

Analysis on the Income Increasing Effect of Farmers' Professional Cooperatives in Poor Areas

A Case Study of Qinba Mountain Area of Sichuan Province

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Abstract—As one of the important new agricultural operators in China, farmers' professional cooperatives (hereinafter referred to as cooperatives) is an important carrier to increase the income of farmers and promote poverty alleviation. The effect of income increase of cooperatives directly affects the process of poverty alleviation in poor areas. Therefore, based on the survey data of 700 households in poverty-stricken county of Qinba mountain area of Sichuan province, this paper used the propensity score matching method (PSM) to analyze the income increasing effect of cooperatives in poverty-stricken areas and explore the influence of cooperatives on household agricultural net income. It is found that cooperatives in Qinba mountainous area of Sichuan province have a significant role in promoting the increase of farmers' agricultural net income, and there are differences in the effect of income increase among different income groups. Whether the local farmers have received technical training, education, health status, and distance to the county are all factors that affect the local farmers to join the cooperatives.

Keywords—Farmers' professional cooperatives; income increasing effect; propensity score matching; poor areas; Qinba mountains

I. INTRODUCTION

Poverty is a social problem that exists and concerns all over the world, improving people's livelihood and gradually realizing common prosperity are regarded as the essential requirements of socialism. As the main battlefield of poverty alleviation, the whole poverty alleviation in this area is the "hard bone" that needs to be chewed in order to build a well-off society in an all-round way. The institutional arrangement of farmers' professional cooperatives (hereinafter referred to as cooperatives) is naturally beneficial to poverty, and is an ideal carrier to help rural poor people out of poverty under the market economy environment [1]. The effect of promoting agricultural

income increase of cooperatives not only directly influences the effect of poverty reduction in poor areas, but also serves as an important indicator and basis to measure the quality of their own development. By the end of April 2019, there have been 2.207 million farmers' cooperatives registered in accordance with the law in China, radiating nearly half of the farmers in the country. At the same time, under the background of high-quality development of agriculture, the academic circles pay more and more attention to the development quality of cooperatives. Does the cooperative have the effect of increasing income? If so, what is the effect of income increase of cooperatives?

It has been pointed out that cooperatives play an important role in promoting farmers' income [2]. Some scholars believe that cooperatives can reduce agricultural production costs by providing various agricultural socialized services to farmers, enhance farmers' market discourse power [3], promote the rational transfer of rural surplus labor force [4], and improve farmers' self-development ability [5], so as to increase farmers' operating income, wage income and property income of households [6].

There are still some scholars who say that cooperatives do not necessarily increase the income of their members. some problems restrict the effect of cooperatives in helping farmers increase their income, such as the irregular development of cooperatives [7], the unreasonable distribution of interests [8], and the lack of close relationship between agricultural cooperatives [9]. So, in poor areas with weak economic foundation and poor geographical location, what is the effect of cooperatives on Farmers' income?

However, the current research on cooperatives in poverty-stricken areas mainly focuses on the problems existing in cooperatives [10], cooperative poverty alleviation model [11], farmers' willingness to participate in cooperatives [12] and behavior mechanism [13]. A few literatures have discussed the role of cooperatives in poverty

reduction and income increase in poverty-stricken areas [14], but mainly used qualitative analysis methods [15].

It is not difficult to find that there is a lack of research focusing on the effect of income increase of cooperatives in such special areas as poverty-stricken areas, and qualitative analysis is often used, while empirical analysis based on micro survey data is rare. Therefore, this paper takes Qinba mountain area of Sichuan province as an example to analyze the effect of income increase of cooperatives in poor areas.

II. RESEARCH METHODS

A. Data Sources

The data used by this research institute comes from the field survey conducted by the research group in Qinba mountain area of Sichuan province in July 2016. The sample counties are selected by random sampling method. The cooperative members and non-members are distributed in 13 poor counties of 4 cities in Qinba mountain area of Sichuan province, which are well representative in the poor areas of Qinba mountain area of Sichuan province. The survey takes the form of one-to-one interview. The content of the questionnaire involves the personal characteristics and family characteristics of farmers.

B. Variable Selection

On the basis of previous studies, combined with the actual research situation, this paper, based on the research of scholars, comprehensively considers that the net income of farmers' family agriculture is selected as the outcome variable, and the gender, age, whether they have received technical training, degree of education, health status, number of family labor force and the distance from home to the county seat are selected as the matching variables. The net income of households is a group variable.

