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Impact of cash crop cultivation on household income and migration decisions: Evidence from low-income regions in China

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Abstract

This study examines the impact of cash crop cultivation on household income and migration decisions, using survey data collected from low-income regions in China. Given farmers decide themselves whether to cultivate cash crops, an endogenous treatment regression model that accounts for potential selection bias issue is used to analyze the data. The empirical results show that cash crop cultivation exerts a positive and statistically significant impact on household income, but it does not affect household migration decisions significantly. The disaggregated analyses reveal that cash crop cultivation significantly increases farm income but decreases off-farm income.

Keywords: cash crop cultivation, household income, migration decisions, endogenous treatment regression model

1. Introduction

In many developing countries, cash crops are widely promoted in low-income regions as a poverty alleviation strategy for at least three reasons. First, cash crop cultivation can help enhance adoption of yield-increasing technologies (e.g., fertilizers, pesticides, and improved seeds) and agronomic practices (e.g., integrated pest management, soil testing and formulated fertilization), and facilitate farmers' access to credit and agricultural extension training (Walker and Alwang 2015; Harou *et al*. 2017). Second, additional income received from cash crop cultivation enables farmers to improve nutrition, health and education conditions of family members. Third, cash crop cultivation can accelerate the investments in rural infrastructure and public services (e.g., road, bridges, electrical grids, and telecommunications) by commercializing crop production and modernizing farming systems (Vanwambeke *et al*. 2007; Klasen *et al*. 2013; Tankari 2017; Radchenko *et al*. 2018). Given the significant importance of cash crop cultivation in enhancing agricultural performance and boosting rural development, its impacts on various outcomes have received increasing attention of researchers and policymakers in developing countries (Maxwell and Fernando 1989). Currently, there are mainly two strands of literature.

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The first literature strand focuses on the economic impacts of cash crop cultivation on household welfare (e.g., Masanjala 2006; Cuong 2009; Carletto *et al*. 2011; Klasen *et al*. 2013; Tankari 2017; Radchenko *et al*. 2018), but the findings remain mixed. Most of the studies find that cash crop cultivation has a positive impact on household welfare. For example, in the study on Malawi, Masanjala (2006) found that tobacco cultivation has a positive and significant impact on household income. Cuong (2009) revealed that cash crop cultivation exhibits a positive and significant impact on household expenditure. Radchenko *et al*. (2018) showed that cash crop cultivation increases harvest value and yields for farmers. However, some studies show a negative relationship between cash crop cultivation and household welfare. For example, in the study on Senegal, Tankari (2017) found that cash crop cultivation has a negative impact on consumption expenditure because of the high opportunity costs involved in cash crop production.

The second strand of literature examines the non-economic impacts of cash crop cultivation, paying special attention to childcare provision, social distress and gender mainstreaming (e.g., Paolisso *et al*. 2002; Hill and Vigneri 2014; Papaioannou and Haas 2017). Paolisso *et al*. (2002) examined the impact of cash crop cultivation on labor time use and childcare provision in Nepal, and they found that cash crop cultivation would increase women's caring time for preschoolers. The study by Papaioannou and Haas (2017) finds that cash crop cultivation could partially mitigate the negative effects of weather shocks on social distress because of higher private incomes from cultivating cash crops relative to growing non-cash crops. Cash crop cultivation can also help women achieve gender equality (Hill and Vigneri 2014).

Despite the existence of a number of studies, one of the key issues scarcely explored in the literature is the effect of cash crop cultivation on migration decisions of farm households. Rural-to-urban migration is a common phenomenon in most developing countries and off-farm income has been playing a significant role in improving rural households' welfare. Cash crop cultivation may require rural households to re-allocate time used for farm and off-farm activities. For example, more time being allocated to off-farm activities would reduce the time used for cash crop cultivation. Therefore, cash crop cultivation may not only have an impact on farm income but also affect off-farm income and household migration decisions. Given the importance of off-farm income in rural poverty alleviation, studies investigating the impact of cash crop cultivation on household migration decisions would also provide significant evidence for policymakers in their efforts to promote cash crop cultivation in rural China and other developing countries. However, to the best of our knowledge, no previous studies have taken into account the possible relationship between cash crop cultivation and household migration decisions.

