Determinants and impacts of marketing channel choice among cooperatives members: Evidence from agricultural cooperative in China

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This paper examines the impact of agricultural cooperatives working as a marketing channel, and the determinant of members' decision to sell products through agricultural based on household-level data of agricultural cooperatives members from poor rural areas in Sichuan province, in China. Employing different treatment effect estimators, i.e. PSM and IPWRA, we find that selling products through agricultural cooperatives has a positive and statistically significant effect on both farmers' annual total household income and farm income. It was also found that the effect on farm income (around 180%) is higher than annual total household income (around 20%). Comparing the difference between ATTs and ATEs, we could suggest that the efficiency of agricultural cooperatives can be improved by encouraging non-sellers to sell products through agricultural cooperatives, which is possible to do according to the results of a probit model. Following empirical results obtained using the probit model, we conclude that farm size, farming machine, distance to market, credit constraint, sale condition, motivation to participate in agricultural cooperatives and the knowledge of agricultural cooperatives positively and significant influence the probability of a member selling products through agricultural cooperatives, while the market information ownership shows a negative significant effect on the choice.

Acknowledegment: Firstly, I would like to offer my sincerest gratitude to my supervisors, Prof. Xinhong Fu and Prof. Houjian Li at Sichuan Agricultural University and Prof. Alan Renwick at Lincoln University in New Zealand. You were patient to answer my questions all the time. You did give me full freedom to develop my own ideas and doing your best to support me. My appreciation goes to Wanglin Ma and Xiaoshi Zhou who were both my daily supervisors. The discussions with you always gave me new ideas and the encouragements from you kept me going in the field.

JEL Codes: J54, Q13

#2570

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Keywords: Agricultural cooperatives; Marketing channel; IPWRA; PSM; Poor rural areas

JEL codes: C83, J54, Q13, P52.

1. Introduction

It is often argued that smallholder farmers are often in unfavorable bargaining positions with the big market, especially in developing countries and transition countries. And small-scale farmers face many constraints that impede them from participating in competitive markets. What's more, having access to output markets is directly linked with the agricultural incomes. Agricultural income plays a pivotal role in smallholders' life condition and career choices. In china, from a sustainable development of agricultural industry and rural areas perspective, improving life condition and keeping labors on the land are the two main goals of government policy. Although agricultural cooperatives have been identified as appropriate institutions for helping smallholder farmers participate in competitive input and output markets (Trebbin, A., 2014), clarifying the role of agricultural cooperatives in enhancing smallholders' income through improving their market participation ability has been overlooked.

An emerging body of literature has investigated how smallholder farmers sell agro-food products and/or how they can be linked to agricultural markets (Katchova, and Miranda, 2004; Da Silva, and Ranking, 2013; Narayanan, 2014; Gatto et al., 2017). For instance, farmers can sell products through traditional channels, such as direct sales to consumers, and spot market sales to wholesalers. And modern sale channels are also available for farmers, just like direct sales to modern retailers, supermarket, as well as companies and so on (Rao, and Qaim, 2011; Franken, Pennings, and Garcia, P., 2014; Ma, and Abdulai, 2016; Ochieng, Veettil, and Qaim, 2017). Different market channels have different transaction characters. For instant, small dealers buy farmers' products directly and casually without any contract. In other words, any small dealers can buy any farmers' products. This marketing channel is more randomly with higher uncertainty (Hao, J et al., 2018). The other common marketing channel is wholesalers, who rarely buy products from farmers directly. Wholesalers usually have brokers in rural areas, and they buy farmers products at a fixed location without contracts (Hao, J et al., 2018). Almost

every farmer can sell products to them. Compared with small dealers and wholesalers, supermarkets and process companies buy smallholders' products though contract and request higher products quality (Rao and Qaim, 2011; Trebbin, 2014). This marketing channel is more stable and lower price uncertainty, but it requests higher specialized asset investment such as technology and other special input. As risk-averse market participants, farmers usually prefer to choose marketing channels with less risk of trading, more convenient and no contracts (Schipmann and Qaim, 2011). Based on rural data from Ethiopia, Tefera, D. A. et al (2017) also found the cooperatives are the preferred channel among farmers who produce honey and milk. Given that agricultural cooperative is designed to reduce the transaction costs and enhancing farmers' market participation ability, agricultural cooperatives are of considerable interest to both researchers and policy makers (Chagwiza et al., 2016; Latynskiy, and Berger, 2016).

Given that agricultural cooperatives are seen as organizations that can efficiently link smallholder farmers with agricultural products markets (Jia, and Huang, 2011; Trebbin, 2014), it is important to analyze the impact of agricultural cooperatives working as a marketing channel on the net returns of farmers. There is a body of literature analyzing the impacts of agricultural cooperatives on such factors as: household welfare; income; revenue (Giannakas, and Fulton, 2005; Abebaw, and Haile, 2013; Cadot, 2015; Pradhan, and Ranjan, 2016; Ma, and Abdulai, 2017). For examples, the studies by Tilahun et al. (2016) for businesses belonging to frankincense cooperatives and Chagwiza et al. (2016) for dairy cooperatives show that membership has a positive and statistically significant impact on farmers' income. Based on a study of apple farmers in China, Ma and Abdulai (2016) certified farmers can benefit from agricultural cooperatives with oral contract. Mojo et al. (2017), for example, finds that participating in agricultural cooperatives is positively associated with household income and assets, based on the survey data from rural Ethiopia. Based on data from 2190 cassava-growing

households in rural Nigeria, Wossen et al. [a] (2017) shows that the more probability for cooperative members to adopt improved cassava varieties than those who do not have cooperative memberships. However, few studies could distinguish the different impacts of cooperative memberships and services provided by agricultural cooperatives. Based on the data from international nongovernmental organizations (NGOs) in Kenya, Fischer, E., and Qaim, M. (2012) conclude that cooperative organizations themselves do not improve market access for smallholder farmers. The participation potential benefits usually depend on the collective activities. In other words, the potential benefits always depend on what the cooperatives do, and what the farmers do. Hence, clarifying how does cooperative do good to its members is more important rather just considering the benefit of membership. However, how agricultural cooperatives have had an impact on the different members has rarely been considered.