C. Model Setting

As a rational economic person, when considering whether to join the cooperative or not, the farmers have considered the influence of many factors, and finally formed the choice of maximizing their own interests. However, the factors that affect whether farmers choose to become members of cooperatives may also affect farmers' agricultural income, which is, whether to join cooperatives is the result of farmers' self-selection. In the existing studies, the simple comparison between the income of members and that of non-members or the OLS model are used to analyze the income increasing effect of cooperatives. However, the above methods ignore the problem of farmers' self-selection, and often can't control the bias of estimation results caused by sample selection bias, which will directly affect the reliability of the conclusions. PSM can effectively eliminate the sample selection bias caused by observable variables such as gender, age, education level, etc. Therefore, in order to more accurately evaluate the income increasing effect of cooperatives in Sichuan poverty-stricken areas, this paper uses PSM to analyze the impact of joining cooperatives in poverty-stricken areas on Farmers' net agricultural income.

In order to analyze the impact of joining cooperatives in poverty-stricken areas on the net agricultural income of farmers, it is necessary to observe the income difference of the same farmers in the two states of joining cooperatives and not joining cooperatives. But this kind of income difference can't be directly observed, because the identity of farmers at the same time can only be members or non-members. PSM can find the non-members who are similar to the members' characteristics as much as possible to observe the members' family agricultural net income in the counterfactual state (non-members). However, it is worth noting that under the condition of non-experimental intervention, farmers' decision to join cooperatives in poverty-stricken areas is not random, so the problem of selection bias should also be considered.

The basic idea of PSM is to find the treated and the untreated that have the same factors that affect the household agricultural net income except for joining the cooperative. By comparing the mean value of the family agricultural net income of the treated and the untreated, the net effect of joining the cooperative is obtained. In view of the difficulty of one-to-one matching according to multi-dimensional criteria, this paper uses logit model to calculate the propensity score to reduce the dimension, and uses different matching methods to find the samples with the closest propensity score for matching. The propensity score is the conditional probability of farmers i joining cooperatives in poverty-stricken areas when the sample characteristic X_i is given, as follows:

$$P(X_i) = P_r(D_i = 1|X_i) = E(D_i|X_i) \quad (1)$$

In equation (1), when D_i is taken as 1, it is the processing group (member group), when D_i is taken as 0, it is the untreated (non member group), and X_i represents the observable characteristics of members (matching variables). After matching according to the tendency score, the average treatment effect of joining cooperatives on the net agricultural income of farmers can be expressed as follows:

$$\begin{aligned} ATT &= E[Y_{1i} - Y_{0i}|D_i = 1] = \{E[Y_{1i} - Y_{0i}|D_i = 1, P(X_i)]\} \\ (2) \quad &= E\{E[Y_{1i}|D_i = 1, P(X_i)] - E[Y_{0i}|D_i = 0, P(X_i)]|D_i = 1\} \end{aligned}$$

In equation (2), y_{1i} and y_{0i} represent the net agricultural income level of the i th peasant household in the two cases of joining the cooperative and not joining the cooperative.

At present, the commonly used matching methods include k-nearest neighbor matching, radius matching, kernel matching and so on. In this paper, the most direct and commonly used matching method, one-to-one matching method in k-nearest-neighbor matching method, is selected to match the samples with the closest tendency score. At the same time, in order to ensure the robustness of the results, radius matching method and kernel matching method are selected to verify the results.

III. EMPIRICAL RESULTS AND ANALYSIS

A. Logit Model Estimation

"Table I" Logit estimates show that farmers who have received technical training are more inclined to increase their own income in agricultural or non-agricultural fields by their own technology and technology, and are less inclined to join

cooperatives. The more educated farmers are, the more they tend to accept cooperatives and join them. The better the health status is, the more willing the farmers are to join the cooperative. The farther away from the county, the more dependent farmers are on cooperatives, the more inclined they are to join cooperatives. Gender, age and family labor force have no significant influence on whether the farmers join the cooperative or not.

