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Off-farm employment and multidimensional poverty: empirical evidences from the Yellow River Basin in China

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ABSTRACT: As an essential way to enhance farmers' self-development ability, off-farm employment plays an indispensable role in farmers' multidimensional poverty reduction in many countries. Employing a survey of 1926 farmers in five provinces of the Yellow River Basin in China, this paper examined the multi-dimensional poverty reduction effect of off-farm employment and the heterogeneous influence of different dimensions of off-farm employment (modes, levels, distances and frequency). The results showed that (1) although absolute poverty in the income dimension was largely eliminated in the Yellow River Basin, the poverty in social resources, transportation facilities, employment security were the key bottlenecks restricting farmers' self-development. (2) The province with the best multidimensional poverty reduction effect for non-farm employment was Shaanxi, with the largest contribution to employment security. (3) Improving off-farm employment level, distance and time can significantly alleviate the multi-dimensional poverty of farmers. Therefore, to lessen the multi-dimensional poverty of farmers in the Yellow River Basin, it is necessary to focus on the governance of multi-dimensional key poverty-stricken areas, such as the middle and upper courses of the Yellow River, adopting multidimensional poverty alleviation strategy of off-farm employment according to local conditions, working on the farmers' deficiencies in social resources, mobility, employment security, and deepening the effect of off-farm employment on benefiting farmers and helping the poor.
Key words: off-farm employment, multidimensional poverty, farmers, Yellow River Basin.

Emprego fora da fazenda e pobreza multidimensional: evidências empíricas da bacia do rio Amarelo na China

RESUMO: Como uma forma essencial de aumentar a capacidade de autodesenvolvimento dos agricultores, o emprego fora da fazenda desempenha um papel indispensável na redução da pobreza multidimensional dos agricultores em muitos países. Empregando uma pesquisa com 1926 agricultores em cinco províncias da Bacia do Rio Amarelo na China, este documento examina o efeito multidimensional de redução da pobreza do emprego e a influência heterogênea de diferentes dimensões do emprego fora da fazenda (modos, níveis, distâncias e frequência). Os resultados mostram que (1) embora a pobreza absoluta na dimensão da renda tenha sido em grande parte eliminada na Bacia do Rio Amarelo, a pobreza em recursos sociais, facilidades de transporte e segurança no emprego são os principais gargalos que restringem o autodesenvolvimento dos agricultores. (2) A província com o melhor efeito multidimensional de redução da pobreza para o emprego não agrícola foi Shaanxi, com a maior contribuição para a segurança no emprego. (3) A melhoria do nível de emprego fora da fazenda, distância e tempo pode aliviar significativamente a pobreza multidimensional dos agricultores. Portanto, para diminuir esta pobreza é necessário concentrar-se na governança de áreas-chave multidimensionais atingidas, tais como os cursos médio e superior do Rio Amarelo, adotando uma estratégia multidimensional de redução da pobreza de emprego fora da fazenda de acordo com as condições locais, trabalhando nas deficiências dos agricultores em recursos sociais, mobilidade, segurança no emprego e aprofundando o efeito do emprego fora da fazenda em benefício dos agricultores e ajudando os pobres.
Palavras-chave: emprego fora da fazenda, pobreza multidimensional, agricultores, Bacia do Rio Amarelo.

INTRODUCTION

Eliminating poverty and achieving shared prosperity are the essential requirements to improve people's life. (XI, 2015). "End poverty in all its forms everywhere" is the first on the United Nations' list of Sustainable Development Goals (SDGs) (UNITED NATIONS, 2020). With the efforts of many countries, the share of the world's population living in extreme poverty declined from 15.7 percent in 2010 to 10.0 percent in 2015. However, the pace of global poverty reduction has been decelerating. The global poverty rate is projected to reach 8.7 percent in 2021. There has been an unprecedented rise in global poverty since 1998, close to the 2017 level (UNITED NATIONS, 2021). Most people below the international poverty

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line live in rural areas (LI et al., 2021; RAJKHOWA et al., 2022). How to eradicate poverty in these poor rural areas is a significant challenge that many developing countries are facing when pursuing sustainable development goals.

It is worth mentioning that China has made remarkable achievements in poverty eradication. In 2020, China completed the arduous task of eradicating extreme poverty according to the national poverty line, lifting 770 million people out of poverty since 1978. It has built a "moderately prosperous society in all respects" (WORLD BANK, 2022). However, multidimensional poverty, mainly manifested by the lack of feasible ability still exists in China. Therefore, the focus of poverty alleviation work in China has moved from eliminating extreme poverty to alleviating unbalanced and insufficient multi-dimensional relative poverty (WANG et al., 2021; QIN et al., 2022). To consolidate and expand the achievements of poverty alleviation, China's "*No. 1 central document*" for 2022 clearly stated that the priority is to solve the employment problem of the poor farmers (ROWLEY et al., 2021). The participation of farmers in off-farm employment is a necessary means to narrow the income gap between urban and rural areas (ELLIS, 2000; SCOONES, 2009; SCHNEIDER et al., 2010), and a Chinese development approach based on rural-urban integration (PLOEG et al., 2010). Most off-farm employment in China is linked to the phenomenon of peasant migrant workers (WANG et al., 2017; FULLER et al., 2021), the proportion of off-farm employment (i.e., the share of peasant migrant workers of the total rural population) approached 56.01% in 2020. It is a crucial way to enhance their self-development ability and the key to realize the "blood production" of poverty alleviation and prevent returning to poverty (MAN et al., 2009).

