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The role of agricultural cooperatives in serving as a marketing channel: evidence from low-income regions of Sichuan province in China

RESEARCH ARTICLE

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Abstract

Although cooperative organizations aim to enhance agricultural production and marketing, in some countries such as China, not all members sell their products through agricultural cooperatives. This study examines the determinants of using agricultural cooperatives as a marketing channel and its effects on farm income and household income, using survey data collected from cooperative members in low-income regions of Sichuan province in China. We employ both propensity score matching model and inverse probability weighting estimator with regression adjustment to address the sample selection bias issue. The empirical results show that risk attitude, farm size, machine ownership, sales ability, and demonstration level of cooperatives are main factors that determine the members' decision to use agricultural cooperatives as a marketing channel, and the marketing channel users obtain significantly higher farm income and household income than non-users. Our findings highlight the importance and necessity of promoting agricultural cooperatives as a marketing channel among non-users.

Keywords: agricultural cooperatives, marketing channel, PSM, IPWRA, low-income regions
JEL code: C83, J54, Q13, P52

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1. Introduction

In many developing and transition countries, the livelihoods of smallholder farmers in rural areas mainly rely on the income generated from farm and/or off-farm activities, and China is no exception. However, in China, during times of economic downturn rural migrant workers tend to return to their home villages, suggesting that agricultural production plays an even more critical role in improving rural households' livelihoods and reducing rural poverty.[1] At the same time, the 2017 'Central First Document' released by the Chinese government has encouraged both urban and rural workers to engage in agricultural production, with the aim of alleviating employment stress in urban areas, increasing rural incomes and enhancing sustainable rural development. However, smallholder farmers are facing difficulty in benefiting from market transactions due to unfavorable marketing conditions, such as lower bargaining power, higher transaction costs, and less ability to access high-quality services and participate in high-value output markets (Ebata and Hernandez, 2017; Hao *et al.,* 2018; Trebbin, 2014). The importance of farm income to rural household income coupled with these marketing challenges suggests that enhancing farmers' access to output markets is essential to improve household welfare in rural areas.

The existing literature shows that a range of marketing channels has been used by rural households in their efforts to sell their products. These include traditional channels such as direct sales to small dealers or spot sales to wholesalers, and modern channels such as selling to supermarkets or processing companies (e.g. Ma and Abdulai, 2016a; Qaim, 2016; Rao and Qaim, 2011; Schipmann and Qaim, 2011). Within traditional channels, small dealers directly buy agricultural products from smallholder farmers, and this is often on an ad hoc basis with no marketing contracts. The smallholder farmers usually prefer this marketing channel due to its convenience (Hao *et al.,* 2018). In terms of selling products to wholesalers, the buyers usually do not purchase products from smallholder farmers directly, but instead, ask their brokers to collect products in rural areas (Hao *et al.,* 2018). Such a marketing channel has high uncertainty caused by unilateral decisions made by the buyers. As typical modern channels, supermarkets and processing companies often require a higher quality of products when they contract with smallholder farmers, and usually have special requirements for the use of production inputs such as fertilizers, pesticides, and seeds (Rao and Qaim, 2011; Trebbin, 2014). In either channel, some researchers have pointed out that smallholder farmers are usually risk-neutral and prefer to choose the marketing channel that involves higher flexibility but lower risks (e.g. Schipmann and Qaim, 2011).

Agricultural cooperatives have been identified as an appropriate institution that enables farmers to participate in competitive inputs and output markets, improve the quality and safety of agro-food, adopt advanced technologies, enhance farm economic performance, and increase rural household welfare (e.g. Abebaw and Haile, 2013; Kumar *et al.,* 2016; Ma and Abdulai, 2016b; Ma *et al.,* 2018; Wossen *et al.,* 2017). For example, Wossen *et al.* (2017) showed that cooperative membership increases the probability of technology adoption, and improves asset ownership and household welfare in Nigeria. In their analysis on India, Kumar *et al.* (2018) found that dairy cooperative membership exerts a positive and significant impact on milk yield, net returns per litre, and adoption of food safety practices. Using data collected from apple farmers in China, Ma *et al.* (2018) revealed that cooperative members are more likely to adopt organic soil amendments in China. When it comes to participation in the output market, agricultural cooperatives are also expected to serve as a marketing channel. However, due to the relatively loose management structure of agricultural cooperatives in some countries such as China, members usually choose to sell only part of their production to agricultural cooperatives, and some of them may choose to not use agricultural cooperatives as a marketing channel.

Some studies have investigated how cooperative membership affects farmers' choice of marketing channels (e.g. Ebata and Hernandez, 2017; Fischer and Qaim, 2012; Hao *et al.,* 2018; Jia *et al.,* 2012; Ma and Abdulai, 2016a; Zhu *et al.,* 2018). Using data collected from 625 apple growing farm households in China, Hao *et al.*

[1] Mohabir *et al.* (2017) summarized factors affecting the return migration of workers from urban areas back to their home villages during times of a weakened economy. These included fewer job opportunities, lower wages, increasing costs caused by strict migrant worker policies issued by the local governments, and the challenges of aging in in cities without a social safety net.

(2018) found that cooperative membership affects farmers' decisions to sell to wholesalers positively and their decisions to sell to small dealers negatively, but it has no significant impact on selling to the cooperative itself. From a perspective of rural development and income growth, it is essential to understand the factors that affect members' decision to use agricultural cooperatives as a marketing channel and the impact of the marketing channel use on farm income. Such empirical investigation can provide significant information for cooperative stakeholders and policymakers in their effort to promote the development of agricultural cooperatives. However, to the best of our knowledge, no previous studies have explored the role of agricultural cooperatives in serving as a marketing channel and how it affects farm income.