TABLE I. LOGIT RESULTS ABOUT PROPENSITY SCORE MATCHING

Variables	Coefficients	Standard error
Gender	0.150	0.250
Age	0.009	0.008
Technical training	3.531***	0.474
Education	0.098***	0.031
Health	0.344***	0.088
Household labor force	0.020	0.069
Distance to county	0.011**	0.005
Cons	0.647	0.807

^a ** and *** represent statistical significance at the 5%, and 1% levels, respectively.

B. Sample Matching Effect

In this paper, one-to-one matching method of k-nearest-neighbor matching is used to match the matching variables. In order to investigate the scientificity of the matching results, the balance hypothesis test is carried out. The test results show the error changes of samples before and after matching. Compared with the results before matching, the

standard deviation of most variables has been reduced to varying degrees, and the absolute value of the standard deviation after matching is less than 10%. The minimum reduction of the standard deviation of gender is 34.2%, and the maximum reduction of health status is 100%. It can be seen that the sample difference between the treated and the untreated is partially eliminated, and the matching effect is satisfactory and acceptable. (See "Table II")

TABLE II. RESULTS OF BALANCE HYPOTHESIS TEST

Variables	Unmatched	mean		% reduct		t - test	
	Matched	Treated	Untreated	%bias	bias	t	p > t
Gender	Unmatched	0.866	0.828	10.4		1.36	0.173
	Matched	0.855	0.831	6.8	34.2	0.91	0.361
Age	Unmatched	54.633	55.787	9.7		1.28	0.201
	Matched	55.112	56.322	10.2	4.9	1.24	0.214
Technical Training	Unmatched	0.712	0.983	81.2		9.90***	0.000
	Matched	0.795	0.795	0.1	99.9	0.01	0.993
Education	Unmatched	7.095	6.351	22.9		2.99***	0.003
	Matched	6.962	7.090	4.0	82.8	0.47	0.640
Health	Unmatched	3.731	3.443	26.8		3.51***	0.000
	Matched	3.667	3.667	0.0	100.0	0.00	1.000
Household labor force	Unmatched	2.804	2.732	5.7		0.74	0.459
	Matched	2.806	2.306	39.1	590.2	4.72***	0.000
Distance to county	Unmatched	26.356	24.034	14.6		1.91**	0.056
	Matched	25.940	26.135	1.2	91.6	0.16	0.871

^a ** and *** represent statistical significance at the 5%, and 1% levels, respectively.

C. Effect of Increasing Income

Under the k nearest neighbor matching one-to-one matching method, the average processing effect of farmers joining cooperatives in Qinba mountain area of Sichuan province is positive, and it has passed the significance test with 99% confidence. That is to say, in the case of keeping other control variables similar to individuals, the net income of household agriculture of farmers increased by 22,880 yuan because of joining cooperatives. Under the methods of

radius matching and kernel matching, the treatment effect of joining cooperatives on the agricultural net income of peasant households is 24,460 yuan and 24,340 yuan respectively, which are significant at the level of 1%. The results of the three matching methods are consistent and robust. The estimated results confirm that cooperatives in poor areas have a significant role in promoting the increase of farmers' net agricultural income, which is consistent with the conclusions of Zhang Jinhua [16] and other scholars. (See "Table III")

TABLE III. ESTIMATED RESULTS OF THREE MATCHING METHODS

Matching method	Treatment effect	Mean (ten thousand yuan)		Difference (ten thousand yuan)	S.E.	t - stat
		Treated	Untreated			
K nearest neighbor matching	ATT	3.168	0.880	2.288	0.497	2.720***
Radius matching	ATT	3.193	0.747	2.446	0.498	3.800***
Kernel matching	ATT	3.168	0.734	2.434	0.503	3.820***

^a. *** represent statistical significance at the 1% levels, respectively;

^b. The standard error of ATT in the table is the result of repeated sampling (Bootstrap) for 500 times.

D. Sensitivity Analysis

Although PSM model can reduce the deviation of observable variables to a great extent, the above analysis

only controls the impact of observable variables on the net income of farmers' households in poverty-stricken areas. If there is a choice based on unobservable variables, it will still bring "hidden deviation", which makes the unobservable heterogeneity in the regression equation caused by the error term become non-random. Therefore, in order to further analyze the influence of recessive bias on the above estimation results, the author uses stata14.0 software and wilconxon signed rank test method to analyze the sensitivity of the above estimation results. It can be seen from "Table IV" that when the gamma coefficient increases to 1.6, the existing conclusion is not significant at the level of 0.05. It can be determined that the unobservable factors may exist, but the estimated processing effect is not very sensitive to these unobservable factors. Therefore, the unobservable variables have no big deviation to the PSM estimation results, so this study can't further analyze the hidden deviation.