There are two main viewpoints on the relationship between off-farm employment and rural poverty. One is that off-farm employment aggravates poverty. Off-farm employment is not conducive to the accumulation of human capital stock in the construction of farmers' families, which increases the economic cost to support the migration of family labour (LIU et al., 2017; XU et al., 2019; USDA ECONOMIC RESEARCH SERVICE, 2022), and off-farm employment may also change farmers' reference frame that high expectations may make they feel poor (BALASUBRAMANIAM, 2021). The other one is the theory of off-farm employment alleviating poverty. It not only improves the economic benefits of farmers (TASSEW et al., 2000; DUONG et al., 2021), but also breaks the original fixed social class, and prevents the intergenerational transmission of poverty (JANVRY et al., 2005; MATA et al., 2012; LIAO et al., 2020). The manifestations of poverty have expanded to multiple dimensions, such as nutrition and health, education, living standards and employment security, and multi-dimensional poverty has become an important content in the field of poverty research (HWANG et al., 2020; LARRÚ et al., 2022; LI et al., 2022). However, most of the above studies focus on poverty. There is a lack of research on the relationship between off-farm employment and multidimensional poverty of farmers, especially the lack of attention to such issues in deeply impoverished areas, such as the Yellow River Basin, which is China's most vulnerable parts with a high population density, water scarcity and human exploit (VARIS et al., 2014).

Conversely, the Yellow River Basin, the second largest river basin in China, plays a vital role in the country's ecological, food, and energy security (SONG, 2022). It faces complex physical and developmental issues that hamper poverty eradication. Due to years of intensive economic development and natural resource exploitation, serious new environmental (such as ecosystem deterioration, biodiversity loss, water scarcity, soil degradation and erosion) and social issues (such as food security, health issues, and social disparities) that hinder the regional sustainable development (WOHLFART et al., 2016), and poverty in the basin has been an overarching challenge over the years. On the other hand, providing opportunities to generate income from off-farm employment could contribute to the betterment of farmers' lives who are generally characterized by high dependence on agriculture in the basin. The off-farm sector, through the enhancement of income, enhances living standards by improving nutrition and food security, smoothening consumption, absorbing the growing rural labor force and reducing poverty (BEZU et al., 2012; ADEOYE et al., 2019). However, how off-farm employment can alleviate poverty is a critical question facing many developing countries.

Therefore, this paper examined the relationship between off-farm employment and the multi-dimensional poverty of farmers in the Yellow River Basin and provided practical recommendations to policy makers to alleviate multidimensional poverty in the post Covid-19 pandemic economic recovery. This paper has two contributions: first, this paper used a multidimensional poverty index (MPI) to measure the poverty status for rural farm households in the Yellow River Basin. This can determine

the contribution levels of different dimensions and indicators of multidimensional poverty in the basin. Second, this paper revealed the impact of off-farm employment and its different dimensions on multidimensional poverty, which can provide a reference for policy interventions, especially for rural farm households in the Yellow River Basin.

The remainder of this paper is organized as follows. Section 2 focuses on the theoretical framework, presenting the steps for establishing the conceptual framework of the study. Section 3 focuses on data and methodology, presenting the data sources, study area, variable description and empirical model. Section 4 presents the results of the study and discussed the ways in which the models proposed in Section 3 were used to analyze the relationship between off-farm employment and multidimensional poverty. Section 5 sets out the main conclusions and details a series of policy implications.

Theoretical framework and hypotheses establishment

The effect of off-farm employment on the multidimensional poverty of farmers

Feasibility theory holds that low income is an external manifestation of poverty, and the lack of viable ability to obtain income, freedom from disease, access to education and information, and social security is the root cause of poverty (SEN, 1985). Off-farm employment can not only rebuild the feasible ability of farmers, but also alleviated their multidimensional poverty. This is manifested in two aspects. One is a direct effect. In contrast to agricultural income that is unstable due to the risks of natural and market, the off-farm transfer increases the family wage income (ADEOYE et al., 2019), improves the feasible ability of farmers (MATA et al., 2012; ZIMMERMAN et al., 2022), enhances their self-development ability (VERGARA et al., 2004), and reduces multidimensional poverty. The second is the indirect effect. The off-farm income can be used not only to adjust agricultural production methods (PFEIFFER et al., 2009; DEDEHOUANOU et al., 2018), but also to channels, such as children's education, social security, savings and investment, which has an indirect income-increasing effect (QIAO et al., 2015; WANG et al., 2017; XIE et al., 2020; LIN et al., 2021). At the same time, with the transfer of rural household labor to off-farm industries, the social network continues to expand, which is conducive to their concept renewal, so as to better engage in off-farm employment and alleviate the problem of ability poverty (LIU, 2020; SEN et al., 2021). In addition, off-farm employment can enhance farmers' values of improving the quality of their living conditions, such as dwelling structure, drinking water safety, sanitation and heating security (YU, 2013; DEHURY et al., 2017; JIAO, 2020). Therefore, we proposed the following hypothesis:

H1: Off-farm employment can alleviate the multidimensional poverty of farmers.

The heterogeneous impact of off-farm employment on the multidimensional poverty of farmers

The Impact of off-farm employment on farmers with different levels of multidimensional poverty

Off-farm employment is characterized by increasing marginal benefits. Due to the lack of their own capital and their weak ability to resist risks and develop themselves, farmers with higher levels of multidimensional poverty find it difficult to escape from poverty through their own resource endowments; and therefore, need to increase their household income, enhance their development ability and improve their living conditions through participation in off-farm employment (DONG et al., 2021). Specifically, farmers with higher levels of multidimensional poverty have fewer assets of their own and are more eager to increase their income and investment in education, health and social security through off-farm employment. At the same time, the off-farm vocational education and training and job matching support for farmers with high levels of multidimensional poverty have an information transfer function and can enhance their information access ability (ZHOU et al., 2022). In addition, the increase in income and the ability to develop themselves also enhances the ability of farmers with higher levels of multidimensional poverty to improve their living conditions (ADEOYE et al., 2019). On the contrary, farmers with lower levels of multidimensional poverty usually have higher levels of income, development ability and living conditions, and off-farm employment has relatively little effect on their multidimensional poverty reduction. Therefore, we proposed the following hypothesis:

H2: Farmers with a higher level of multidimensional poverty benefit more from off-farm employment than those with a lower level of multidimensional poverty.