This study, therefore, investigates the factors that affect members' decisions to use agricultural cooperatives as a marketing channel and analyse how the marketing channel use affects farm income and household income. Focusing on both farm income and household income will lead to a deeper understanding of the welfare implications of the marketing function of cooperatives because farm income from crop production only provides a partial picture of income effects. We attempt to make a fourfold contribution to the literature on agricultural cooperatives and rural economic development. First, this study focuses on the impact of the marketing function of agricultural cooperatives. Previous studies have identified the role of agricultural cooperatives in contributing to rural income growth by employing different econometric approaches to compare cooperative members and non-members (Ma and Abdulai, 2016a; Shumeta and D'Haeseb, 2016; Verhofstadt and Maertens, 2014; Wossen *et al.,* 2017). However, they have not focused on the marketing role of agricultural cooperatives and how it determines the income of members. Second, this study uses unique household survey data collected from low-income regions of Sichuan province in China. Although agricultural cooperatives may play a much more significant role in enhancing agricultural production and marketing in low-income regions, relevant studies are absent from the literature. Third, we use both the propensity score matching and inverse probability-weighting estimator with regression adjustment models to address the potential sample selection bias issue. The issue of sample selection bias arises because cooperative members decide themselves whether or not to use the cooperative as a marketing channel and their decisions may be influenced by household and farm-level characteristics (e.g. age, gender, education, and farm size). Fourth, in addition to analysing the income impact of agricultural cooperatives in serving as a marketing channel (i.e. a dummy variable), we also estimate the impact of the proportion of their production that members sold through agricultural cooperatives on the outcome variables of interest.

The rest of the paper is organized as follows. Section 2 gives an overview of the development of agricultural cooperatives in China. This is followed by a description of the analytical framework and estimation technique. Section 4 presents a description of the data used in the analysis. The empirical results and discussion are given in Section 5. Conclusions and policy implications are presented in the final section.

2. The development of agricultural cooperatives in China

In China, low-income regions are generally located in peripheral mountainous areas, characterized by poor public infrastructure, such as road, low agricultural yields, and high production and transaction costs (Ren *et al.,* 2017). Thus, farmers usually find it hard to benefit from agricultural production (Ji *et al.,* 2017). In view of these problems, agricultural cooperatives have been promoted to maintain land utilization, increase rural economic development, and ensure food security. As an institutional arrangement, agricultural cooperatives enable smallholder farmers to be organized so as to improve their agricultural production and marketing performance (Fischer and Qaim, 2012; Hao *et al.,* 2018; Jia and Huang, 2011; Ma and Abdulai, 2016a).

The Chinese government has made significant efforts to develop agricultural cooperatives with the aim of increasing market competitiveness and the incomes of rural households (Hoken and Su, 2018; Jia *et al.,* 2012; Ma and Abdulai, 2016a). After the central government enacted the Law of the Farmer's Professional Cooperatives in 2007, the Government at regional levels in China promulgated a range of policies (for example, the 'Temporary strategy of assessment and monitoring of national demonstration of farmer professional cooperatives') to encourage the sustainable development of agricultural cooperatives. In rural China, most

of the agricultural cooperatives are established by local government, private entrepreneurs, and farmers with relatively large-scale farms, because farmers cultivating small-scale farms usually lack the motivation to initiate agricultural cooperatives (Ito *et al.,* 2012). Agricultural cooperatives can receive subsidies from the government due to their contribution to agricultural production and improvement of members' income.

In essence, cooperatives are expected to enhance both agricultural production and marketing, and enable their members to realize economic benefits that smallholder farmers usually could not achieve alone (Fischer and Qaim, 2012; Hoken and Su, 2018; Ito *et al.,* 2012; Kumar *et al.,* 2018; Ma *et al.,* 2018). In terms of crop production, they can help members benefit from economies of scale to lower their costs of acquiring production inputs (e.g. fertilizers, pesticides and improved seeds) or hiring services (e.g. storage, transport and mechanization). With respect to product marketing, they can directly serve as a marketing channel and directly purchase products from their members. Selling products through agricultural cooperatives enables members to develop new market opportunities and improve their position in the marketplace.

Nevertheless, there is still quite a loose relationship between members and their agricultural cooperatives in China. In practice, many members combine direct selling and marketing through agricultural cooperatives (Agbo *et al.,* 2015; Hao *et al.,* 2018).[2] Some members may sell part of their products to the cooperatives and the rest is sold to other buyers who can provide better prices. The partial reason for this may be the low cost for members to join and the lack of strict contracts between members and agricultural cooperatives. From the perspective of developing agricultural cooperatives sustainably, it is significant to understand and identify the constraints and incentives that influence the decision by members to use their cooperative as a marketing channel and also to evaluate the impact on income of their decision.

3. Analytical framework and estimation technique

3.1 Analytical framework

The analytical framework employed in this study is based on the assumption that members decide whether or not to use agricultural cooperatives as a marketing channel to sell their products. As shown in previous studies (e.g. Hao *et al.,* 2018), cooperative members may choose to sell their products to different marketing channels, such as cooperatives, wholesalers and small dealers due to the loose management structure of agricultural cooperatives. Within the framework of utility maximization (Fischer and Qaim, 2012; Ito *et al.,* 2012; Ma and Abdulai, 2016b), members are assumed to use agricultural cooperatives as a marketing channel if this maximizes the expected utility of net returns. For analytical purposes, we assume that the decision of members on whether or not to use agricultural cooperatives as a marketing channel depends on the utility difference (U_i^*) between the expected utility of net returns (U_i^1) derived from using and that (U_i^0) obtained from not using. Members choose to use agricultural cooperatives as a marketing channel, only if $U_i^*= U_i^1-U_i^0>0$. However, U_i^* cannot be observed directly, but can be expressed as a latent variable function:

$$U_i^* = \varphi X_i + \mu_i, U_i = \begin{cases} 1 \; if \; U_i^* > 0 \\ 0 \; otherwise \end{cases} \quad (1)$$

where U_i is an observed dummy variable, indicating whether or not cooperative members choose to use agricultural cooperatives as a marketing channel. In particular, U_i takes the value of one, if a member uses an agricultural cooperative as a marketing channel, and zero otherwise. X_i is a vector of household and farm-level characteristics (e.g. age, gender, education, household size and machine ownership); φ is a vector of parameters to be estimated; μ_i is an error term, which is assumed to be independently and identically distributed with a zero mean.

[2] It is not compulsory for members to sell products to agricultural cooperatives in developing countries including China. This appears to be different from the situation in Western countries. For example, in the United States, members and agricultural cooperatives have a tight relationship in terms of product marketing (Gijselinckx *et al.*, 2014).

To link the relationship between using agricultural cooperatives as a marketing channel and rural incomes, we assume that the income indicators can be expressed as a function of a marketing channel use dummy (U_i), a vector of explanatory variables (X_i), and an error term (σ_i):

$$Y_i = \beta U_i + \gamma X_i + \sigma_i \quad (2)$$

Where Y_i represents farm income or household income; β and γ are vectors of parameters to be estimated.