This paper, by analyzing the example of agricultural cooperatives members in poor areas of Sichuan province in China makes a threefold contribution to the literature. First, we analyze the impact of agricultural cooperatives working as a marketing channel on the members' household income. Second, we focus on agricultural cooperatives which are treated as an efficient institution to enhancing farmers income and developing the local agriculture production in poor rural areas in China. Third, we employ treatment effect models (both propensity score matching and inverse probability weighting estimator with regression adjustment) to address the sample selection problem. Given that cooperative members themselves choosing to sell products through agricultural cooperatives may be influenced by both observed and unobserved factors (e.g. members' innate abilities), employing the usual ordinary least squares (OLS) method to analyze the impact of agricultural cooperatives working as marketing channel on members' income leads to sample selection bias. The propensity score matching (PSM), which has been widely used to address the selection bias on observables, can solve the impact evaluation problem of missing data on counterfactual (Van Rijsbergen et al.,

2016). However, the average treatment effect on treated (ATT) from PSM can still produce biased results in the presence of misspecification in the propensity score model (Robin et al., 2007; Wooldridge, 2007, 2010). A potential remedy for such misspecification bias is to use inverse probability weighting estimator with regression adjustment (IPWRA) (Wooldridge, 2010). The IPWRA estimator used in the presents studies, estimate the effects which will be consistent and have double-robust property, if either the treatment model or the outcome model is miss-specified (Cattaneo, 2010; Wossen et al. 2017[b]).

The rest of the paper is structured as follows: Section 2 gives an overview of agriculture and agricultural cooperatives in poor areas in China. This is followed by the conceptual framework and estimation technique. Section 4 presents a description of the data used in the analysis. The estimated results and discussion are given in Section 5. Conclusions and policy implication are present in the final section.

2. Overview of agriculture and agricultural cooperatives in poor areas in China

In rural China, areas of poverty are generally located in areas where hills, mountains, plateaus and ethnic minorities gather, with mountainous ditch deep, vast territory, scattered farmer settlements and (the term peripheral) poor conditions of transportation and communication. Under the constraints of natural conditions and resources, these areas have a number of characteristics. For example, agricultural yields are generally low, production and transaction costs are high, marketing information is asymmetric, and markets are imperfect. For example, farmers have more information about the quality of agricultural products, while buyers have more information about markets. However, asymmetric information impedes the efficient operation of agricultural transactions. Farmers who have weak market negotiation skills are also in a disadvantaged position in the course of market transactions. As a result, market mechanisms cannot operate effectively. farmers can hardly benefit from agriculture, young and middle-aged people in rural areas abandon farming. Meanwhile, the major livelihood of large numbers of poor farmers and rural families is mainly from agriculture. Due to the fact that farmers are aging have less education and physical weakness. It is almost impossible for farmers to change their production conditions and obtain market information by themselves. In view of the constraints faced by Chinese farmers, especially in poor areas, in terms of production and sales, the Chinese government encourages develop the large-scale operation of agriculture, as well as endeavors small hold farmers to combine.

Based on the experience of developed countries in agriculture and summarizing the characteristics of their own development, the Chinese government has made great efforts to develop agricultural cooperatives with the aim of increasing the market competitiveness of small-scale farmers and their incomes. Farmers in poor areas are not only lacking in the production technologies, cheap and affordable means of production needed for agricultural productions but also lack market information and stable sales channels. Hence, it is very

difficult for farmers to set up agricultural cooperatives themselves. Following the promulgation of the "Law of the People's Cooperative Farmer Cooperatives" in 2007 China's governments at all levels have promulgated other policies to encourage rural leaders with political, economic and cultural resources to set up and lead agricultural cooperatives. The aims are to help farmers overcome the contradiction between "smallholder farmers vs big market". For example, enabling small farmers to better connect with the market and enhancing the competitiveness of small farmers in the market. The agricultural cooperatives are rated by governments, according to the number of farmers assisted by the agricultural cooperatives. Moreover, governments give different financial subsidies to different levels of cooperatives. In order to obtain higher social reputation and economic benefits, and obtain more government support and subsidies, the agricultural cooperatives choose to unite small farmers and provide them with advanced production technology and timely market information. The most direct method which helps farmers is to purchase their agricultural products. Therefore, under normal circumstances, the prices of agricultural products given by agricultural cooperatives in poor areas will be at least equal to the market price and not lower. Meanwhile, the basic motivation for the overwhelming majority of farmers in joining agricultural cooperatives in China is to solve the problem of selling agricultural products. Like agricultural cooperatives in other undeveloped countries (Wollni, M., and Zeller, M., 2007; Bernard, T., and Spielman, D. J., 2009) agricultural cooperatives in poor areas in China have proved to be effective organizations that can link smallholders to markets, and help farmers to gain more farm income (Ma, W., and Abdulai, A., 2016).