The impact of different off-farm employment approaches on the multidimensional poverty

Off-farm employment generally includes self-employment, employment and part-time employment. Specifically, self-employment is more autonomous and flexible, with higher market excess

profits, and promotes the accumulation of human capital and upward mobility of farmers (BENNETT et al., 2015; MATYSIAK et al., 2020), but self-employed farmers also face higher market risks and barriers to entry in their entrepreneurial activities, and only those with certain human capital, social capital and risk appetite will choose non-farm self-employment, thus the multidimensional poverty reduction effect of non-farm self-employment is limited. Employment is the main approach for farmers to participate in off-farm employment. Farmers earn a relatively stable wage income through off-farm employment (KEY, 2019; ZHANG et al., 2021), but since they are mainly employed to provide low-end labour and services, the income they earn basically meets their subsistence consumption, limiting their investment in other dimensions, such as education, health, social security and living conditions. As a result, the poverty reduction effect of employment on development ability and living conditions is limited. Part-time employment include both types of self-employed and employed labour, which can avoid the disadvantages of a single off-farm employment mode, farmers rely on their own resource endowment and social network to obtain more market dividends and income, accumulate more social resources and work skills, and they are more likely to escape from multidimensional poverty (AWAN et al., 2011). Therefore, part-time employment is more effective in alleviating multidimensional poverty than the other two. Therefore, we proposed the following hypothesis:

H3: Compared with employed and self-employment, part-time employment has a greater effect on alleviating the multidimensional poverty of farmers.

Data and methodology

Data sources

To fully understand the relationship between off-farm employment and poverty alleviation in rural China, we collected the microscopic survey data from the Yellow River Basin in July 2020. Stratified random sampling is used to select 182 villages, 44 towns, 13 counties, 6 provinces (including Qinghai, Ningxia, Inner Mongolia, Shaanxi, Shanxi and Henan) of the Yellow River Basin. 2362 farmers conducted a one-to-one questionnaire survey. The questionnaire includes basic household information, household assets, household income and expenditure. Since the sample farmers in Qinghai province are mainly herdsmen, it is difficult to obtain poverty data in some dimensions. Therefore, after excluding the Qinghai province sample and questionnaires with missing data, 1926 valid questionnaires were obtained, covering 138 villages, 38 towns, 11 counties, 5 provinces (Figure 1). The effective rate of questionnaire is 81.54%.

Study area

The Yellow River, the world's 6th largest river and China's 2nd longest river, is known as the mother river (SONG, 2022). It has a drainage area of 795,000 km^2 and an elevation drop of 4,480 meters, and the main stream is 5464 km. The Yellow River Basin incorporates nine provinces (including Qinghai, Sichuan, Gansu, Ningxia, Inner Mongolia, Shaanxi, Shanxi, Henan and Shandong) and it divided 3 sub-basins, namely, the upper basin mountain region, the middle plateau and the lower basin low plain (YANG et al., 2021a).

The Yellow River Basin is experiencing increasingly environmental challenges due to its rapid economic development, an expanding population and growing urbanization (ZHANG, 2010). Most poor people in the basin depend on farming for their livelihoods and access to off-farm employment is a key factor in their economic well-being. Meanwhile, the Yellow River Basin is an important area for poverty alleviation in China. Among the 14 concentrated and contiguous poverty-stricken areas, 5 are in the Yellow River Basin. The major occupation of the people in the upper and middle reaches are dominated by agricultural activities, specifically, crop and livestock productions, with relatively lagging economic development, they are key areas to consolidate the achievements of poverty alleviation. The North China Plain has good natural conditions, dense population and developed economy, but faces the risk of returning to poverty due to the high risk of disasters. Therefore, the above discussion justifies the selecting of the Yellow River Basin as the research area.

Variable description

Poverty includes not only income poverty, but also poverty in education, health, drinking water, and energy supply. It is a multidimensional concept (BABALOLA et al., 2021; CHEN et al., 2022). The multidimensional poverty index (MPI) is widely used in the academic literature as a measuring tool (LI et al., 2019; DUTTA et al., 2021; LARRÚ et al., 2022). For example, BERSISA et al. (2021) measure multidimensional poverty from consumption expenditure, health, education, housing, asset ownership, and energy use. WANG et al. (2020a) believed that multidimensional poverty includes economic conditions, social development, and ecological environment. Due to the relatively