A number of studies have examined the effect of agricultural cooperative membership on farm income and household income (e.g. Abebaw and Haile, 2013; Kumar *et al.,* 2018; Ma and Abdulai, 2016a; Michalek *et al.,* 2018; Wossen *et al.,* 2017). They show that agricultural cooperatives affect members' farm income and household income through providing high-quality technologies, enhancing the quality of members' products, and improving the negotiation power of members with input sellers and output buyers. In the present study, we attempt to extend the existing studies by investigating the marketing function of agricultural cooperatives.

Our hypotheses are that: (1) socioeconomic and demographic factors affect the decision of members to use agricultural cooperatives as a marketing channel; and (2) members using agricultural cooperatives as a marketing channel tend to achieve higher farm and household incomes than those that do not.

3.2 Estimation techniques

In order to analyze the impact of using agricultural cooperatives as a marketing channel, there is a need to look at the differences between the same subject in two states (users and non-users). However, this cannot be directly observed because at any one time an individual either uses or does not use cooperatives as a marketing channel. This means counterfactual outcomes are not observable. Following previous studies (Maertens and Vande Velde, 2017; Michalek *et al.,* 2018; Mojo *et al.,* 2017), the research goal can be achieved by finding a control group of non-users whose characteristics are very similar to the users. However, under the conditions of non-experimental intervention, a cooperative member's decision whether or not to choose to use agricultural cooperatives as a marketing channel is not random and therefore selection bias should be considered.

Among available approaches that address sample selection bias, the instrumental variable based approaches, such as the endogenous switching regression and treatment effects models have been widely applied (Läpple *et al.,* 2013; Ma and Abdulai, 2016a; Mojo *et al.,* 2017; Wossen *et al.,* 2017). For example, using an endogenous switching regression model and Irish Farm Accountancy Data Network (FADN) data, Läpple *et al.* (2013) assessed the effectiveness of a government funded extension program. However, if a valid instrumental variable cannot be identified, the estimates may still be biased and inconsistent. Alternatively, we follow previous studies and employ both the propensity score matching (PSM) model and the inverse probability-weighting estimator with regression adjustment (IPWRA) model for empirical analysis (Chagwiza *et al.,* 2016; Fischer and Qaim, 2012; Mojo *et al.,* 2017). These approaches do not rely on the usage of instrumental variables and they can generate unbiased estimates once the pre-treatment characteristics are sufficiently controlled for.

■ *Propensity score matching*

The PSM estimator consists of two steps. The first step involves the use of a probit model to estimate the influence of explanatory variables on the decision to use agricultural cooperatives as a marketing channel, based on Equation 1. Concurrently, the probit model can also be used to estimate the predicted probability that a farmer uses agricultural cooperatives as a marketing channel, which is referred to as the propensity score as indicated in the following equation:

$$p(X) = P_r\{U = 1|X\} = E\{U|X\} \quad (3)$$

where *U* is a treatment indicator, which presents whether or not a member uses agricultural cooperatives as a marketing channel in the present study. Pre-treatment characteristics (control variables) are represented by *X*, and *p*(*X*) represents the propensity score. The predicted propensity scores can be used to construct a control group by matching group users to non-users.

In the second step, the average treatment effects (ATE), which measure the impact of using agricultural cooperatives as a marketing channel on farm income and household income, are calculated. We calculate the ATE on outcome variable *Y* using matched observations of these two groups (i.e. users and non-users). The ATE is the difference in outcomes between group users (treatment group) and non-users (control group) appropriately matched by the propensity score *p*(*X*). In particular, the ATE estimated from the PSM model can be computed as follows:

$$ATE_{PSM} = \frac{1}{N}\sum_{i=1}^{N}[E(Y_{1i}|U=1, p(X)) - E(Y_{0i}|U=0), p(X)] \quad (4)$$

where Y_{1i} and Y_{0i} represent outcome variables (i.e. farm income or household income) for users and non-users of the marketing channel, respectively. Both Y_{1i} and Y_{0i} are measured at per capita base in the present study. *N* refers to the total number of observations including all users and non-users.

Several matching methods, including nearest neighbor matching, radius matching and kernel matching have been applied in previous studies (Rao *et al.,* 2016; Shumeta and D'Haese, 2016). We use the kernel matching in this study, because it produces the best balance statistics and it uses information from all control group households and a weighting function to construct the counterfactual outcome (Caliendo and Kopeinig, 2008; Shumeta and D'Haese, 2016).

■ *Inverse probability weighting estimator with regression adjustment*

Although the PSM method can address the selection bias issue and solve the impact evaluation problem of missing data on the counterfactual, it may still produce biased results in the presence of misspecification in the propensity score model (Michalek *et al.,* 2018; Wossen *et al.,* 2017). This issue can be solved by use of the IPWRA estimator. Compared with the PSM model, the IPWRA estimator has a double-robust property. The double-robust property means that the estimation of the effects will be consistent as long as either the treatment model or the outcome model is correctly specified.

The IPWRA estimations can be conducted in two steps. At the first step, the propensity scores are calculated, which follow the same process as PSM model. Meanwhile, a series of regressions are estimated in which the inverse of the estimated propensity scores is used as weights on covariates and the treatment dummy variable. In our case, the treatment dummy variable is whether or not a member uses their agricultural cooperative as a marketing channel. At the second step, ATE_{IPWRA} is computed by the following equation (Wossen *et al.,* 2017):

$$ATE_{IPWRA} = \frac{1}{N}\sum_{i=1}^{N}[(\hat{\alpha}_1 - \hat{\alpha}_0) + (\hat{\beta}_1 - \hat{\beta}_0)X_i] \quad (5)$$

where $(\hat{\alpha}_1, \hat{\beta}_1)$ are estimated inverse probability weighted parameters of outcome function represented by a linear regression model for members who used agricultural cooperatives as a marketing channel, while $(\hat{\alpha}_0, \hat{\beta}_0)$ are the parameters for members who did not use agricultural cooperatives as a marketing channel, which are estimated by inverse probability weighted least squares; X_i represents a vector of exogenous variables that affect the farm income and household income; *N* stands for the total sample members.