Additionally, there are some features of agricultural cooperatives in poor areas: a) there is at least one agricultural cooperative in almost every village, based on the aim of agricultural bureaus. As we know, the government in China has strong and promotional powers. And the increasing number of agricultural cooperatives is one of the important indicators for assessing

the workload of the local agricultural administration. b) the scale of agricultural cooperatives in poor areas are not large and most of the members are the local villagers. So, most of members know each other, and some of them are relatives. c) With regard to the dual nature of cooperatives, the public welfare of cooperatives is more prominent than the economic nature. Since most cooperatives are established under the guidance of government policies, cooperatives tend to take care of the interests of farmers in order to gain more support from the government.

3. Conceptual framework and estimation technique

3.1 The conceptual framework

The first objective of this study is to identify the determinants of selling products through agricultural cooperatives by smallholders. The conceptual framework employed here is based on the assumption that farmers choices relating to methods of marketing are mutually exclusive. Economic choices, such as selling products, is associated with potential costs and benefits, which may be perceived differently by different households. In our study, all sample households at least belong to one agricultural cooperative and the costs involved include the time taken to participate in group activities (such as workshops) membership fees and transportation costs to deliver products to the cooperative. Whereas, the benefits are mostly in terms of better access to output markets, involving more stable sale channel and market information.

Following Baltas, and Doyle (2001); Fischer, and Qaim（2012）the individual decision as to which form of contracts to use can be modeled in a random utility framework. Therefore, whether to sell products through agricultural cooperatives can be modeled as a binary choice decision, assuming utility maximization in consideration of household resource constraints (Manski, 1977). The actual utility level of each individual household U_i is unobserved. The part of the utility function that is observable can be expressed as a function of a vector of exogenous variables x_i and a vector of parameters φ to be estimated:

$$V_i(\varphi x_i), \text{ where}, U_i = V_i(\varphi x_i) + \mu_i \quad (1)$$

where, x_i includes farm, household and household head characteristics, and the relationship with agricultural cooperatives. For example, asset endowment, as well as financial and human capital. The unobserved part of the farmers' utility is represented by an error term μ_i which is assumed to be independently and identically distributed with mean zero. The farmer will choose to be the member if the utility U_i^u derived from group sellers is higher than the utility U_i^n derived from non-sellers.

The probability of a member selling products through agricultural cooperatives is given by $\mathrm{P}(u_i < \varphi x_i)$. Hence, the seller model to be estimated is:

$$\mathrm{P}(C_i = 1) = \mathrm{P}(u_i < \varphi x_i) = \varphi x_i + \mu_i \quad (2)$$

Where $C_i = 1$ if $U_i^u > U_i^n$ (in our cases, selling products through agricultural cooperatives, respectively) and $C_i = 0$ if $U_i^u < U_i^n$ (in our cases, not selling products through agricultural cooperatives, respectively). Hence, this binary choice model can be estimated with a probit specification.

On the one hand, to identify explanatory variables, we draw on the existing literature. Supporting the hypothesis that human capital increases "the ability to perceive, interpret, and respond to new events" (Schultz, 1982), education and age, both proxies for human capital, are included in our analysis. The marital status of the household head is also controlled for. We use physical assets such as farm size, farming machine ownership (Farming machine), credit constraint (Credit constraint), access to sell products (Sale) and marketing information (Information) as proxies for physical and financial capital. Household size is used to measure labor availability. Additionally, credit constraints have been shown to affect factor allocation in the production decisions of rural China' households (Feder et al., 1990). Credit constraints are considered as one of the main factors restricting the development of the retail market. Therefore, we assume that farmers facing credit constraints will choose to sell agricultural products to cooperatives. Furthermore, the efficiency of information flow may influence the decision to sell products through agricultural cooperatives. Empirical evidence shows that individual social networks are often relevant for the input and output decisions among smallholder farmers. In our study, we include access to market information from relatives and/or neighbors (Information) to account for individual social networks effect. Gender can also influence a farmer's choice of the selling contract. We can treat selling products through agricultural cooperatives as a collective action. Men may have different opportunities, motivation, and

capabilities with women to engage in collective action (Meinzen-Dick, R. et al., 2005). Abdulai, A., and Birachi, E. A. (2009) noted that the choice of selling products through agricultural cooperatives in Kenyan fresh milk supply chain are statistically significant effected by gender. And female was more likely to sell products through agricultural cooperatives than men. Hence, we include a dummy for male-headed households to account for possible gender effects.

Even though selling products to agricultural cooperatives is not an obligation for agricultural cooperatives members in our samples, whether selling products through agricultural cooperatives is mainly decided by expected benefits, which were influenced by higher prices, and lower transaction costs, such transportation fee, negotiation fee. Given that agricultural cooperatives are famous for saving negotiation fee (Lemeilleur, S., and Codron, J. M., 2011; Chaddad, F., and Iliopoulos, C., 2013), and all our sample agricultural cooperatives usually purchase members' production by the price which was not less than marketing prices, transportation fee should be considered. In this study, we use the distance to nearest markets as a proxy for transportation fee. What's more, the risk preferences of farmers also influence their sales decisions (Musser et al., 1996). For different sales channels of agricultural products, the market risks faced by farmers are not consistent, so it is necessary to take into account the farmers' risk preference (Risk). And finally, the initial motivation always leads the activity of people and drives the people to do something. Once a member joined an agricultural cooperative in order to sell their products, they may be more likely to sell products through agricultural cooperatives. So, when analyzing the determination of selling products through agricultural cooperatives, it is critical to account for the participation motivation (Motivation). A better understanding of an organization can build a stable trust mechanism within the institution, which would promote members act more cooperation with the organization (Österberg, P. and Nilsson, J., 2009). Hence, considering the farmers' knowledge about agricultural cooperatives is necessary in this study (Knowledge). Moreover, we include a

dummy for location (Location), because policy and economy environments are different in different areas, which should be considered.