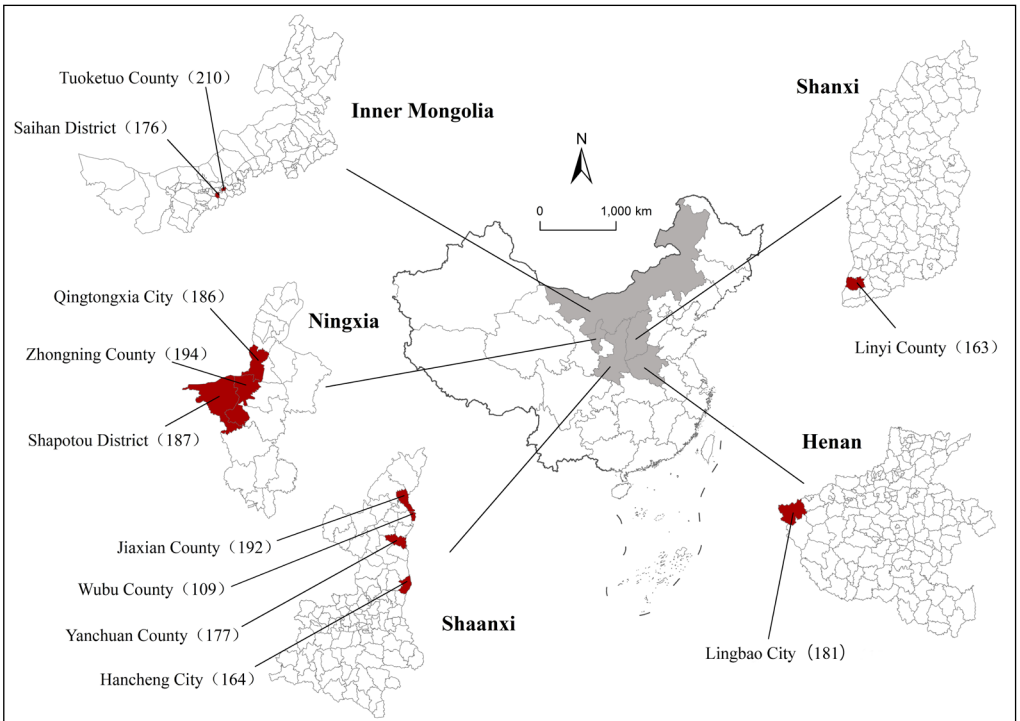

Figure 1 - Sample distribution.

backward socio-economic conditions and fragile ecological environment in the Yellow River Basin, economic, social and ecological dimensions should be comprehensively considered when measuring the multidimensional poverty of farmers in the basin. Base on the global MPI analytical framework and relevant empirical studies (YU, 2013; LIU et al., 2016; CHI et al., 2022), we comprehensively integrated 10 indicators from 3 dimensions of income ability, development ability, living conditions to measure the multidimensional poverty of farmers in the basin. If a farmer was deprived in any of the indicators within a dimension, the farmer was considered deprived in this dimension. As AABERGE et al. (2015) recommended, weights of dimensions and indicators chosen should be in a manner that reflects equality. In this paper, the equal weight method is used to assign values to each dimension and its indicators (ALKIRE et al., 2013).

The deprivation thresholds and weights of each dimension indicator are shown in table 1.

The formula for calculating the multidimensional poverty index of farmers is as follows:

$$MPI_i = \Sigma_j^d = 1\, w_j y_{ij} \quad (1)$$

where MPI_i is the multidimensional poverty index of farmer i, wj is the weight of the jth indicator, y_{ij} is the value of farmer i on the jth indicator; d is the number of dimensions, i = 1, 2,…, 1926; j = 1, 2,…, 10.

The core explanatory variables include off-farm employment and its approaches, which indicates the farmers who have labor ability and do not work in agriculture at all. Off-farm employment is measured by the ratio of off-farm laborers to the total labor force of the household (WANG et al., 2017). Off-farm employment approaches include self-employment (If only self-employment exists in the family, the self-employment variable is assigned a value of 1, otherwise it is assigned a value of 0), employed (If only employment exists in the family, the employment variable is assigned a value of 1, otherwise it is assigned a value of 0), and part-time employment (If both self-employment and employment exist in the family, the part-time employment variable is assigned a value of 1, otherwise it is assigned a value of 0) (MATYSIAK et al., 2020). In our sample, the average proportion of off-farm labour force was 25.8% and predominantly employed.

In addition, human capital, household endowments and social security expenditures

Table 1 - Multidimensional poverty indicator system and weights.

Target level	Criteria level	Indicators	Indicator interpretation and assignment	References	Threshold
Income ability (1/3)	Income (1/3)	Net income per capita	A value of 1 is assigned if the per capita disposable income of the farming household is less than 40% of the national median per capita disposable income of rural residents, otherwise the value is 0.	(YU, 2013; DONG et al., 2021)	5755.6
Development ability (1/3)	Education (1/12)	Years of schooling	A value of 1 is assigned if the number of years of schooling per household member is less than 9, otherwise the value is 0.	(LIU et al., 2016; MAITY et al., 2017)	9
	Health (1/12)	Health status	A value of 1 is assigned if minimum value of health status of household members greater than 3, otherwise the value is 0.	(POMATI et al., 2020; CHI et al., 2022)	3
	Social Security (1/12)	Health insurance	A value of 1 is assigned if no household member has health insurance, otherwise the value is 0.	(YU, 2013; MOHANTY et al., 2017)	1
		Pension insurance	A value of 1 is assigned if no household member has pension insurance, otherwise the value is 0.	(HU et al., 2022)	1
	Access to information (1/12)	Internet use	A value of 1 is assigned if the respondent does not use a mobile device to access the internet, otherwise the value is 0.	(YANG et al., 2021b)	1
Living conditions (1/3)	Housing (1/12)	Dwelling structure	A value of 1 is assigned if household primary construction materials are wood and/or adobe, otherwise the value is 0.	(ALKIRE et al., 2021)	1
	Drinking water (1/12)	Clean drinking water	A value of 1 is assigned if not drinking tap water, otherwise the value is 0.	(YU, 2013; DEHURY et al., 2017)	1
	Sanitation (1/12)	Health facilities	A value of 1 is assigned if not using flush toilets, otherwise the value is 0.	(YU, 2013; MOHANTY et al., 2017)	1
	Heating (1/12)	Heating facilities	A value of 1 is assigned if no access to heating facilities, otherwise the value is 0.	(JIAO, 2020)	1

Note: ①According to the Statistical Bulletin on National Economic and Social Development of the People's Republic of China in 2019, the median per capita disposable income of rural residents in 2019 was CNY 14389, so the critical value of farm household income is CNY 14389 X 40% = CNY 5755.6 (DONG et al., 2021). ②The values in brackets in the target and criterion layers in the first and second columns are the weights corresponding to each dimension and each indicator, respectively.

may also have an impact on the poverty of rural households (XU et al., 2021; PENG et al., 2021; YANG et al., 2021a; YU et al., 2021). Therefore, this paper controls individual, family, and village-level characteristic variables. The specific meaning of each variable and its statistical characteristics are shown in table 2.