4. Data and descriptive statistics

4.1 Data

The data used in this analysis were derived from a field survey conducted between April and May 2017 in Sichuan province, South-west of China. A multistage sampling procedure was used to select regions, cities, counties, agricultural cooperatives and members for this survey. First, we randomly selected two from fourteen typically low-income regions in China, which were Qinling-Daba Mountain region and Wumeng Mountain region.[3] Each of these two regions includes some provinces and both of them include Sichuan province. Second, we randomly selected seven cities from these regions, and purposely selected 17 counties in those seven cities, using a stratified sampling approach based on the total number of agricultural cooperatives. The selection of the cities was guided by the agricultural department in Sichuan province, with reference to their poverty conditions and the number of agricultural cooperatives. Then, between one and three agricultural cooperatives, specialized in rice production and marketing, were randomly selected from each of the 17 counties. Finally, we randomly selected around 10 to 15 members from each agricultural cooperative.

Research Group of Agricultural Cooperatives (RGFC) members who are experienced specialists in undertaking surveys conducted the survey in the form of face-to-face interviews. A structured questionnaire was used for data collection. The questionnaire covered information including household and farm-level characteristics (e.g. age, gender education, and farm size), access to credit, distance to markets, the members' knowledge about cooperatives, as well as the demonstration level of the cooperative.[4] In total, we interviewed 515 farm households from 39 cooperatives. Specifically, 298 members are located in Qinling-Daba Mountain region, and 217 are located in Wumeng Mountain region.

4.2 Variable selection

The treatment variable used in the present study captures a member's decision whether or not to use agricultural cooperatives as a marketing channel, which gives the value of one if a member chooses agricultural cooperative as a marketing channel and zero otherwise. The outcome variables considered in the present study include farm income and household income, which are measured by Yuan/capita. In particular, farm income refers to the income exclusively from rice production and marketing. Household income is comprised of income from rice production and marketing, income from other farm activities (e.g. raising livestock and growing other crops), income from off-farm activities, and income from unearned sources (e.g. rents and pension). We draw on the existing literature to identify the explanatory variables used in the present study (Fischer and Qaim, 2012; Hakelius, 1996; Hao *et al.,* 2018; Ito *et al.,* 2012; Ma and Abdulai, 2016a; Pandolfelli *et al.,* 2007). In particular, the variables representing age, gender, education, risk attitude, household size, farm size, machine ownership, distance, credit constraint, marketing condition, market information, demonstration level, and knowledge are selected for empirical analysis. Table 1 presents the descriptive statistics of the selected variables.

Human capital increases a person's ability to perceive and respond to new events (Schultz, 1982). Previous studies have shown that age and education, which are two essential proxies for human capital, have positive impacts on members' marketing channel choice (Hakelius, 1996; Hao *et al.,* 2018). We include age and education in our empirical model and expect that they will have a positive impact on the probability of using agricultural cooperatives as a marketing channel. Gender can influence a member' choice of engaging in

[3] According to 'China Rural Poverty Alleviation and Development Program (2011-2020)' implemented in 2011, there are fourteen low-income areas in China which are characterized by extremely poor living conditions (Ren *et al.,* 2017). In order to alleviate the poverty of the fourteen areas, the Chinese government have made them the main focus of government poverty alleviation policies. The Chinese government has invested considerable resources (e.g. subsidies, professional agents, and new technologies) in their efforts to reduce poverty.

[4] According to the act 'Opinions on carrying out the construction action of the farmer's professional cooperative demonstration' published by Ministry of Agriculture in 2009, the selection principles of demonstration agricultural cooperatives include management democracy, economic strength, the number of members, and social reputation. From low to high, there are four levels of demonstration agricultural cooperatives, including county-level demonstration, city-level demonstration, province-level demonstration, and national-level demonstration.

collective action (Fischer and Qaim, 2012; Pandolfelli *et al.,* 2007). For example, Pandolfelli *et al.* (2007) showed that relative to men, women are more likely to participate in collective action. We include the gender variable in the empirical model and expect that men are less likely to use agricultural cooperatives as a marketing channel (i.e. a collective action) relative to their female counterparts. Following Ito *et al.* (2012), we include a risk attitude variable to capture the effect of members' risk preference on their decision to choose agricultural cooperative as a marketing channel. Previous studies have shown that households with large member size are more likely to participate in agricultural cooperatives due to labor endowments (Bernard and Spielman, 2009; Ma and Abdulai, 2016a), and we also expect that household size has an impact on the probability of choosing agricultural cooperatives as a marketing channel.

Farm size and farm machine are two important physical assets for agricultural production (Fischer and Qaim, 2012; Ma *et al.,* 2018). Farm size and farm machine ownership variables are expected to have a positive effect on the probability of using cooperatives as a marketing channel. Distance from the village to output markets, in theory, can be a proxy of the transportation cost of members to sell products to the targeted markets. Longer transportation distance increases marketing costs, which, in turns, reduces farm

Table 1. The definitions and summary statistics of the variables used in the analysis.

Variables	Definition	Mean (SD)[1]
Dependent variables		
Marketing channel	1 if a member used agricultural cooperatives as a marketing channel in 2016, 0 otherwise	0.55 (0.50)
Farm income	Income from rice production (1,000 Yuan/ capita)[2]	2.00 (1.64)
Household income	Annual household income (1,000 Yuan/ capita)	10.12 (7.28)
Sales intensity	The ratio of rice sold to agricultural cooperatives to the total rice sales (%)	0.48 (0.02)
Independent variables		
Age	Age of respondent (years)	53.31 (11.19)
Gender	1 if respondent is male, 0 otherwise	0.89 (0.31)
Education	Years of formal education of respondent	6.70 (3.04)
Risk attitude	Self-stated openness to innovation and risk: 1 = risk averter; 2 = risk neutral; 3 = risk lover	1.78 (0.78)
Household size	Number of household members who share meals	4.55 (1.61)
Farm size[3]	Total farm size cultivated (mu)	5.93 (8.42)
Machine ownership	1 if respondent owns farm machines, 0 otherwise	0.68 (0.47)
Distance to market	Distance from the village to the output markets (km)	5.86 (5.93)
Credit constraint	1 if respondent is credit constrained, 0 otherwise	0.62 (0.49)
Sales ability	The self-reported difficulty that a member sells the products (from 1 = no difficulty to 5 = very difficult)	3.56 (1.17)
Information acquisition	1 if a member acquires output market information from neighbors and/or relatives, 0 otherwise	0.74 (0.44)
Demonstration level	Demonstration level of agricultural cooperatives from low to high: 1 = not a demonstration cooperative, 2 = county-level; 3 = city-level; 4 = province-level; 5 = national-level.	4.17 (0.87)
Knowledge	To what extent a member knows about the cooperatives' business conditions (from 1 = almost no idea to 5 = perfectly understand)	3.95 (0.89)
Qinling-Daba	1 if a household is located in Qinling-Daba region, 0 otherwise	0.58 (0.49)
Wumeng	1 if a household is located in Wumeng region, 0 otherwise	0.42 (0.49)

[1] SD = standard deviation.