The present study, therefore, attempts to extend the existing studies by analyzing the impacts of cash crop cultivation on household income and household migration decisions. Further, we use disaggregated analyses to explore the impact channels by assessing the impacts of cash crop cultivation on farm income and off-farm income, respectively. We aim to contribute to the literature in twofold. First, we use an endogenous treatment regression (ETR) model to control for the selection bias issue associated with cash crop cultivation. Cash crop cultivation is not randomly assigned among rural households, but they usually decide themselves whether or not to cultivate cash crops. Thus, both observed factors (e.g., education, age, and household size) and unobserved factors (e.g., farmers' motivation and risk preference) may affect farmers' decisions to cultivate cash crops, resulting in a selection bias issue and inconsistent estimates. Second, we analyze rural household survey data collected from low-income regions in China under the Cash Crop Poverty Alleviation (CCPA) program. Although the CCPA program is mainly implemented in low-income regions, the relevant study is currently missing in the literature. The findings of this study would provide policymakers with information to enhance the effectiveness of the CCPA program in the low-income regions and further improve rural poverty alleviation programs. For the purpose of robustness check and comparison, we also present the results estimated from a propensity score matching (PSM) method.

China has been successful in poverty reduction in the past four decades, but there is still a large number of people living in low-income rural areas (Zhang *et al*. 2014). According to the official statistics released by the National Bureau of Statistics of the People's Republic of China, China still has about 30 million poor people by 2017. Rural poor households are usually living in the remote hilly and mountainous areas where it is hard to set up industries to facilitate local economic development due to poor infrastructure and resource endowment conditions (Jalan and Ravallion 2000; Li *et al*. 2016; Mahmud and Sawada 2018). In order to reduce rural poverty, different government programs have been proposed and implemented in China, and the CCPA program is one of them. The primary objective of the CCPA program is to enhance agricultural production and marketing performance and finally improve rural household welfare through promoting the improved crop varieties and changing the crop cultivation structure. Compared with developing industries, cash crop cultivation needs lower initial investment and shorter time to produce so it can help develop the rural economy in low-income regions at a reasonable pace.

In the early 1990s, the government has established a special institution to promote the development of the CCPA program. In 1997, a poverty alleviation policy, China Poverty Alleviation Funds Management Policy (CPAFMP), stressed that the CCPA program should become an important measure to poverty alleviation. In 2001, the central government emphasized that the government department at regional levels should offer pre-production and post-production services for CCPA program. In 2015, the CCPA program was listed as one of the ten priority poverty alleviation policies by the State Council of China. Supervised by the CCPA program, the government urges the poor villages to formulate plans for the development of the agricultural sector, focusing on cash crop cultivation through investing in financial funds.

There is a need to evaluate the effects of cash crop cultivation on household income and understand the effectiveness of the CCPA program in China. This is because the program in low-income regions has been implemented for more than twenty years and the government has invested a large number of financial funds to support and facilitate its development. Cash crop cultivation may not only influence the farm income but also affect household migration decisions and off-farm income due to the requirement of labor reallocation. That is, cash crop cultivation often needs more labor input relative to non-cash crops and rural households need to trade off the time used for farm works and off-farm activities. Therefore, it is significant to understand how cash crop cultivation affects rural incomes and household migration decisions for efficient agricultural policy design.

2. Data and methods

2.1. Data

The data used in the present study were collected from low-income regions in China in 2013. A multistage sampling procedure was used for data collection. First, four provinces (municipality) including Hubei, Hunan, Chongqing[1], and Guizhou were purposively selected. In particular, Hubei and Hunan are located in the central part of China, while Chongqing and Guizhou are located in the western part of the country. Second, we chose one county from each selected province (municipality) randomly, including Lichuan County in Hubei, Shizhu County in Chongqing, Zhijiang County in Hunan, and Yinjiang County in Guizhou[2]. Third, ten villages were randomly selected from each county. Finally, around 15 to 25 households including both cash crop cultivators and non-cultivators were interviewed randomly in each selected village, resulting in a total sample of 730 households for the study.

We used a face-to-face interview with a structured questionnaire to collect a wide range of information on household and social-economic characteristics (e.g., age, education, household size, and farm size), incomes, access to credit, household migration status, and cash crop cultivation status. The village-level information on infrastructure investment and public services (e.g., transportation and telecommunications) was also collected.

Table 1 presents the descriptive statistics of the variables used in the empirical analysis. The selection of the explanatory variables is based on the previous studies on new crop adoption, rural migration, and income growth (e.g., Knight *et al*. 2011; Asfaw *et al*. 2012; Bezu *et al*. 2014; Coromaldi *et al*. 2015; Ghimire *et al*. 2015; Khonje *et al*. 2015; Shiferaw *et al*. 2015; Zeng *et al*. 2015; Euler *et al*. 2017; Biyase and Zwane 2018).