Methodology

OLS model

Using an OLS model, we empirically estimated the relationship between off-farm employment and the multidimensional poverty of farmers. The specific model is as follows:

$$MPI_i = \alpha + \beta Off_i + yX_i + \eta H_i + \mu V_i + \varepsilon_i \quad (2)$$

where MPI_i is the multidimensional poverty status for the i th household, α is constant, Off_i represents off-farm employment in i th household, β is the coefficients of Off_i. X_i is a vector of characteristics of the i th farmer, y is the coefficients of X_i. H_i is a vector of the characteristics of the i th household, η is the coefficients of H_i. V_i is a vector of the characteristics of the i th village, μ is the coefficients of V_i, and ε_i is the error term.

Propensity score matching (PSM) model

The OLS regression can only obtain the conditionally expected impact of off-farm employment on the multidimensional poverty of farmers, and its results are easily affected by sample

Table 2 - Variable definition and descriptive statistics.

Variable name	Variable symbol	Meaning and description of variables	Mean	Standard deviation
----------Explained variables----------				
Multidimensional poverty	MPI	Multidimensional poverty index	0.325	0.204
Income ability poverty	IAPI	Income ability poverty index	0.083	0.144
Development ability poverty	DAPI	Development ability poverty index	0.112	0.077
Living conditions poverty	LCPI	Living conditions poverty index	0.131	0.068
----------Explanatory variable----------				
Off-farm employment	Off	Proportion of household off-farm labour	0.258	0.331
----------Control variables----------				
Individual characteristics				
Gender of householder	Gen	Man=1, woman=0	0.952	0.214
Age of householder	Age	Actual age of householder (years)	57.602	11.382
Square of age of householder	Age2	Square of actual age of householder (years)	3447.450	1294.153
----------Family characteristics----------				
Quantity of labor force	Lab	The actual number of family labor force	2.411	1.403
Is it the village surname?	Sur	Yes=1, no=0	0.585	0.493
Industrial organization	Org	Participating=1, Not participating=2	0.054	0.225
----------Village characteristics----------				
Village collective economic situation	Eco	Very bad = 1, poor = 2, fair = 3; good = 4, very good = 5	3.291	0.990
Operation evaluation of village regulations	Reg	Very bad = 1, poor = 2, fair = 3, good = 4, very good = 5	3.758	0.811

selection bias, which will seriously interfere with the authenticity of the estimate. Therefore, this paper adopted the PSM model to eliminate the endogeneity problem that may be caused by self-selection. Constructing a counterfactual framework, the logit regression based on characteristic variables is used to calculate the propensity scores, and then we matched a sample with off-farm employment experience to a sample without off-farm employment experience according to the propensity scores. These two samples have similar characteristics except for off-farm employment experience. The difference between the multidimensional poverty indices of these two samples (i.e., the average treatment effect, ATT) is the impact of off-farm employment on the multidimensional poverty.

$$ATT = E(MPI_{1i} \backslash X, Off_i = 1) - E(MPI_{0i} \backslash X, Off_i = 1) \quad (3)$$

where MPI_{1i} and MPI_{0i} represent the multidimensional poverty index when farmers participate and do not participate in off-agricultural employment, respectively. $E(MPI_{1i} \backslash X, Off_i = 1)$ can be directly observed, However, $E(MPI_{0i} \backslash X, Off_i = 1)$ cannot be directly observed, so it is necessary to use propensity score matching to construct counterfactual results and calculate the corresponding surrogate indicators.

Quantile regression model

To test the impact of off-farm employment on farmers with different levels of multidimensional poverty, this paper uses the quantile regression model to set up equation (4).

$$MPI_i = \phi_{0,q} + \phi_{1,q} Off_i + \phi_{2k,q} X_{ik} + \varepsilon_i \quad (4)$$

q denotes the specific quantile, q = 10, 25, 50, 75, 90. $\phi_{0,q}$, $\phi_{1,q}$, $\phi_{2k,q}$ are coefficients to be estimated. ε_i is the random error term. The other core and control variables are the same as in equation (2).

RESULTS AND DISCUSSION

Multidimensional poverty of farmers in the Yellow River Basin

The multidimensional poverty of farmers in the Yellow River Basin has spatial and dimensional heterogeneity. As shown in table 3, the mean value of the MPI is 0.325, which indicates that eliminating the multidimensional poverty of farmers in the Yellow River Basin still faces severe challenges. Specially, Shaanxi and Inner Mongolia that are in the middle and upper reaches of the Yellow River, their MPI were 0.401 and 0.345, respectively. This indicated that those two provinces are key areas with high incidence of multidimensional poverty among

Table 3 - Multidimensional poverty index (MPI) and its dimensions of farmers in the Yellow River Basin.

Provinces	MPI	IAPI	DAPI	LCPI
Yellow River Basin	0.325	0.083	0.112	0.131
Ningxia	0.294	0.071	0.094	0.129
Inner Mongolia	0.345	0.074	0.136	0.134
Shaanxi	0.401	0.125	0.123	0.153
Shanxi	0.217	0.027	0.097	0.094
Henan	0.214	0.037	0.089	0.088

farmers. From the perspective of sub-dimensions, Shaanxi was at a high level of poverty in the three dimensions of income ability, development ability and living conditions, while the other four provinces still have more room for improvement in terms of living conditions and development ability. Different sample provinces showed strong heterogeneity in terms of employment security. For example, the employment security poverty indices in Inner Mongolia and Shanxi were 0.83 and 0.29, respectively.

To sum up, due to the poor natural conditions, backward economic development, and lack of infrastructure in the Yellow River Basin, the poverty-stricken population is large, and the degree of poverty is relatively deep (ZHANG, 2010). Although absolute poverty basically solved through the support of the national targeted poverty alleviation policy. The multidimensional poverty problem in the middle and upper reaches of the Yellow River is still relatively severe, and there are still many farmers who are troubled by development conditions.