[2] Yuan is a Chinese currency (1 US$=6.64 Yuan in 2018).

[3] 1 mu =1/15 hectare.

income. To save these costs and for convenience, members who are more remote from markets are more likely to sell their products through agricultural cooperatives (Rao and Qaim, 2011). Thus, we expect that the variable representing distance to output markets has a positive effect on the probability of using agricultural cooperatives as a marketing channel.

Previous studies have shown that households facing credit constraint are less likely to invest in agricultural inputs such as fertilizers, pesticides and improved seeds (Abebaw and Haile, 2013; Gong *et al.,* 2016). Because members can purchase the production inputs from agricultural cooperatives on credit, it is not surprising that they choose agricultural cooperative as a main marketing channel in order to pay back the debt. Thus, we expect that credit constraint variable increases the probability of using agricultural cooperatives as a marketing channel. As discussed earlier, agricultural cooperatives are an institutional arrangement that can help reduce information asymmetry and transaction costs through collective actions (Fischer and Qaim, 2012, 2014), which finally enhance members' access to output markets. Thus, we expect that members having difficulty selling their products are more likely to use agricultural cooperatives as a marketing channel. Information sharing reduces information asymmetry. Members who require marketing information from neighbors and/or friends are more likely to obtain better marketing information. Thus, we expect a negative relationship between information acquisition and using agricultural cooperatives as a marketing channel.

The knowledge variable is used in this study as a proxy to measure the extent that a member knows about the cooperatives' business conditions. Previous studies have shown that if cooperatives share more information among members, the members are more likely to increase their commitment to cooperatives and participate in its collective activities (e.g. Barraud-Didier *et al.,* 2012; Marcos-Matas *et al.,* 2018). Thus, we expect that members who can understand cooperative's economic conditions better are more likely to use it as a marketing channel. The demonstration level of agricultural cooperatives represents the extent that the cooperatives have developed with the support of the government. To some extent, by classification, agricultural cooperatives with a higher demonstration level have relatively higher marketing ability. Thus, we expect that the demonstration level variable has a positive effect on the probability of using agricultural cooperatives as a marketing channel. Finally, we also include a regional dummy to control for unobserved heterogeneities such as climate, geographical characteristics, and institutional arrangements that may also affect the decision to use agricultural cooperatives as a marketing channel.

4.3 Descriptive statistics

Table 1 presents the definitions of the variables used in this study as well as their summary statistics. Around 55% of households used agricultural cooperatives as a marketing channel. The average farm income and household income were around 2,000 Yuan/capita and 10,120 Yuan/capita per year. Farm income from rice production accounted for 19.11% of total household income (Figure 1). It is reported that the average household income in China was 23,821 Yuan/capita, and in rural areas, it was 12,363 Yuan/capita in 2016 (CSY, 2013). As we can see, household income in these areas was lower than household income at a national level during the same year. As noted earlier the reason for the low-income figures from our surveyed households is that our research regions are located in two out of the fourteen typically low-income areas in China. The average age of the respondent was 53.31 years with an average schooling of 6.70 years. The average household size is 4.55 members. Just over 62% of members appeared to have credit constraint issues. Around 74% of members acquired marketing information from their neighbors and/or relatives.

Table 2 presents the sample mean values between the marketing channel users and non-users and also reports the difference in means between the two groups. At first glance, cooperative members who use agricultural cooperatives as a marketing channel tend to receive 50.97% more farm income and 23.48% more household income in comparison to non-users. However, the observations are not conclusive, because these comparisons are merely descriptive and do not take into account the confounding factors (e.g. age, gender, farm size and household size) that affect the differences. Thus, econometric methods such as PSM model and IPWRA

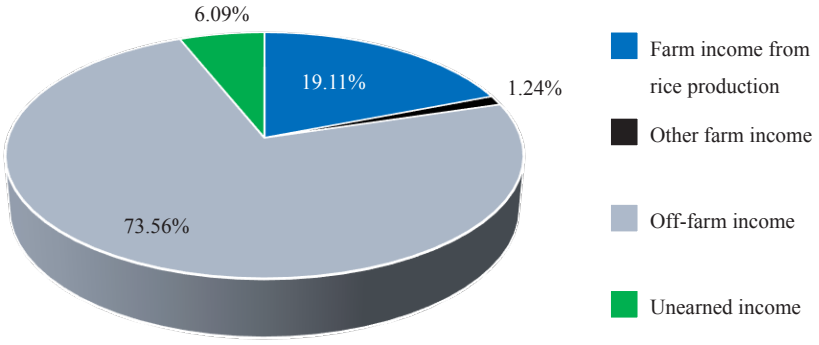

Figure 1. The composition of household income.

Table 2. Mean difference in characteristics between users and non-users of the marketing channel.[1]

Variables	Users	Non-users	Diff.
Dependent variables			
Farm income	2.34 (0.11)	1.55 (0.08)	0.79 (0.14)***
Household income	11.41 (1.00)	9.24 (0.43)	2.17 (1.17)***
Independent variables			
Age	53.81 (0.67)	52.69 (0.73)	1.12 (1.00)
Gender	0.90 (0.02)	0.88 (0.02)	0.03 (0.03)
Education	6.91 (0.19)	6.44 (0.20)	0.47 (0.27)*
Risk attitude	1.84 (0.05)	1.70 (0.05)	0.14 (0.07)**
Household size	4.66 (0.10)	4.43 (0.10)	0.23 (0.14)
Farm size	6.65 (0.63)	5.03 (0.31)	1.62 (0.75)**
Machine ownership	0.74 (0.03)	0.60 (0.03)	0.13 (0.04)***
Distance to market	6.27 (0.36)	5.36 (0.39)	0.90 (0.52)*
Credit constraint	0.69 (0.03)	0.54 (0.03)	0.15 (0.04)***
Sales ability	3.78 (0.07)	3.28 (0.08)	0.50 (0.10)***
Information acquisition	0.74 (0.03)	0.72 (0.03)	0.02 (0.04)
Demonstration level	4.30 (0.05)	4.01 (0.06)	0.29 (0.08)***
Knowledge	4.24 (0.04)	3.60 (0.06)	0.64 (0.07)***
Qinling-Daba	0.72 (0.03)	0.41 (0.03)	0.31 (0.04)***
Wumeng	0.28 (0.03)	0.59 (0.03)	-0.31 (0.04)***

[1] Standard errors are reported in parentheses; *, ** and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

model are necessary to help understand the impact of using agricultural cooperatives as a marketing channel on farm and household income.