The other main object of our study is to explore the impact of the agricultural cooperatives working as a marketing channel on members' total annual household income and total annual farm income while controlling other key factors (i.e. the above explanatory variables). Because we cannot observe how the income levels would have looked like without selling products through agricultural cooperatives, we will use treatment effect models to solve this problem of missing data on the counterfactual. The methodology will be introduced further below. In terms of total annual household income (HH income) and total annual farm income (Farm income), we include questions about household wage income, property income, and operating income, as well as transfer income during the past one year in the questionnaires to estimate HH income. The Farm income was assessed by asking a series of questions about agricultural incomes for each season during the past one year.

3.2 Estimation technique

Through the above theoretical analysis, the research of this paper is divided into two stages. In the first stage, we select the probit model to analyze the determinants of selling products though agricultural cooperatives. The purpose is to find out why some members choose to sell products through agricultural cooperatives, while others do not take the opportunity to sell products though agricultural cooperatives. In the second stage, firstly, we analyze the impact of the agricultural cooperatives working as a marketing channel on household income which include household total income and farm income, using propensity score matching (PSM) model. The purpose is to confirm that how the selling service form agricultural cooperatives affect the household income, in the control of other possible factors. The PSM results were then robustly tested using IPWRA model.

3.2.1 Probit model

In this paper, we employ a probit model to estimate the influence of explanatory variables on farmers' selling products through agricultural cooperatives. The probit model specification employs a latent variable y_i^* to an observable dependent variable y_i according to the rule:

$$y_i^* = \rho_i x_i + \sigma_i \tag{3}$$

$$y_i = \begin{cases} 1 \; if \; y_i^* > 0 \\ 0 \; otherwise \end{cases} \tag{4}$$

where, y is an explained variable (in our cases, selling products through agricultural cooperatives or not). x_i is a vector of explanatory variables, ρ_i is a vector of coefficients, and σ_i is a stochastic disturbance item.

3.2.2 Propensity score matching

In order to study the impact of selling products though agricultural cooperatives, one needs to look at the differences between the same subject selling products though agricultural cooperatives and not selling products though agricultural cooperatives. However, since we cannot directly observe that a subject has opted to not sell products though agricultural cooperatives after having chosen to sell products though agricultural cooperatives. In other words, counterfactual outcomes are unobservable as an individual is either in one state or the other at a point in time. In line with the literatures (Rubin, 1978; Rosenbaum and Rubin, 1983; Heckman et al., 1998), we can achieve the research goal by finding a group of other sellers whose characteristics are very similar to the sellers as the control group. However, on the condition of non-experimental intervention, it is not random whether to choose to sell products though agricultural cooperatives (De Janveru et al., 2010; Heckman and Vytlacil, 2007) and therefore selection bias also needs to be considered. Both can be controlled by propensity score matching (PSM) (Rosenbaum and Rubin, 1983). Therefore, the first step in the application of PSM is to estimate the predicted probability that a household sell products though agricultural cooperatives, also known as the propensity score, which can be expressed as:

$$\mathrm{p(x)} = P_r\{D = 1|x\} = E\{D|x\} \tag{5}$$

where, D is a treatment indicator (in our cases, selling products through agricultural cooperatives of treated and untreated households). Pre-treatment characteristics (control variables) is represented by x, given that $p(x)$ in both sellers and non-sellers groups are similar.

Then, the difference between expected outcome values of sellers and non-sellers can be contrasted with the expected value of the average treatment effect (ATE), which can be defined as follows:

$$ATE = E[Y(1)|D = 1] - E[Y(0)|D = 0] \quad (6)$$

where, $Y(1)$ and $Y(0)$ are outcome indicators. In our cases, household income and farm income of treated and untreated households, respectively.

However, our main interest is the difference between expected outcome values with sellers and non-sellers for those who actually sold products though agricultural cooperatives can be contrasted by the expected value of the average treatment effect on the treated (ATT). Following Imbens and Wooldridge (2009), ATT is defined as:

$$ATT = E[Y(1)|D = 1] - E[Y(0)|D = 1] \quad (7)$$

By creating comparable counterfactual households for treated households, PSM reduces the bias due to observable factors. As long as treated and untreated households are matched with observable factors, PSM assumes that there are no systematic differences in unobservable characteristics between two groups. Given this assumption of conditional independence and the overlap conditions, ATT is computed as:

$$ATT = E[Y(1)|D = 1, p(x)] - E[Y(0)|D = 0, p(x)] \quad (8)$$

Then the differences in the outcomes of the treated and untreated group can be attributed to the treatment (Caliendo and Kopeinig, 2008). Kernel matching (KM) was used in this study as it is known to produce the best balance statistics (Becerril and Abdulai, 2010).