The impact of off-farm employment on the multidimensional poverty of farmers

Group descriptive statistical analysis

Subgroup descriptive statistics on the multidimensional poverty index and its dimensions (Table 4) found that participating in off-farm employment can reduce the MPI of farmers in the Yellow River Basin from 0.385 to 0.261, with a decrease of 0.124. Off-farm employment can alleviate the multidimensional poverty of farmers in the basin. It is noteworthy that farmers in Shaanxi and Inner Mongolia have the most obvious effect in reducing the incidence of multi-dimensional poverty through off-farm employment, and their MPI reduced by more than 0.17, followed by Henan, Ningxia and Shanxi.

From the perspective of sub-dimensions, off-farm employment has the most significant poverty reduction effect on the dimension of income ability poverty, and the poverty index in this dimension dropped from 0.116 to 0.047, with a decrease of 0.070. Shaanxi and Inner Mongolia decreased by 0.112 and 0.105, respectively, which are higher than the overall level of the sample. Off-farm employment reduces the development ability poverty by 0.033. The most pronounced effect of poverty reduction in this dimension is in Inner Mongolia, dropped by 0.050. The poverty reduction effect of off-farm employment for living conditions dimensions was 0.022, and Shaanxi has the most prominent performance, its poverty index in this dimension decreased by 0.033. Although, off-farm employment reduced farmers' multidimensional poverty and its dimensions, the F-statistic test of the ANOVA found that the performance between provinces is significantly different, such as farmers in Shaanxi, Inner Mongolia and Henan achieved different degrees of living improvement through off-farm employment, while the living standards of farmers in Shanxi and Ningxia declined. The above results are only a preliminary analysis of grouped descriptive statistics. The impact of off-farm employment on the multidimensional poverty of farmers in the Yellow River Basin needs to be further confirmed by regression analysis.

OLS regression analysis

The OLS regression results of off-farm employment on the multi-dimensional poverty are presented in table 5. We found that the coefficient of off-farm employment was -0.0588, and it is significant at the 1% level, indicating that farmers' participation in off-farm employment played an important role in alleviating the multidimensional poverty of farmers. For sub-dimensions, off-farm employment has a significant alleviating effect on farmers' income ability poverty and living conditions poverty, and a smaller and insignificant alleviating effect on development ability poverty. The possible reason is that off-farm employment can directly

Table 4 - Results of subgroup descriptive statistics for off-farm employment.

Provinces	----------MPI----------		----------IAPI----------		----------DAPI----------		----------LCPI----------	
	Off-farm	Farm	Off-farm	Farm	Off-farm	Farm	Off-farm	Farm
Yellow River Basin	0.261	0.385	0.047	0.116	0.095	0.128	0.120	0.141
Ningxia	0.285	0.301	0.077	0.067	0.077	0.108	0.131	0.126
Inner Mongolia	0.250	0.420	0.016	0.121	0.109	0.158	0.125	0.141
Shaanxi	0.296	0.471	0.058	0.170	0.105	0.135	0.133	0.166
Shanxi	0.218	0.216	0.021	0.044	0.100	0.087	0.096	0.086
Henan	0.196	0.251	0.027	0.056	0.084	0.099	0.084	0.096
F-value	---------57.12***	---------	---------27.17***	---------	---------27.04***	---------	---------52.10***	---------

Note: The F-value represents the statistic for the test of significance of the difference between the means of the five provinces for multidimensional poverty and its sub-dimensions between the two groups. ***, $P < 0.01$.

increase the household income of farmers and provide a financial basis for improving the living conditions and increasing human capital accumulation (MATA et al., 2012; ZIMMERMAN et al., 2022). At the same time, the relatively superior living conditions in the city during off-farm employment enhances farmers' perceptions and aspirations for a better quality of life, and encourages them to improve their housing, drinking water, sanitation and heating conditions through the capital accumulation gained from off-

Table 5 - Regression results of off-farm employment on multidimensional poverty and its dimensions of farmers in the Yellow River Basin.

Model	(1)	(2)	(3)	(4)
Explained variable	MPI	IAPI	DAPI	LCPI
Off	-0.0588***	-0.0432***	-0.0037	-0.0119***
	（0.0126）	（0.0094）	（0.0047）	（0.0045）
Gen	0.0083	-0.0009	0.0127*	-0.0035
	（0.0177）	（0.0144）	（0.0074）	（0.0066）
Age	-0.0132***	-0.0063***	-0.0069***	-0.0000
	（0.0031）	（0.0024）	（0.0010）	（0.0010）
Age2	0.0001***	0.0001***	0.0001***	0.0000
	（0.0000）	（0.0000）	（0.0000）	（0.0000）
Lab	-0.0072**	0.0015	-0.0077***	-0.0010
	（0.0033）	（0.0027）	（0.0016）	（0.0011）
Sur	0.0307***	0.0274***	-0.0028	0.0061**
	（0.0081）	（0.0063）	（0.0029）	（0.0027）
Org	-0.0464***	-0.0146	-0.0173***	-0.0145**
	（0.0168）	（0.0124）	（0.0059）	（0.0069）
Eco	（0.0090）	（0.0069）	（0.0032）	（0.0030）
	-0.0086**	-0.0064*	0.0005	-0.0028**
Reg	（0.0043）	（0.0033）	（0.0015）	（0.0014）
	-0.0078	-0.0059	-0.0037**	0.0018
Cons	（0.0054）	（0.0043）	（0.0019）	（0.0017）
	0.7557***	0.2613***	0.3321***	0.1623***
R^2	（0.0869）	（0.0666）	（0.0280）	（0.0290）

Note: standard errors are in parentheses. ***, $P < 0.01$; **, $P < 0.05$; *, $P < 0.1$. The sample size of each model is 1926.

farm employment (YU, 2013; DEHURY et al., 2017; JIAO, 2020). The effectiveness of off-farm employment in reducing poverty in the development ability of farmers is still limited, mainly because most of the off-farm jobs that farmers participate in are in low-skilled and labour-intensive industries, such as construction, manufacturing, transportation, storage and postal services, etc. (DONG et al., 2021). Enterprises in these industries invest less in the education, health, social security and information ability of farmers, and due to the limitations of their own wealth and the household registration system, the difficulty degree for farmers to improve their development capacity in education, health, social security and access to information through their own efforts is greater.