In fact, Table 2 shows that the marketing channel users and non-users are systematically different in terms of observed characteristics. In particular, relative to non-users, users are more educated, and tend to have larger farms and are more likely to own farm machines. Meanwhile, users tend to have a more active attitude to risk and are more likely facing credit constraints compared to non-users. Users are also more likely to feel that it is difficult to sell their products, and the distances between the villages that users reside in and output markets are greater than those of non-users. In addition, Table 2 shows that users have more knowledge about agricultural cooperatives than non-users. Furthermore, the demonstration level of agricultural cooperatives to which users belong is generally higher than non-users. With increasing demonstration level, the ability of agricultural cooperatives to provide marketing services to their members tends to increase as well.

5. Empirical results and discussion

5.1 Determinants of using agricultural cooperatives as a marketing channel

The parameter estimates of the determinants of using agricultural cooperatives as a marketing channel are presented in Table 3. As mentioned earlier, a probit model is used for empirical analysis. Given the fact that the magnitudes of the coefficients from the probit model are difficult to interpret, we not only present the coefficients, but also the marginal effects.

The positive and statistically significant marginal effect of the risk attitude variable suggests that risk-lover are more likely to choose to use agricultural cooperatives as a marketing channel. This finding provides further support for the finding of Ito *et al.* (2012). The marginal effects of the farm size and machine ownership variables are positive and statistically significant, which suggest that rural households with larger farms and agricultural machinery are 7.5 and 6.8% more likely to use agricultural cooperatives as a marketing channel, respectively, which are consistent with our expectations. These results may be explained by the fact that land and agricultural machinery are two types of specific assets used for agricultural production. Higher specific asset investment means higher transaction costs and a higher risk of uncertainty (Williamson, 1987). Using agricultural cooperatives as a marketing channel is a collective action, which can reduce transaction costs. Thus, members who invested more in land and machinery prefer to use agricultural cooperatives as a marketing channel.

With regards to the sales ability variable, its marginal effect is positive and statistically significant, which indicates that members having greater difficulty in accessing markets for their products are more likely to market through their cooperative. A possible explanation for this result is that cooperatives are efficient institutions to reduce market information asymmetry between cooperative members and buyers (Royer *et al.,* 2016). For example, agricultural cooperatives supply market information regarding market price to members and product quality information to buyers, which could help members access to markets. As

Table 3. Determinants of using agricultural cooperatives as a marketing channel: probit model estimation.[1]

Variables	**Marketing channel use**	
	Coefficients	**Marginal effects**
Age	-0.002 (0.007)	-0.001 (0.002)
Gender	-0.017 (0.193)	-0.005 (0.057)
Education	0.007 (0.023)	0.002 (0.007)
Risk attitude	0.172 (0.085)**	0.051 (0.025)**
Household size	0.015 (0.040)	0.004 (0.012)
Farm size	0.254 (0.108)**	0.075 (0.031)**
Machine ownership	0.232 (0.140)*	0.068 (0.041)*
Distance to market	0.013 (0.010)	0.004 (0.003)
Credit constraint	0.077 (0.134)	0.023 (0.039)
Sales ability	0.218 (0.059)***	0.064 (0.017)***
Information acquisition	-0.192 (0.152)	-0.056 (0.045)
Demonstration level	0.148 (0.076)*	0.044 (0.022)**
Knowledge	0.582 (0.085)***	0.171 (0.021)***
Qinling-Daba	1.061 (0.148)***	0.332 (0.043)***
Constant	-5.015 (0.810)***	
Observations	515	515

[1] Robust standard errors are reported in parentheses; *, ** and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively. The reference region is Wumeng mountain region

mentioned above, the other possible explanation for this result is that the cooperative is a stable marketing channel which can provide slightly higher prices for members.

The positive and statistically significant marginal effect of the variable representing the cooperative demonstration level indicates that members from agricultural cooperatives with high demonstration level are 4.4% more inclined to use agricultural cooperatives as a marketing channel. In addition, the more a member knew about how the cooperative operated and conducted its business, the more inclined they were to sell through the cooperative. This finding is consistent with our expectation, because greater knowledge means less information asymmetry and more trust between members and cooperatives (Barraud-Didier *et al.,* 2012; Marcos-Matas *et al.,* 2018). Less information asymmetry was found to reduce transaction costs, which results in a higher delivery intention (Biswas, 2004). This finding is also in agreement with the literature which highlights that providing sufficient information to reduce information search costs is the core element of purchase intention formation (Wu *et al.,* 2014).

Finally, the results show that members located in Qinling-Daba mountain region are more likely to use agricultural cooperatives as a marketing channel, compared with their counterparts living in Wumeng mountain region (the reference region). The findings suggest the presence of spatial fixed effects that may also influence the decision by members to use agricultural cooperatives as a marketing channel. The findings in Table 3 support our hypothesis 1 that socioeconomic and demographic factors affect the members' decisions to use agricultural cooperatives as a marketing channel.

5.2. Treatment effects of using agricultural cooperatives as a marketing channel

■ *Results of propensity score matching model*

The PSM estimates with respect to the effects of using agricultural cooperatives as a marketing channel are presented in the second column of Table 4. A Kernel matching technique was performed in Stata 14. Figure 2 presents the propensity score distribution and common support for propensity score estimation of farm income and household income. Visual inspection of the density distributions of the estimated propensity scores for members who use or do not use their cooperative as a marketing channel show no significant differences in covariate distributions or pre-treatment variables. There are observations with identical propensity score values between users and non-users. Thus, the common support assumption is satisfied.