TABLE IV. RESULTS OF SENSITIVITY ANALYSIS

Gamma	Sig -	Sig +
1.0	0.000	0.000
1.1	0.000	0.000
1.2	0.000	0.002
1.3	0.000	0.010
1.4	0.000	0.038
1.5	0.000	0.104
1.6	0.000	0.000

^a. Gamma represents the logarithmic occurrence ratio of different arrangements caused by uncontrolled factors;

^b. Sig - represents the lower bound of significance level, while sig+ represents the upper bound of significance level.

E. Income Difference of Different Income Groups

In order to further test the effect of cooperatives on different income farmers in poverty-stricken areas, this paper divides the sample farmers into low-income group and high-income group according to household agricultural net income. Under the k nearest neighbor matching one-to-one matching method, the average agricultural net income of farmers with higher family net income is higher no matter whether they join the cooperative or not; from the perspective of income growth, the increase of agricultural net

income of farmers in the high-income group joining the cooperative is slightly lower than that in the low-income group, indicating that the increase of agricultural net income brought by joining the cooperative is greater for farmers with relatively lower family net income. However, from the absolute value of growth, the average treatment effect of high-income group is much higher than that of low-income group, indicating that the absolute value of agricultural net income growth of high-income group is greater after joining the cooperatives.

TABLE V. RESULTS OF K NEAREST NEIGHBOR MATCHING ESTIMATION FOR DIFFERENT INCOME GROUPS

Groups	Treatment effect	Mean (ten thousand yuan)		Difference (ten thousand yuan)	S.E.	t - stat
		Treated	Untreated			
Low income	Unmatched	1.079	0.441	0.638	0.161	3.970***
	ATT	1.111	0.424	0.687	0.163	3.540***
High income	Unmatched	7.102	2.292	4.810	1.653	2.910***
	ATT	7.451	3.019	4.432	1.771	2.700***

^a. *** represent statistical significance at the 1% levels, respectively;

^b. The standard error of ATT in the table is the result of repeated sampling (Bootstrap) for 500 times;

^c. This table is the estimation result based on k-nearest neighbor matching, and the estimation result using other two matching methods is relatively close to it.

The above grouping results ("Table V") show that although some farmers have achieved income growth by joining cooperatives, there are differences in the effect of income growth among farmers of different income levels. It is found that cooperatives in this area are mainly established by "rural elites" with certain economic strength. For different

reasons, such farmers usually invest more capital, land and other production factors in cooperatives. Under such circumstances, this part of high input farmers gets higher factor returns and higher decision-making rights in cooperatives. Even as Lin Jian and Huang Shengzhong [17] pointed out, owning the main residual control rights and

residual claim rights of cooperatives makes it difficult for low input low-income farmers to protect their interests in cooperatives. This is also one of the main reasons for the difference in the effect of cooperatives on the income of farmers with different income levels.

IV. CONCLUSION

As an important organization carrier of industrial poverty alleviation, the effect of income increase of cooperatives directly affects the process of poverty alleviation campaign in poor areas. In order to evaluate the effect of increasing income of cooperatives in poverty-stricken areas of Sichuan Province, this paper uses PSM to analyze the effect of increasing income of cooperatives in poverty-stricken areas of Qinba mountain area of Sichuan province. It is found that in poor areas where the economy is relatively backward and the natural environment is more complex, joining cooperatives can significantly promote the increase of agricultural net income of farmers; however, for different income groups of farmers, there are differences in the effect of increasing income. The increase of low-income group is more obvious, while the absolute value of the increase of high-income group is greater; the farmers who have not received technical training are more inclined to join the cooperatives, the higher the education level, the better the health status, and the farther away from the county, the farmers are more willing to join the cooperatives.

Therefore, it is necessary to increase the support for education and medical care in poor areas. The government should improve the comprehensive quality of farmers in poverty-stricken areas from education, health and other aspects, enhance the awareness and ability of farmers in poverty-stricken areas to participate in cooperatives, so as to improve the probability of farmers in poverty-stricken areas to join cooperatives. At the same time, we should fully protect the legitimate interests of low-income farmers, especially the poor ones, and give full play to the role of cooperatives in promoting agricultural income in poor areas.