Table 1 shows that about 45% of the households are cash crop cultivators. The average household income is 3 760 CNY. The mean number of migrant workers in a household is 0.84, suggesting that not all households have family members working off the farm. The average education level of the household heads is 6.50 years. The average age of the household head is 54.20 years. The average household size is 4.01, and the mean farm size is 4.48 mu (1 mu=1/15 ha). The results in Table 1 also show that 22% of the households have membership in agricultural cooperatives and 70% of the households have access to good road condition. The mean of infrastructure investment in a village is 709.57 thousand CNY.

The mean differences in terms of household and farm-level characteristics between the cash crop cultivators and non-cultivators are presented in Table 2. Compared with the non-cultivators, the cash crop cultivators have a relatively higher education level and tend to be younger. They are more likely to have a larger family size and cultivate a larger farm size. In addition, these cultivators are more likely to be cooperative members and they tend to live in the villages where the committee can help

[1] Chongqing is a municipality directly-controlled by the central government, which has the same administrative responsibility as a province.

[2] In the selected counties, different varieties of cash crops have been promoted by the local governments and cultivated by farmers. For instance, tea and medicinal herbs are cultivated in Lichuan County of Hubei, while fruits, vegetables, and tobacco are grown by farmers in Zhijiang County of Hunan. In Shizhu County of Chongqing, pepper, tobacco, gold-thread and water shield are planted and the main cash crops in Yinjiang County of Guizhou include walnut, tea, edible fungi, and tobacco.

work-related migration, compared with their non-cultivator counterparts.

With respect to the mean differences in household income, farm income, off-farm income and the number of migrant workers between cash crop cultivators and non-cultivators, the upper parts of Table 2 show that household income of cash crop cultivators is lower than that of non-cultivators, but the mean difference is not statistically significant. Farm income of cash crop cultivators is significantly higher than that of non-cultivators. However, the off-farm income of cash crop cultivators is significantly lower than that of non-cultivators. The results also show that the average number of migrant workers in a cash crop cultivation household is higher than that in a non-cultivation household, but the mean difference is not statistically significant. These findings tentatively show that cash crop cultivation increases farm income but decreases off-farm income significantly, and there is no significant impact of cash crop cultivation on household income and the number of migrant workers. However, given that the potential selection bias is not taken into consideration in the descriptive analysis, the findings are not conclusive and rigorous econometric methods such

Table 1 Definition and summary statistics of the selected variables

Variables	Definition	Mean	Std. Dev.
Household income	Household income (1 000 CNY per capita)[1)]	3.76	4.84
Farm income	Farm income (1 000 CNY per capita)	2.03	3.73
Off-farm income	Off-farm income (1 000 CNY per capita)	1.62	3.25
Migrant workers	The number of migrant workers in a household	0.84	0.97
Cultivation	1 if household is a cash crop cultivator, 0 otherwise	0.45	0.50
Age	The household head's age in years	54.20	12.62
Education	Education level of the household head in years	6.50	3.77
Household size	Household size	4.01	1.66
Farm size	Farm size (mu)[2)]	4.48	7.95
Cooperative membership	1 if household is a member of cooperative, 0 otherwise	0.22	0.42
Road condition	1 if the road condition is good, 0 otherwise	0.70	0.46
Sales help	1 if the village committee helps the sales of agricultural products, 0 otherwise	0.50	0.50
Migration help	1 if the village committee helps work-related migration, 0 otherwise	0.43	0.49
Hubei	1 if household lives in Hubei, 0 otherwise	0.28	0.45
Hunan	1 if household lives in Hunan, 0 otherwise	0.34	0.47
Chongqing	1 if household lives in Chongqing, 0 otherwise	0.24	0.43
Guizhou	1 if household lives in Guizhou, 0 otherwise	0.14	0.34
Infrastructure investment	Investment on the infrastructure in the village (1 000 CNY)	709.57	1 076.84

[1)] CNY is Chinese currency unit, 1 USD=6.78 CNY.
[2)] 1 mu=1/15 ha.