3.2.3 Inverse probability weighting estimator with regression adjustment (IPWRA)

However, ATT from PSM can still produce biased results in the presence of misspecification in the propensity score model (Robin et al., 2007; Wooldridge, 2007, 2010). The IPWRA estimator has the double-robust property, which means that the estimation of the effects will be consistent as long as either the treatment model or the outcome model is correctly specified (Cattaneo, 2010). ATT in the IPWRA model is estimated in two steps. Suppose that the outcome model is represented by a linear regression function of the form:

$$\mathrm{Y}_i = \alpha_i + \beta_i \mathrm{x}_i + \varepsilon_i \quad \mathrm{i} = [0,1] \tag{9}$$

Firstly, we estimate the propensity scores as $\mathrm{p}(\mathrm{x}; \hat{\gamma})$. Secondly, we then employ linear regression to estimate (α_0, β_0) and (α_1, β_1) using inverse probability weighted least squares as:

$$\min_{\alpha_0, \beta_0} \sum_i^N (Y_i - \alpha_0 - \beta_0 \mathrm{x}_i)/\mathrm{p}(\mathrm{x}, \hat{\gamma}) \qquad if\ D_i = 0 \tag{10}$$

$$\min_{\alpha_1, \beta_1} \sum_i^N (Y_i - \alpha_1 - \beta_1 \mathrm{x}_i)/\mathrm{p}(\mathrm{x}, \hat{\gamma}) \qquad if\ D_i = 1 \tag{11}$$

The ATT is then computed as the difference between Eq. (8) and Eq. (9).

$$\mathrm{ATT} = \frac{1}{N_j} \sum_i^{N_j} [(\hat{\alpha}_1 - \hat{\alpha}_0) - (\hat{\beta}_1 - \hat{\beta}_0) x_i] \tag{12}$$

Where, $(\hat{\alpha}_1, \hat{\beta}_1)$ are estimated inverse probability weighted parameters for treated households while $(\hat{\alpha}_0, \hat{\beta}_0)$ are estimated inverse probability weighted parameters for untreated households. Finally, N_j stands for the total number of treated households.

4. Data and descriptive statistics

4.1 Data

The data used in this analysis were derived from a primary field survey conducted from April to May 2017 in Sichuan province, south-east of China. A multistage sampling process was used to select cities, agricultural cooperatives, and farm households in this survey. At first, we contacted the main agricultural department in Sichuan province to obtain the list of cities, including their poverty condition and the number of agricultural cooperatives. Secondly, we randomly went to 7 cities on the list, and purposely selected 17counties in those 7 cities, using a stratified sampling based on the total number of agricultural cooperative. Then, 1-3 cooperatives specialized in planting production and marketing were randomly selected from each of the 17 counties, according to the information provided by the local agricultural bureau. Moreover, all the cooperatives purchased their members' products in the previous years. The purchasing prices provided by all the cooperatives were no less than marketing prices. Finally, we randomly selected 15-20 members from each agricultural cooperative. All the surveyed farmers were engaged in crop production. Totally, we interviewed 39 agricultural cooperatives and 669 farm households. 421 farmers live in Qinling- Daba Mountain region, while 248 are in Wumeng Mountain region. Qinling- Daba Mountain region and Wumeng Mountain region are two of eleven contiguous destitute areas in China, which are the key areas for government to carry out poverty alleviation work.

All the farmers are members of agricultural cooperatives, but not all members of the agricultural cooperatives actually sold products to agricultural cooperatives. Hence, selling activity is an individual decision. Based on random selection, it turns out that our samples include 345 non-use households, who have not chosen to sell products through agricultural cooperatives (the control group), and 324 use households, who have chosen to sell products through agricultural cooperatives (the treatment group). The survey was conducted as a face-

to-face interview by Research Group of Agricultural Cooperatives (RGFC) members who spoke local languages and experienced a professional specifically trained. The farmers were interviewed with a structured questionnaire, which covered household characteristics, household head characteristics, household total income, household farm income, and the relationship with agricultural cooperatives. The exact variables are introduced in the above.

4.2 Descriptive statistics

The description of variables used in this study, including their means and standard deviation are presented in Table 1. The table shows that almost half of sampled farmers (48%) had chosen to sell products through agricultural cooperatives. The average household farm income and household income were around 16380 Yuan and 57880 Yuan per year, which is low. The reason is that our research regions are located in two of eleven contiguous destitute areas in China, where people always suffered from lower income. So, it is more critical to analyze how to enhance their productivity and improve their income. The average age of household heads in the sample was 52.82 years with an average schooling of 6.88 years. Sixty-eight per cent of household heads were married. Furthermore, 87% of sample household have male heads. In the sample, average farmers are risk-neutral with regard to the type of risk. There were 4.51 people in each sample household with 5.89 acres of land. The land area is very small, which is also a reflection of the issue of land fragmentation in China. The average distance to the nearest market is 5.93 kilometers. About 67 percent of sample farmers own their own farming machine. Thirty-eight per cent of households were found to be credit constrained in the sample, and just 20% could acquire output marketing information from their neighbors and/or relatives, rather than agricultural cooperatives and/or local governments. More than half of farmers face sales problems. According to the table 1, we know that 57% of the sample farmers originally wanted to achieve better sales of agricultural products through joining cooperatives. Most members said they did not know much about

cooperatives. In fact, the more you know about an organization, the more trust you have with that organization and the more you will want to deal with it. In total, 63% sample household were located in Qinba mountain region.