REFERENCES

[1] B. Wu, X. C. Xu, "Pro-poverty and its mechanism of farmer professional cooperatives," *Rural Economy*, pp. 115-117, 2009.

[2] S. H. Zhang, Y. D. Shen, and L. H. Gao, "The effect of poverty alleviation by cooperative economic organizations on farmers' income — An empirical analysis based on propensity score matching method," *East China Economic Management*, vol. 32, pp. 165-172, 2018.

[3] H. L. Yang, "Development of farmers' specialized cooperatives in underdeveloped areas and increase of farmers' income," *Truth Seeking*, pp. 249-253, 2012.

[4] G. B. Lian, Y. D. Li, "The approaches of transferring rural surplus labor force in agricultural industrialization: perspective based on an analysis of farmers specialized cooperatives," *Journal of Northwest University(Philosophy and Social Sciences Edition)*, vol. 39, pp. 66-69, 2009.

[5] Y. Y. Liu, X. J. Wang, and X. H. Fu, "Impact of agricultural cooperatives on the self-development ability of small household — the empirical evidence from Qinlin-Daba mountain region in Sichuan," *Journal of Sichuan Agricultural University*, vol. 36, pp. 413-420, 2018.

[6] N. N. Mu, X. Z. Kong, and Z. Zhong, "Innovation of agricultural socialized service model and long-term mechanism of increasing farmers' income: An empirical analysis based on multiple cases," *Jianghai Academic Journal*, pp. 65-71, 2016.

[7] W. H. Peng, Z. H. Huang, "Can cooperatives help to increase farmers' income? — Analysis based on endogenous switching regression model and cooperatives' service functionality," *Journal of Northwest A & F University (Social Science Edition)*, vol. 17, pp. 57-66, 2017.

[8] J. R. Deng, C. J. Qi, "Analysis of ordinary members' investment intention in farmers' specialized cooperative: taking x citrus cooperatives in Hubei Province as example," *Hubei Agricultural Sciences*, vol. 52, pp. 213-215+218, 2013.

[9] D. Yang, Z. M. Liu, Farmers' specific investment, relationship between farmers and cooperatives and farmers' income growth, *Chinese Rural Economy*, pp. 45-57, 2017.

[10] N. Y. Guo, Z. X. Zhang, and Q. Gao, "Problems and reflections on the development of farmers' cooperatives in poverty-stricken areas: based on the survey of two counties in Pingliang city, Gansu province," *China Farmers' Cooperatives*, pp. 38-41, 2016.

[11] Y. X. Liu, "Research on cooperative poverty alleviation mode in contiguous poverty areas," *Journal of Hunan University of Finance and Economics*, vol. 32, pp. 41-48, 2016.

[12] X. Chen, X. H. Fu, and G. Q. Liu, "Impact factors of rural households' willingness to participate in farmers' professional cooperatives in poverty-stricken areas — based on a survey of 320 rural households in Qinba mountain poverty-stricken areas of Sichuan Province," *Guangdong Agricultural Sciences*, vol. 44, pp. 177-185, 2017.

[13] W. H. Peng, L. L. Fu, "Analysis on the mechanism of rural households participating in farmer cooperatives in poor area: evidences from Fuchuan County, Guangxi Province," *Issues in Agricultural Economy*, pp. 134-144, 2018.

[14] L. Hu, "Poor Areas farmers' professional cooperatives and farmers income growth — based on an empirical analysis of the difference-in-differences method," *Finance & Economics*, pp. 117-126, 2014.

[15] W. Qian, Y. Q. Guo, "An empirical study on the role of Xinjiang farmers' professional cooperatives in poverty reduction: taking Hetian Area as an example," *Xinjiang State Farms Economy*, pp. 39-44, 2012.

[16] J. H. Zhang, K. W. Feng, Y. W. Huang, "An empirical study on the performance of farmer' professional cooperatives in increasing farmer's income," *Chinese Rural Economy*, pp. 4-12, 2012.

[17] J. Lin, S. Z. Huang, "An analysis on membership heterogeneity and the ownership of fanners' cooperatives," *Issues in Agricultural Economy*, pp. 12-17+110, 2007.