In Table 4, the PSM results show that using agricultural cooperatives as a marketing channel has a positive and statistically significant impact on both farm and household income. In particular, the causal effect of using agricultural cooperatives as a marketing channel on farm income is 0.694. The coefficient is statistically significant at the 1% level. This finding is also in agreement with the result of Ito *et al.* (2012) who found that agricultural cooperatives increase farm income of watermelon farmers in China. Lower transaction costs and higher prices may explain this relatively good correlation between farm income and the use of agricultural

Table 4. Treatment effects of using agricultural cooperatives as a marketing channel.[1]

Outcomes	PSM estimation	IPWRA estimation	
	ATE_{PSM}	ATE_{IPWRA}	ATE_{IPWRA} (%)
Farm income	0.694 (0.193)***	0.697 (0.160)***	10.35
Household income	0.277 (0.087)***	0.265 (0.083)***	3.01

[1] *** represents statistical significance at the 1% level. Standard errors are reported in parentheses; ATE_{PSM} and ATE_{IPWRA} refer to average treatment effects, which are estimated from propensity score matching (PSM) model and inverse probability-weighting estimator with regression adjustment (IPWRA) estimator, respectively. Because the dependent variables used are the logs of farm income (Yuan/capita) and household income (Yuan/capita), the predictions are also given in log forms.

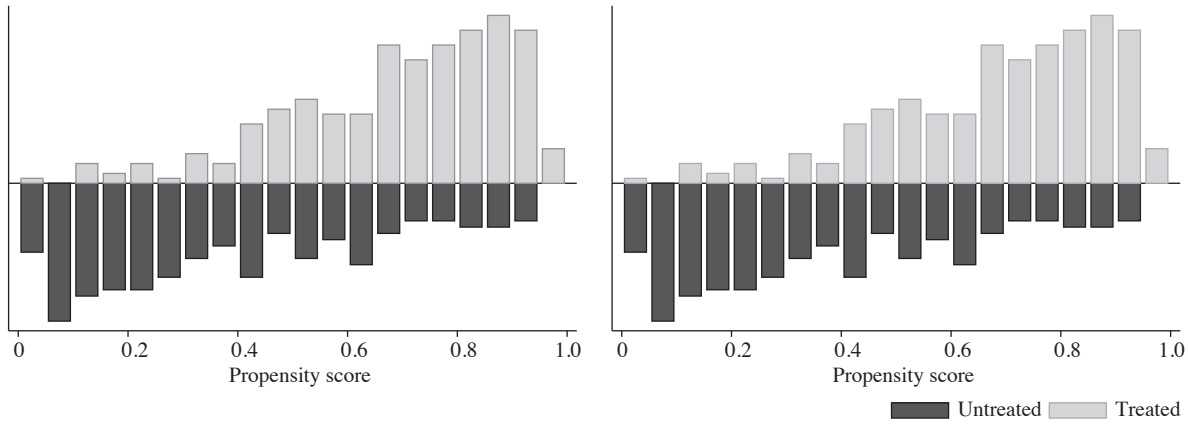

Figure 2. Propensity score distributions and common supports for propensity score estimation of farm income (A) and household income (B).

cooperatives as a marketing channel. As discussed previously, cooperatives can reduce the transaction costs faced by their members through collective action and also help them to sell their products at a higher price.

In addition, the causal effect of using agricultural cooperatives as a marketing channel on household income is 0.277, which is statistically significant at the 1% level. The finding suggests that agricultural cooperatives significantly increase household income of members through serving as a marketing channel. The possible reason is that using agricultural cooperatives as a marketing channel can save households' labor time which can be reallocated to off-farm work activities to earn additional income, which finally increases household income. In their study on China, Ma and Abdulai (2016b) also found that agricultural cooperatives have a positive and statistically significant impact on household income of apple farmers. The findings in Table 4 support our hypothesis 2 that members using agricultural cooperatives for the marketing of their products tend to receive higher farm income and household income than those who do not market through the cooperative.

■ *Results of inverse probability-weighting estimator with regression adjustment estimator*

As mentioned previously, the results from the PSM model are consistent and unbiased only if the propensity score model (i.e. selection equation) is correctly specified. However, if there exists misspecification in the propensity score model, the estimated results would still be biased (Wossen *et al.,* 2017). Therefore, we also present in the last two columns of Table 4 the results estimated from the IPWRA estimator for comparison purpose.

The IPWRA results in Table 4 show that the causal effects of using agricultural cooperatives as a marketing channel on farm income and household income are 0.697 and 0.265, respectively, which are quite similar to those estimated by the PSM model. The slightly different impacts between the two estimators may be due to the bias resulting from the misspecification in the PSM. As emphasized previously, the IPWRA estimator has the doubly robust property, which the PSM method does not (Wossen *et al.,* 2017). Generally, the findings further confirm the positive role of using agricultural cooperatives as a marketing channel in increasing farm income and household income of rural households in China. The findings obtained from the IPWRA estimator further support our hypothesis 2.

A significant advantage of the IPWRA method is its ability to report the proportional impact of using agricultural cooperatives as a marketing channel on outcomes of interests. The results presented in the last column of Table 4 show that using agricultural cooperatives as a marketing channel statistically significantly increases farm income and household income by 10.35 and 3.01%, respectively. Such results cannot be observed if we only compare the mean farm income and mean household income between the marketing channel users and non-users (Table 2). This is because the descriptive mean comparisons do not control for

household and farm-level characteristics (e.g. age, gender, education and farm size) that may also affect members' decisions to use agricultural cooperatives as a marketing channel and the outcome variables used in the present study. Thus, IPWRA method reports model reliable results that help us better understand the relationship between members' marketing channel choice and their incomes.

■ *Disaggregated effects*

To gain further insight into the effects of using agricultural cooperatives as a marketing channel on different groups of members, we disaggregated our results estimated by farm size. The third column of Table 5 presents the results estimated from the PSM model, while the last two columns of the same table report the results estimated from the IPWRA model. Generally, the results show that even within the different farm size groups, using agricultural cooperatives as a marketing channel tends to positively and significantly affect farm income regardless of farm size. In the large farm size group, using agricultural cooperatives as a marketing channel shows positive and statistically significant effect on household income, while the effect is not statistically significant within the small farm size group. In comparison to the PSM method, IPWRA has doubly robust property and it can produce more reliable results. Thus, we interpret our results estimated from IPWRA estimates. To ease the interpretation, we only discuss the results related to the proportional impact which are presented in the last column of Table 5.