Table 2 presents the sample mean values in characteristics between sellers and non-sellers and also reports the difference in means between the two groups. The mean differences are statistically significant (1%) for all our outcome indicators. However, the average household size and the average household head' age and gender are not statistically significant difference between sellers and non-sellers. For instance, the household sizes are 4.52 (sellers) and 4.49 (non-sellers); the household ages are 52.70 (sellers) and 52.94 (non-sellers); and 89% sellers' household head is male, while 86% non-sellers has male household head. The household heads in the sellers group had more literature than those in non-sellers group. And 24% of household heads in the sellers group were single, while the ratio is 39% in non-sellers group. And the difference between two groups is statistically significant at 5% and 1%. In addition, though sellers' education level is higher than that of non-sellers at a significant level of 5%, the difference in average level of education is only 0.5 years. Compared with non-sellers, sellers tend to have larger farm size and farming machines, and they were more likely to face the problem of agricultural products sales, and more likely to be credit constraint. And all of the differences are statistically significant at 1%. As for the farm size, although sellers' is larger than non-sellers', the average of the farm size of sellers is 6.86 mu per household, which is not so large that can be called large-scale farm. One possible reason is that the farms in remote rural areas in China are usually small. The other possible reason is that large farm owners are more likely to sell their product directly to market other than agricultural cooperatives (Österberg, P. and Nilsson, J., 2009).

Additionally, we found significant differences with regard to the distance to the nearest markets and how difficult to sale products. And the average distance to the nearest market faced

by sellers is 6.71 km, while the average distance faced by non-sellers is 5.2 km. Although the difference is also statistically significant at 1%, the absolute difference in average distance is only about 1.5 km. With regard to information, although there is no statistically significant difference between the use and non-sellers, the average information in the non-sellers group is slightly more than the sellers group. As for the relationship with agricultural cooperatives, the75% sellers' initial motivation to participate in a cooperative is to have access to sell their products. Furthermore, as 41% farmers hold the same motivation, they actually did not choose to sell their products to agricultural cooperatives. In the two groups, though most average farmers are risk-neutral with regard to the type of risk, the difference is statistically significant at 1%. The table also shows that sellers have a more knowledge about cooperatives, and the difference is statistically significant at 1%. More sample farmers sell products though agricultural cooperatives in Qinba mountain region than sample farmers in Wumeng region.

5. Empirical results and discussion

5.1 Determinants of selling products though agricultural cooperatives

We now estimate the probit model of selling products through agricultural cooperatives, as described above in Eqn. (3). As mentioned, the sample for this estimation is confined to selling products though agricultural cooperatives sellers and non-sellers. The results are shown in Table 3. Household head age exhibits a negative effect significantly. This can be explained by new marketing conception, which is usually negative correlation with age. There was the agricultural cooperation movement and a type of cooperatives in rural areas in 1950s in China, which had left a very bad impression on farmers. As a result, it is harder for older farmers to accept the agricultural cooperatives and use the selling products though agricultural cooperatives with them. Household head gender and education does not affect significantly the decision to sell products through agricultural cooperatives. However, marital status has significantly negative effect on farmers' decision. In term of marital status, the members who have married and whose couple is alive are more likely not to sell products though agricultural cooperatives. In line with exist literature (Jensen, K., 1990), selling products through agricultural cooperatives is one of stable marketing channel for farmers. Farmers will experience less market risk by selling products through agricultural cooperatives. Furthermore, if farmers got married with their couple alive, they full more ability to offend risks. Hence, the negative significantly affect explained by members' anti-risk ability. Although, the risk preference has no significantly effect on selling products through agricultural cooperatives, the effect is negative too, which can lightly confirm the above explanation.

With regard to the ownership of property, farm size and ownership of arm machinery have a positive and statistically significant effect on selling products through agricultural cooperatives. That may imply that smallholders with larger farm size and farming machines are more likely sell products through agricultural cooperatives, which may be due to the fact that

they face both relatively low market participation capacity and greater sales demand. Similarly, the distance to the nearest market has a positive effect on the selling products though agricultural cooperatives. Members located very far to the output market have less access to markets anyway, so that they intend to rely on agricultural cooperatives. Additionally, members who perceived that it was hard to sell products were more likely to sell products through agricultural cooperatives. It implies that members with less difficulties in accessing to output markets have more choices to sell products and may expect higher price than provided by agricultural cooperatives. Hence, they are less likely to sell products through agricultural cooperatives. Members facing more credit constraint are more likely to selling products through agricultural cooperatives.

In addition, easy access to information can significantly decrease members' likelihood of selling products through agricultural cooperatives by 24.4 percentage points. In addition, it may be driven by the original motivation for participating in agricultural cooperatives and the members motivated by the sale of agricultural products are more likely to sell products through agricultural cooperatives with agricultural cooperatives. Based on the survey data, we know that there are 301 members who intend to sell agricultural products to cooperatives, but in fact only 324 members sell agricultural products to cooperatives. Only 243 of members selling products through agricultural cooperatives following their original motivations. Besides, the greater the farmers' knowledge about agricultural cooperatives, the more inclined they are to sell products through agricultural cooperatives. This is plausible, because well knowledge could build a trust mechanism between cooperatives and its members, so that the members are more likely to sell the products to a familiar institution (i.e. the agricultural cooperative) other than strange market buyers. Finally, the results show that members located in Qinling- Daba mountain region are likely to sell products through agricultural cooperatives, compared with Wumeng mountain region. The findings suggest the presence of spatial fixed effects that

influence farmers' decisions to sell products through agricultural cooperatives.

5.2 Treatment effects of selling products though agricultural cooperatives

Table 4 reports treatment effect estimates for selling products through agricultural cooperatives using alternative estimation techniques. In general, the reported effects of selling products through agricultural cooperatives are robust across all estimation strategies, showing the critical positive role of selling products though agricultural cooperatives on annual total household income and farm income. Specifically, we estimate the ATEs and the results are presented in Row 3. For the entire sample members, we can find that if members, including sellers and non-sellers, sell products though agricultural cooperatives, their annual total household incomes will be more 26 percentage points (PSM) and 22 (IPWRA) than the incomes without selling products though agricultural cooperatives ($P < 0.01$). Nevertheless, as for the sellers, their actual revenue is 18% (PSM) and 17 (IPWRA) percentage points higher than those owned by them without selling products though agricultural cooperatives. This variable is significant at 5% significant level both for PSM and IPWRA estimators.