Table 2 Mean differences in characteristics between cash crop cultivators and non-cultivators

Variable[1)]	Cultivators	Non-cultivators	Diff.	*t*-value
Household income	3.72 (0.25)	3.79 (0.25)	–0.07	0.20
Farm income	3.06 (0.25)	1.15 (0.13)	1.91***	7.13
Off-farm income	1.23 (0.12)	1.94 (0.15)	–0.71***	–2.97
Migrant workers	0.90 (0.05)	0.79 (0.04)	0.11	1.47
Age	52.40 (0.47)	55.70 (0.67)	–3.30***	–3.54
Education	7.21 (0.20)	5.90 (0.19)	1.31***	4.74
Household size	4.27 (0.08)	3.79 (0.09)	0.48***	3.91
Farm size	6.29 (0.59)	2.97 (0.20)	3.32***	5.74
Cooperative membership	0.40 (0.03)	0.06 (0.01)	0.34***	11.75
Road condition	0.60 (0.02)	0.79 (0.02)	–0.19***	5.69
Sales help	0.53 (0.03)	0.47 (0.03)	0.06	1.54
Migration help	0.50 (0.03)	0.36 (0.02)	0.14***	3.88
Hubei	0.02 (0.01)	0.51 (0.03)	–0.49***	–17.50
Hunan	0.70 (0.03)	0.04 (0.01)	0.66***	26.26
Chongqing	0.20 (0.02)	0.27 (0.02)	–0.07*	–1.94
Guizhou	0.08 (0.01)	0.19 (0.02)	–0.11***	–4.40
Infrastructure investment	787.25 (49.96)	655.02 (46.45)	132.23*	1.90

[1)] The variables of farm income and off-farm income are measured in 1 000 CNY per capita.
Standard errors are in parentheses. *, $P<0.1$; ***, $P<0.01$.

as ETR models should be used to examine the impact of cash crop cultivation on household income and household migration decisions.

2.2. Methods

Analytical framework Cash crop cultivation can influence household income by influencing farm income and off-farm income. A simple framework of potential pathways is illustrated in Fig. 1. The first pathway shows that cash crop cultivation affects the crop yields, with a corresponding direct impact on farm income. For example, cash crop cultivation enhances adoption of yield-increasing technologies (e.g., fertilizers) and agronomic practices (e.g., integrated pest management) (Walker and Alwang 2015; Radchenko *et al*. 2018), which finally increases crop yields. Higher crop yields respond to higher farm income and higher household income. The second pathway shows that more favorable commodity prices of cash crops can help explain the increase in the farm income. Klasen *et al*. (2013) revealed that a higher price of cocoa makes switching of cropping pattern, which could be a crucial strategy to achieve farm income growth, especially the poorer rural population.

The third pathway shows the effect of cash crop cultivation on household migration decisions. As discussed earlier, cash crop cultivation may require rural households to re-allocate time used for farm and off-farm work. If more time is allocated to cash crop cultivation, there less time can be allocated to off-farm work. Therefore, cash crop cultivation requires smallholder farmers to adjust their migration decisions, which finally affects their off-farm income. Both farm income and off-farm income determine household income. In this study, we examine the impact of cash crop cultivation on household income and migration decisions, also provide evidence to show how cash crop cultivation affects farm income and off-farm income, respectively.

Endogenous treatment regression model As mentioned earlier, farmers randomly select themselves to be cash crop cultivators and non-cultivators, resulting in an endogeneity issue of cash crop cultivation variable (Asfaw *et al*. 2012; Radchenko *et al*. 2018). To put it in other words, both observed and unobserved factors may affect farmers' decisions to choose to cultivate cash crops, which finally affect the outcome variables. In this case, estimating the impact of cash crop cultivation on household income and migration decisions using an ordinary least square (OLS) regression model would result in a biased estimate because the OLS model treats all independent variables exogenously. Although the PSM method has been widely used to address the sample selection bias issue (Ma and Abdulai 2016b; Nakano *et al*. 2017; Azeem *et al*. 2018), this approach only controls for selection bias arising from the observed factors.

In this paper, we employ an ETR model to control for the selection bias. Compared with the PSM method, the ETR model can produce consistent estimates by removing the bias originating from both observed and unobserved factors (Hübler 2016; StataCorp 2017). In addition, the ETR model enables to estimate a direct impact of cash crop cultivation on the outcome variables of interest. The ETR model estimates jointly one selection equation which models farmers' decision to cultivate cash crop and one outcome equation which models the impact of cash crop cultivation on outcomes of interest.