The results show that the causal effect of using agricultural cooperatives as a marketing channel is to increase the farm income of households with the smallest farms (<=5 mu) by 7.15%. For households with larger farms (>5 mu), the causal effect of using agricultural cooperatives as a marketing channel is to increase farm income by 14.22%. The findings suggest that, with increasing farm size, rural households appear to benefit more from using agricultural cooperatives as a marketing channel. With respect to household income, our IPWRA results show the causal effect of using agricultural cooperatives as a marketing channel is to increase household income for large-scale farm households by 2.87%, which is statistically significant at 5% level. This result is supported by the findings of Verhofstadt and Maertens (2014) who show that agricultural cooperatives are more beneficial for members cultivating large farms.

5.3 Income effects of sales intensity

Given the marketing channel use is measured as a dichotomous variable, it can only partially capture the income effect of using agricultural cooperatives as a marketing channel because members selecting different proportions of their products to agricultural cooperatives may receive different levels of income. In view of this, we also analyzed the impact of sales intensity (i.e. the proportion of rice sold to agricultural cooperatives) on farm income and household income using ordinary least squares regression model and presented the results in Table 6. The results show that the coefficients of sales intensity variable are positive and statistically

Table 5. Treatment effects of using agricultural cooperatives as a marketing channel by farm size.

Outcomes	**Farm size**[2]	**PSM estimation**	**IPWRA estimation**	
		ATE_{PSM}	ATE_{IPWRA}	ATE_{IPWRA} (%)
Farm income	small (≤5 mu)	0.454 (0.136)**	0.454 (0.136)**	7.15
	large (>5 mu)	0.922 (0.434)**	0.922 (0.434)**	14.22
Household income	small (≤5 mu)	0.191 (0.128)	0.191 (0.128)	1.75
	large (>5 mu)	0.315 (0.126)**	0.315 (0.126)**	2.87

[1] ** represents statistical significance at the 5% level. Standard errors are reported in parentheses; ATE_{PSM} and ATE_{IPWRA} refer to average treatment effects, which are estimated from propensity score matching (PSM) model and inverse probability-weighting estimator with regression adjustment (IPWRA) estimator, respectively. Because the dependent variables used are the logs of farm income (Yuan/capita) and household income (Yuan/capita), the predictions are also given in log forms.

[2] 1 mu =1/15 hectare.

Table 6. The effects of sales intensity on farm income and household income.[1]

Variables	Ordinary least squares	
	Farm income	**Household income**
Sales intensity	0.586 (0.150)***	0.253 (0.082)***
Age	0.002 (0.006)	0.001 (0.004)
Gender	0.036 (0.195)	-0.026 (0.125)
Education	0.053 (0.024)**	0.027 (0.013)**
Risk attitude	0.086 (0.069)	0.011 (0.048)
Household size	-0.034 (0.049)	-0.042 (0.022)*
Farm size	0.479 (0.121)***	0.027 (0.062)
Machine ownership	0.149 (0.135)	0.245 (0.080)***
Distance	0.011 (0.009)	-0.011 (0.005)**
Credit constraint	0.237 (0.139)*	0.356 (0.077)***
Marketing condition	0.022 (0.042)	0.064 (0.029)**
Market information	0.448 (0.182)**	0.067 (0.085)
Demonstration level	0.030 (0.062)	0.033 (0.043)
Knowledge	0.005 (0.080)	-0.043 (0.044)
Qinling-Daba	-0.471 (0.182)***	0.146 (0.086)*
Constant	4.937 (0.749)***	8.058 (0.427)***
Observations	515	515

[1] Robust standard errors are reported in parentheses; *, ** and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively. The reference region is Wumeng mountain region. The dependent variables used are the logs of farm income (Yuan/capita) and household income (Yuan/capita).

significant in columns 2 and 3, suggesting that selling a higher proportion of agricultural products through cooperatives increases farm income and household income. Generally, the findings confirm the positive role of using agricultural cooperatives as a marketing channel in increasing members' farm and household income.

6. Conclusions and policy implications

This study analyzed the determinants of using agricultural cooperatives as a marketing channel and its effects on farm income and household income, using household survey data collected from Qinling-Daba and Wumeng regions that are low-income regions in China. Both PSM and IPWRA models were used to address the issue of sample selection bias. The empirical results showed that risk attitude, farm size, machine ownership, sales ability, demonstration level of cooperatives and knowledge about the cooperative's business conditions are important factors that affect members' decision to use agricultural cooperatives as a marketing channel.

Our results generated from both PSM and IPWRA models showed that using agricultural cooperatives as a marketing channel has a positive and statistically significant effect on both farm and household income. In comparison to the PSM model, the IPWRA model has a doubly robust property and it can generate more robust results. Thus, we interpreted our results estimated from the IPWRA estimator. We showed that the causal effects of using agricultural cooperatives as a marketing channel were to increase farm income by 10.35% and household income by 3.01%, respectively. Our disaggregated results by farm size showed that large-scale farm households tended to benefit more from using agricultural cooperatives as a marketing channel in comparison to small-scale farm households. The estimates for the income effects of sales intensity showed that higher proportion of agricultural products selling through cooperatives increases farm income and household income significantly.

Given the finding that using agricultural cooperatives as a marketing channel plays a significant role in enhancing both farm income and household income, smallholder farmers in rural China should be encouraged to join cooperatives and make use of their marketing services. In addition, given that members from agricultural cooperatives with higher demonstration level are more likely to use them for marketing purposes, the government should continue to support the development of cooperatives in terms of how effectively they function. Furthermore, since members who know more about agricultural cooperatives are more likely to market through them, improving the channels of communication with their members would be beneficial. For example, this could be achieved by providing regular updates to members as to the business conditions of the cooperative or encouraging members to participate more fully in the management and governance of the cooperative.

Finally, this study is based on household survey data collected from low-income rural areas in China. Our results show that there are spatial fixed effects that influence members' decision to use agricultural cooperatives as a marketing channel. These findings suggest that research on other regions may help improve the understanding of the income effect of using agricultural cooperatives as a marketing channel in a broader context.

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