With regard to farm incomes presented in Row 4, for sample sellers and non-sellers, if they sell products though agricultural cooperatives, they could earn more average 200 (PSM) and 194 (IPWRA) percentage points of annual total household incomes than they do not use. However, in term of sellers, their percentage of added farm incomes are 174 (PSM) and 166 (IPWRA). This variable is statistically significant ($P<0.01$) both for PSM and IPWRA estimators. In addition, Fig. 1 presents the common support region for annual total household income and Fig. 2 for farm income. A visual inspection of the distribution of the estimated propensity scores for members with and without selling products through agricultural cooperatives that the common support condition is satisfied. As indicated earlier, the IPWRA estimator has the double-robust property (Cattaneo, 2010). The results show that both ATEs and ATTs for IPWRA estimator are substantially lower than PSM approach. However, the

differences are not that much actually. Hence, we can conclude the average effects of selling products through agricultural coopertaives on household incomes are stable.

6. Conclusions and policy implications

Based on the survey data from southeast China, this article analyzed the effect of agricultural cooperatives working as a marketing channel on members' household income, including annual total household income and farm income. PSM was used to address selection bias that arises from observed factors whilst an IPWRA model was applied to address possible biases arising from misspecification. Specifically, we investigated how household and household head characteristics, as well as relationship with agricultural cooperatives influence the members' decision to sell products through agricultural cooperatives using a probit model.

Our findings generally confirm the significant role of selling products through agricultural cooperatives in smallholder farmers' household income, especially for the farm incomes. Therefore, we think that selling products though agricultural cooperatives is useful for promote the household income, and more conducive to raising farm income of farmers in poor areas. (1) This suggests that the government should intensify its efforts to enhance the market participation ability of agricultural cooperatives and encourage smallholder farmers to participate in agricultural cooperatives and sell products through agricultural cooperatives with them in remote rural areas. (2) Given that compared with seller members, the average treatment effect among all sample members, including sellers and non-sellers, is more positive. We believe that if non-sellers choose to sell products through agricultural cooperatives, their income will increase by a greater margin. Thus, this suggest that agricultural cooperatives can enhance their efficiency by encouraging the non-sellers to sell products through agricultural cooperatives.

According to the probit model results, we know that household head' age and marital status have a negative statistically significant effect on selling products through agricultural cooperatives. And the farm size and the ownership of farming machines show positive statistically significant effect on selling products through agricultural cooperatives.

Furthermore, (1) given that credit constraint, members' participation motivation and sale condition faced by smallholder farmers have positives effect on selling products through agricultural cooperatives, while the marketing information ownership has negative effect on the use, agricultural cooperatives should try their best to provide members credit service and boarder marketing channels, as well as market information such as prices. What's more, (2) the positive and significant impact of distance to markets on selling products through agricultural cooperatives highlights the importance of developing agricultural cooperatives in remote poor rural areas. Additionally, (3) the finding of positive and significant impact of farmers' knowledge about agricultural cooperatives working as a market channel suggests that improving communication between smallholder members and agricultural cooperatives would help enhance the possibility of members' selling productions through agricultural cooperatives.

Finally, this study is based on survey data focusing on crop farmers in poor rural areas, without consideration of other livestock farmers in other developing and developed areas. Our results show that there are spatial fixed effects that influence the sell products though agricultural cooperatives. Further research on other types of farmers, for example livestock farmers and other regions may help improve our understanding of the effect of selling products through agricultural cooperatives in a broader context.

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Table 1 The definitions of the variables used in the analysis

Variables	Description	Mean(SD) (669)
Seller	1 if a member selling products through agricultural cooperatives [a], 0 otherwise	0.48 (0.50)
Farm income	Agricultural products revenue (Yuan/1000) [b]	16.38 (24.11)
HH income	Annual household income per capita (Yuan/1000)[b]	57.88 (62.13)
Age	Age of household head (years)	52.82 (11.26)
Gender	1 if the household head is male, 0 otherwise	0.87 (0.33)
Education	Farmer's maximal education level (years)	6.88 (3.21)
Marital	1 if member has married and his/her couple is alive, 0 otherwise	0.32 (0.47)
Risk	1 if member is a risk averter, 2 if member is a risk neutral, 3 if member is a risk lover.	2.03 (0.69)
Household size	Number of people residing in household	4.51 (1.69)
Farm size	Land owned by household (mu) [c]	5.89 (11.11)
Farming machine	1 if member owns farming machines, 0 otherwise	0.67 (0.47)
Distance	Distance to markets (km)	5.93 (6.44)
Credit constraint	1 if member is credit constrained, 0 otherwise	0.38 (0.49)
Sale	How difficulty for member to sale products (1, 2, 3, 4, 5)	3.53 (1.16)
Information	1 if member can acquired output marketing information from neighbors and/or relatives, 0 otherwise	0.20 (0.40)
Motivation	1 if member's goal is to obtain sale service form cooperative, 0 otherwise	0.57 (0.50)
Knowledge	How much member know the cooperatives' condition (1, 2, 3, 4, 5)	3.01 (1.25)
Location	1 if member is located in Qinlin-Daba region, 0 if member is located in Wumeng region	0.63 (0.48)

Note: [a] Members can choose to sell their products either to agricultural cooperatives or other buyers. [b] Yuan is Chinese currency (1 US$=6.64 Yuan in 2017); [c] 1 mu =1/15 hectare.