PSM model evaluation

To overcome sample selection bias, this paper uses the PSM model to calculate the average treatment effect (ATT) of off-farm employment on the multidimensional poverty of farmers under the framework of counterfactual analysis. First, to ensure the estimation quality of the PSM, the balance test of the matching method was carried out, and we found that the mean error and median error after sample matching decreased significantly from 13.7% and 6.7% to 3.3% and 2.3%, respectively. LR chi^2 statistics decreased from 260.45 to 11.80, while its significance level increased from 0.000 to 0.462. Pseudo-R^2 dropped from 0.098 to 0.005, less than 0.02. The B value dropped from 76.4% to 16.0%, less than 25%. The above results indicated that the matching was effectively corrected by sample selection bias, and the equilibrium hypothesis was also satisfied (RUBIN, 2001).

Then, we used the PSM model to calculate the average treatment effect of the off-farm employment on the MPI. The result is shown in table 6. Despite using different matching methods, off-farm employment has a significant negative impact on farmers' MPI, which once again verified that off-farm employment can significantly reduce the multidimensional poverty of farmers. This paper also found that, to increase family income and get rid of multidimensional poverty, a large number of rural laborers in the Yellow River Basin went out for off-farm employment, and 48.23% of the sample farmers' family members participated in off-farm employment. Henan, a province with a large population, had the highest off-farm employment rate at 67.40%. In each dimension of multidimensional poverty, sample farmers who participated in off-farm employment had better income ability, development ability and living conditions than sample farmers who did not participate in. Off-farm employment have the largest impact on farmers' income ability. The above findings reaffirmed that the empirical results of the OLS model are relatively robust.

2SLS regression analysis

The endogeneity problem mainly stems from the possible mutual causality of the impact of off-farm employment on the multidimensional poverty of farmers. The higher the multidimensional poverty of farmers, the more they are restricted by the requirements of off-farm employment, which in turn reduces their participation in the off-farm labor market. If this endogeneity problem is ignored, it will weaken the reliability of the estimated results of the multidimensional poverty reduction effect of off-farm employment. Therefore, this paper refers to the idea of DONG et al. (2021) and selected the average level of off-farm employment of other sample farmers in the same village other than this sample farmer as the instrumental variable (IV) for off-farm employment of this sample farmer. The reasons are as follows: first, due to the peer effect in rural areas, the off-farm employment participation behavior of farmers is often

Table 6 - Estimated results of the propensity score matching (PSM) method.

Matching method		MPI	IAPI	DAPI	LCPI
Nearest neighbor matching (k=4)	ATT	-0.0994***	-0.0720***	-0.0134***	-0.0140***
		（0.0158）	（0.0084）	（0.0044）	（0.0040）
Radius matching	ATT	-0.1213***	-0.0682***	-0.0316***	-0.0214***
		（0.0090）	0.0065	0.0035	0.0032
Kernel matching	ATT	-0.0859***	-0.0602***	-0.0121***	-0.0136***
		（0.0105）	0.0076	0.0040	0.0036

Note: standard errors are in parentheses. ***, $P < 0.01$; **, $P < 0.05$; *, $P < 0.1$.

influenced by other farmers around them. Second, the average level of off-farm employment participation of other farmers around them generally does not directly affect the multidimensional poverty level of the farmers, and the farmers cannot control the off-farm employment participation of other farmers. Therefore, the instrumental variables selected in this paper were chosen to satisfy the requirements of relevance and exogeneity and were estimated using a two-stage least squares approach.

Table 7 reports the estimation results of the instrumental variables. In the two-stage instrumental variable estimation, the coefficient of instrumental variable was 0.8928, and it is significant at the 1% level, indicating that the instrumental variables satisfy the relevance requirement. In addition, the weak instrumental variables test statistic is larger than the 10% critical value level, indicating that the instrumental variables is not a weak instrumental variable. The coefficient of off-farm employment in the second stage was -0.2404, and it is significant at the 1% level, indicating that off-farm employment can significantly alleviate the multidimensional poverty of farmers after accounting for potential endogeneity problems, which is consistent with the previous findings.

The heterogeneous impact of off-farm employment on multidimensional poverty

The Impact of off-farm employment on farmers with different levels of multidimensional poverty

Table 7 - Regression results of two-stage least squares (2SLS).

	First stage	Second stage
Explained variable	Off	MPI
IV: Mean_Off	0.8928***	
	（0.0504）	
Off		-0.2404***
		（0.0338）
Control variables	Yes	Yes
First stage F	45.949	
Weak IV test: Wald F value	350.063	
Cons	-0.0652	0.7661***
	（0.1496）	（0.0893）
R^2	0.2064	0.1573

Note: standard errors are in parentheses. ***, P < 0.01; **, P < 0.05; *, P < 0.1. Mean_Off refers to the average level of off-farm employment of other sample farmers in the same village other than this sample farmer.

This paper further tests the heterogeneous effects of off-farm employment on farmers with different levels of multidimensional poverty using a quantile regression model, where higher quantile points indicate higher levels of multidimensional poverty. The estimated results are shown in table 8. In general, off-farm employment has a greater effect on poverty reduction for farmers in the high multidimensional poverty quartile. At the 75th quartile, participation in off-farm employment has the greatest alleviating effect (reduced the multidimensional poverty by 0.1214), while off-farm employment has the least alleviating effect at the 25th quartile. The above results indicated that the multidimensional poverty reduction effect of off-farm employment gradually increases as the multidimensional poverty level of farmers increases, which also highlights the important role of off-farm employment in alleviating multidimensional poverty of farmers.

