.241)	0.195*** (0.019)
(10) Technical training	0.111* (0.059)	-0.444 (0.396)	0.112*** (0.039)
(11) Family size	0.005 (0.008)	0.212*** (0.024)	-0.066*** (0.002)
(12) Types of districts and counties	-0.073*(0.038)	-1.631*** (0.118)	-0.087*** (0.010)
(13) Transportation conditions	0.098** (0.049)	-0.245 (0.193)	0.026* (0.016)
(14) Self-development dynamics	0.097* (0.052)	-0.401** (0.166)	-0.012 (0.014)
(15) Resource endowment	-0.223*** (0.036)	-0.586*** (0.102)	-0.060*** (0.008)
(16) Education× Labor Migration	0.829*** (0.041)	-0.220*** (0.060)	0.049*** (0.006)
(17) Education× Technical Training	0.263*** (0.087)	-0.238 (0.236)	0.046* (0.023)
(18) Labor Migration× District Type	1.172*** (0.066)	-1.548 (0.100)	-0.080*** (0.009)
(19) Own development dynamics× Labor migration	0.976*** (0.061)	-0.317** (0.161)	0.049*** (0.015)
sample size	7432	7432	7432

Note: 1) Values in parentheses indicate standard errors of regression coefficients; 2) * indicates level of statistical significance (*p<0.1, **p<0.05, ***p<0.01)

3.3.1 Laddering effect of educational level

The results in rows 1 to 4 of Table 4 show that the increase in education level has a significant heterogeneous effect on household income. Education level is positively associated with wage income in a stepwise manner, with primary, lower secondary, and upper secondary and above education increasing wage income by 24.6%, 33.8%, and 35.6%, respectively, validating the positive relationship between education level and human capital accumulation. However, the effect of elementary school education on business income is not significant, suggesting that it mainly enhances total household income by increasing non-farm employability. Lower secondary education significantly reduces operating income by 25.6%, suggesting that the lower secondary education group prefers non-farm employment and reduces reliance on agricultural production. Upper secondary and above education significantly reduces operating income by about 64.5 percent, indicating that this group is almost entirely dependent on

non-farm employment. This pattern may indicate that higher levels of education reinforce the propensity of the labor force to move off-farm, while basic primary education has not yet significantly altered household business patterns due to insufficient skill suitability.

3.3.2 Compensation strategies for health shocks diverge

The results in rows 5 to 8 of Table 4 show that households in different states of health out of poverty show differentiated patterns of survival adaptation. Disabled households, households with major illnesses, and households with long-term chronic illnesses have significantly lower wage incomes than healthy households, but significantly higher business incomes, suggesting that such households with illnesses rely more on agriculture for their livelihoods when their ability to work is limited. The impact of health problems on wage income is larger, while the impact on business income is more complex, and may be related to the coping strategy of poverty-stricken households to compensate for the loss of income from labor by increasing agricultural inputs.

3.3.3 Heterogeneity analysis of interaction terms

(1) Synergistic effect of education and labor migration. The results in row 16 of Table 4 show that the interaction term between education level and labor migration has a significant positive association with wage income, with the income-enhancing effect of migration expanding by 82.9 percent for each level of education. However, the interaction term dampens business income, leading to a 22% loss in farm business income. On the one hand, highly educated migrants are more likely to enter skilled positions such as machine operation and service sector management, resulting in compound human capital gains. On the other hand, intergenerational exit from agriculture is evident, with education reinforcing the irreversibility of the migration decision, and offspring leaving agriculture through education, leading to the shrinkage of family business.

(2) Weak synergy between education and technical training. The results in row 17 of Table 4 show that the interaction term between education and technical training is positively associated with wage earnings, but does not significantly affect business earnings. Specifically, the wage gain of training expands by 26.3 percent for each unit of education, which is much lower than the migration interaction effect. The reason for this may be that the content of technical training deviates from demand, and most of the available training is based on low-end skills that do not match the expected jobs for the junior high school and above group.

(3) Synergistic effects of regional policies and labor migration. The results in row 18 of Table 4 show that the labor migration interaction term in the national rural revitalization focus counties is strongly positively associated with wage income but negatively associated with net income, mainly because of the resulting loss of business income of 154.8%. It may stem from the fact that migrant workers in the National Rural Revitalization Priority Counties are concentrated in low-end industries such as construction and extractive industries, whose income volatility creates a superimposed risk with the hollowing out of local industries.

(4) Synergistic effects of own development dynamics and labor migration. The results in row 19 of Table 4 show that the participation of households with low self-development incentives in migration results in a significant increase in wage income, but limited gains in net income. This phenomenon may map out that local governments tie the label of insufficient self-development motivation to policy employment through targeted delivery mechanisms such as public welfare jobs, resulting in the solidification of low-quality nonfarm employment and limited impact on the improvement of household net income.

4 Research findings and policy implications

4.1 Conclusions of the study

Based on the microdata of 7,432 poverty-eradicating households in Yunnan-Guizhou-Guizhou rocky desertification area, this study systematically analyzes the heterogeneous impact of human capital on household income and its path of action. The core conclusions are as follows:

(1) Gradient characteristics of returns to education. The increase in education level significantly drives the growth of wage income, but at the same time triggers the loss of agricultural labor, leading to a decline in business income of 25.6% and 64.5% for the junior high school and senior high school and above groups, respectively. The quantile regression shows that the returns to education are nonlinear, with the middle-income group benefiting most significantly, while low-income households face the problem of an efficiency trap in education conversion due to bottlenecks in the quality of basic education.

(2) Cumulative effects of health capital. Households with impaired health, such as disability, major illness, and chronic disease, that escape poverty partially compensate for income loss through intensified agricultural operations, but cannot offset wage income shortfalls, ultimately leading to a net loss of net income. Quantile regressions reveal that the income-enhancing effect of improved health in the high-income group is 7.1 times greater than in the low-income group. This stratification stems from the fact that high-income households form a positive cycle of health and income through high-quality medical care and safe environments, while low-income groups are constrained by nutritional provisions and occupational risks that make it difficult to escape from the corresponding limitations.

(3) Income-generating divergence of labor migration. Labor migration is significantly and positively associated with the wage income of poverty-eradicating households, but leads to a 96.5% loss of business income, creating a fragile livelihood pattern of economic dependence on labor and shrinking agriculture. Quantile regression shows that the return to migration is significantly higher for high-income groups than for low-income groups, mapping the structural exclusion of low-skilled workers from the labor market. The concentration of labor migration groups in the key counties of the National Rural Revitalization Program in low-end industries, such as construction, has resulted in income volatility superimposed on the hollowing out of agriculture, exposing a mismatch between policy coverage and livelihood resilience.

(4) Mismatch between supply and demand for technical training. The coverage rate of technical training is only 1.4%, and its impact on wage income is weak, while the net income gain mainly relies on the transformation of skills in non-agricultural fields. The quantile regression reveals that the return rate of training for high-income groups is 11 times higher than that of low-income groups, reflecting that low-income poverty-eradicating families in Yunnan-Guizhou-Guizhou Desertification Area are constrained by equipment, capital and market channels, making it difficult for them to transform their skills into productivity. At the same time, the training content is out of line with local agricultural demand, exacerbating the structural mismatch between supply and demand.

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