Table 2 Mean difference in characteristics between sellers and non-sellers

Variables	Sellers (N=324)	Non-sellers (N=345)	Diff
Farm income	22.34 (27.24)	10.76 (19.13)	11.58 (17.80)***
HH income	68.63 (66.87)	47.75 (55.54)	20.88 (46.59)***
Age	52.70 (11.33)	52.94 (11.21)	-0.24 (0.86)
Gender	0.89 (0.32)	0.86 (0.35)	0.03 (0.03)
Education	7.10 (3.23)	6.68 (3.18)	0.43 (0.24)**
Marital	0.24 (0.43)	0.39 (0.49)	-0.15 (0.05)***
Risk	1.96 (0.67)	2.10 (0.69)	-0.15 (0.05)***
Household size	4.52 (1.62)	4.49 (1.74)	0.02 (0.13)
Farm size	6.86 (12.75)	4.98 (9.20)	1.88 (0.84)***
Farming machine	0.76 (0.43)	0.59 (0.49)	0.17 (0.04)***
Distance	6.71 (7.17)	5.20 (5.58)	1.52 (0.49)***
Credit constraint	0.46 (0.46)	0.29 (0.50)	0.17 (0.04)***
Sale	3.76 (1.17)	3.30 (1.12)	0.46 (0.09)***
Information	0.19 (0.39)	0.21 (0.41)	-0.03 (0.03)
Motivation	0.75 (0.43)	0.41 (0.49)	0.34 (0.04)***
Knowledge	3.22 (1.19)	2.82 (1.28)	0.40 (0.09)***
Location	0.75 (0.43)	0.52 (0.50)	-0.23 (0.04)***

Note: Standard errors clustered at enumeration level are reported in parentheses; *, ** and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 3 Probit model for selling products through agricultural cooperatives

Variables	trade
Age	-0.009 (0.005)*
Gender	-0.069 (0.160)
Education	-0.016 (0.018)
Marital	-0.237 (0.122)*
Risk	-0.115 (0.086)
Household size	-0.019 (0.032)
Farm size	0.248 (0.084)***
Farming machine	0.279 (0.121)**
Distance	0.021 (0.008)**
Credit constraint	0.195 (0.114)*
Sale	0.178 (0.049)***
Information	-0.244 (0.147)*
Motivation	0.804 (0.110)***
Knowledge	0.093 (0.046)**
1.Location	0.697 (0.128)***
Constant	-2.100 (0.476)***
Observations	669

Note: Robust standard errors in parentheses; *, ** and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 4 Treatment effects of selling products through agricultural cooperatives on household income

	PSM estimation		IPWRA estimation	
	ATE_{PSM}	ATT_{PSM}	ATE_{IPWRA}	ATT_{IPWRA}
Log of HH income	0.26 (0.07)***	0.18 (0.07)**	0.22 (0.08)***	0.17 (0.08)**
Log of Farm income	2.00 (0.27)***	1.74 (0.30)***	1.94 (0.25)***	1.66 (0.28)***

Note: *, ** and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

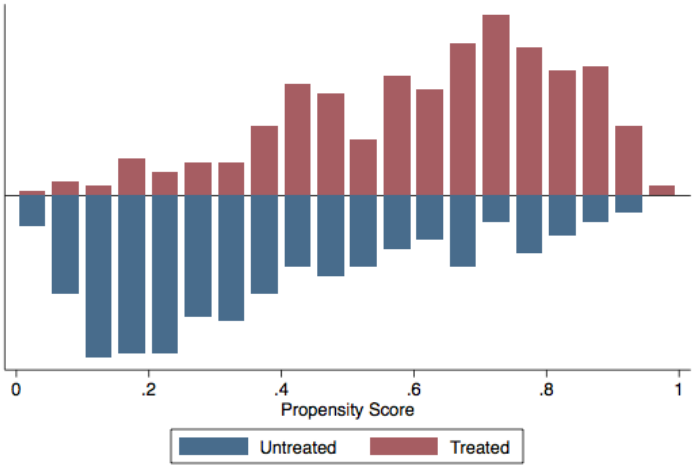

Fig. 1 Common support region for annual total household income

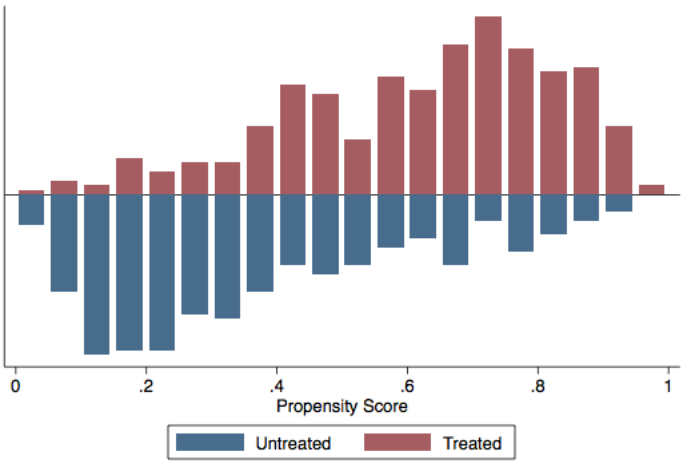

Fig. 2. Common support region for farm income