The impact of different off-farm employment approaches on the multidimensional poverty

The OLS model is further used to test the impact of different off-farm employment approaches on the multidimensional poverty, including self-employment, employment and part-time employment. Table 9 shows that employment, self-employment and part-time employment significantly alleviate multidimensional poverty. Part-time employment has the most significant multidimensional poverty reduction effect, with an estimated coefficient of -0.1070. In terms of the sub-dimensions of multidimensional poverty, part-time employment had the biggest effect on income ability poverty, development ability poverty and living conditions poverty, followed by employment, self-employment. It can thus be seen that part-time employment has a better effect on improving the multidimensional poverty than the other two approaches. The possible reason for this is that self-employment and employment are generally in industries with limited profit margins and development potential, such as wholesale and retail trade, transport, storage and postal services, restaurants and accommodation (NAMINSE et al., 2018; NBSC, 2022). Although, self-employment is more autonomous and flexible, with the excess market profits generally higher than the wage income of the employed, self-employed farmers also face higher market risks and business barriers, requiring higher resource endowments from the farmers themselves. Although, employment can avoid the market risks that self-employment may bring, and the barriers to entry are relatively low, the

Table 8 - The impact of off-farm employment on farmers with different levels of multidimensional poverty.

	----------Explained variable: MPI----------				
	q10	q25	q50	q75	q90
Off	-0.0222*	-0.0168*	-0.0462***	-0.1214***	-0.0821**
	(0.0122)	(0.0096)	(0.0114)	(0.0217)	(0.0387)
Control variables	Yes	Yes	Yes	Yes	Yes
Cons	0.4144***	0.6347***	0.8091***	0.9403***	0.9228***
	(0.0831)	(0.0668)	(0.0630)	(0.1108)	(0.2035)

Note: standard errors are in parentheses. ***, P < 0.01; **, P < 0.05; *, P < 0.1.

wage income that farmers receive is generally lower than the income from self-employment. Our field survey has also found that off-farm self-employment in the Yellow River Basin is mostly in the form of street services, mobile vendors and small workshops, which can sustain basic survival and have limited room for development (WANG et al., 2020b). While part-time employment combined both self-employed and employed labour in off-farm employment, achieving complementary advantages in terms of livelihood capital accumulation and improvement of living conditions, which can effectively avoid the risk of multidimensional poverty that may be faced by a single off-farm employment channel.

CONCLUSION

As an important area in China's poverty alleviation, the Yellow River Basin region has basically eliminated absolute poverty in terms of income through the poverty alleviation campaign, but it still faces many challenges in consolidating the achievements of poverty alleviation, managing multidimensional poverty and achieving common prosperity. The multidimensional poverty situation of farmers in the middle and upper reaches of the Yellow River, represented by Inner Mongolia, is still grim, and the shortage of development conditions is the key bottlenecks.

Off-farm employment has a significant alleviation effect on the multidimensional poverty of farmers in the Yellow River Basin, but this alleviation effect is markedly heterogeneous. First, the multidimensional poverty reduction effect of off-farm employment in Shaanxi was the greatest, followed by Inner Mongolia and Henan, and the smallest in Ningxia and Shanxi. Second, off-farm employment has the greatest inhibitory effect on

Table 9 - The impact of off-farm employment approaches on the multidimensional poverty of farmers.

Model	(5)	(6)	(7)	(8)
Explained variable	MPI	IAPI	DAPI	LCPI
Employment	-0.0893***	-0.0618***	-0.0143***	-0.0132***
	（0.0088）	（0.0068）	（0.0033）	（0.0030）
Self-employment	-0.0790***	-0.0608***	-0.0066	-0.0116*
	（0.0166）	（0.0125）	（0.0057）	（0.0061）
Part-time employment	-0.1070***	-0.0692***	-0.0150*	-0.0229***
	（0.0200）	（0.0154）	（0.0088）	（0.0077）
Control variables	Yes	Yes	Yes	Yes
Cons	0.6919***	0.2169***	0.3220***	0.1530***
	（0.0844）	（0.0649）	（0.0278）	（0.0289）
R^2	0.2665	0.0979	0.3413	0.2368
F	49.8633	14.7189	75.4402	41.4794

Note: standard errors are in parentheses. ***, P < 0.01; **, P < 0.05; *, P < 0.1.

income ability poverty, followed by living conditions poverty and development ability poverty. Third, off-farm employment is more favourable to farmers with higher levels of multidimensional poverty. Fourth, part-time employment has a better effect on improving the multidimensional poverty of farmers than self-employment and employment. The above conclusions are of great practical significance for promoting rural revitalization and common prosperity and provide policy basis for effectively controlling the multidimensional poverty of farmers in the Yellow River Basin.

Policy implications

(1) Against the backdrop of the reality that the middle and upper reaches of the Yellow River, such as Shaanxi and Inner Mongolia, are still areas with a high incidence of multidimensional relative poverty, resources, such as capital, technology and policies, should be further directed to the middle and upper reaches of the Yellow River to promote the full employment of the poor through increasing off-farm employment opportunities, thereby enhancing the holistic and coordinated approach to poverty management in the Yellow River Basin.

(2) Targeting the key areas where poverty occurs in different regions, governments can give full play to the multidimensional poverty reduction effect of off-farm employment, such as increasing the employment opportunities and incomes of farmers in Ningxia and Inner Mongolia through information sharing and targeted assistance; promoting the construction of livelihood projects in housing, drinking water, sanitation and heating in Shaanxi and Inner Mongolia to improve the living conditions of farmers; and guiding farmers to invest more in education, health, social security and access to information for their family members.

(3) To strengthen off-farm employment support for farmers with higher levels of multidimensional poverty, governments can encourage and support them to take up off-farm employment through a combination of self-employment and employment, to improve their family income and development capacity, and achieve poverty alleviation.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTIONS

All authors contributed equally to the conception and writing of this manuscript. All authors critically revised the manuscript and approved of the final version.

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