To derive the selection equation, we assume that farmers are making decisions on whether or not to cultivate cash crops based on the expected net returns. Let the expected net returns from cash crop cultivation be T_M^* and that from non-cultivation be T_N^*, a rational household will choose to cultivate cash crops if the expected net returns difference from cultivation and non-cultivation is higher than zero, i.e., $T_i^*=T_M^*-T_N^*>0$. However, T_i^* cannot be observed directly since it is subjective. We can only observe the household's final decision to be a cultivator or non-cultivator. T_i^* can be expressed as a latent variable model as follows:

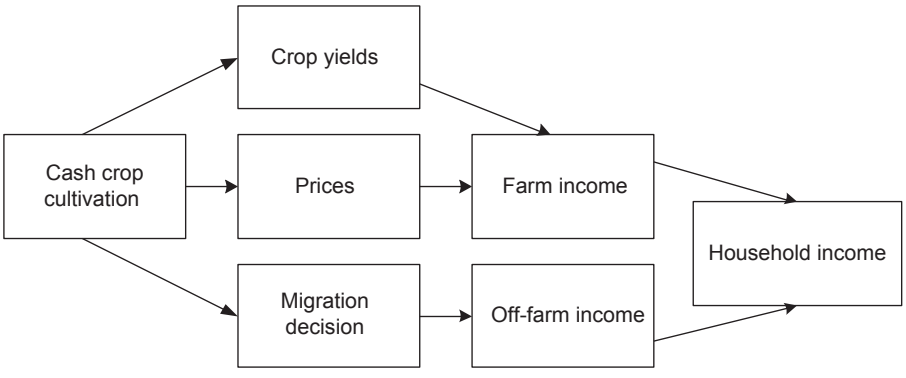

Fig. 1 The relationship between cash crop cultivation and household income.

$$T_i^*=Z_i\alpha+\mu_i,\ T_i=1 \text{ if } T_i^*>0 \quad (1)$$

where T_i is a binary variable, which equals 1 if a household *i* chooses to be a cash crop cultivator and 0 otherwise; Z_i is a vector of household and farm-level characteristics (e.g., age, education, and farm size); α represents a vector of parameters to be estimated; μ_i is an error term.

The outcome question of the ETR model links cash crop cultivation with outcome variables (i.e., household income and migration decisions). In particular, we assume that the outcome variable is a function of explanatory variables and a cash crop cultivation variable:

$$Y_i=X_i\beta+T_i\eta+\varepsilon_i \quad (2)$$

where Y_i represents the vector of outcome variables; X_i represents the vector of explanatory variables (e.g., age, education, household size, and farm size); T_i is an indicator representing cash crop cultivation status of households; β and η are parameters to be estimated, and ε_i is an error term.

The ETR model is composed of eq. (1) for the endogenous treatment variable and eq. (2) for the outcome variable. The error terms ε_i in eq. (2) and μ_i in eq. (1) are assumed to be bivariate normal with mean zero and covariance matrix:

$$\begin{bmatrix} \sigma^2 & \sigma_{\mu\varepsilon}\rho_{\mu\varepsilon} \\ \sigma_{\mu\varepsilon}\rho_{\mu\varepsilon} & 1 \end{bmatrix} \quad (3)$$

where var $(\varepsilon_i)=\sigma^2$, cov $(\varepsilon_i, \mu_i)=\sigma_{\mu\varepsilon}$ and corr $(\varepsilon_i, \mu_i)=\rho_{\mu\varepsilon}$. If $\rho_{\mu\varepsilon}$ is statistically significant, it indicates that there is a selection bias arising from unobserved factors (Ma *et al*. 2018). In particular, the negative and significant sign of $\rho_{\mu\varepsilon}$ would suggest the presence of negative selection bias. That is, households with lower than average outcome variables are more likely to be cash crop cultivators. Moreover, the negative sign of $\rho_{\mu\varepsilon}$ would suggest that the OLS and PSM would underestimate the effects of cash crop cultivation on outcome variables. However, the positive and significant sign of $\rho_{\mu\varepsilon}$ indicates a positive selection bias.

Given the continuous nature of household income, we use the ETR model for a continuous outcome to estimate the impact of cash crop cultivation on household income. Because the variable of household migration decisions is measured as a count variable in this study, we employ the ETR model to estimate the impact of cash crop cultivation on household migration decisions.

For the purpose of model identification, there will be one or more variables in Z_i, served as an instrumental variable, that does not appear in X_i. The valid instrumental variable is expected to significantly affect farmers' decision to cultivate cash crops, but it does not affect the outcome variables directly. In this study, we use the logarithm value of infrastructure investment in a village in which household *i* lives as an instrumental variable. We use the probit model, OLS model, and Poisson regression model to test the validity of this instrumental variable. The probit model is used to check if infrastructure investment variable affects the household's decision to cultivate cash crops. The OLS regression is used to test if the instrumental variable has a significant impact on household income, farm income and off-farm income, while the Poisson regression is used to test the effect of cash crop cultivation on the number of migrant workers. The preliminary test results, which are presented in Appendix A, show that the coefficient of the instrumental variable is statistically significant in the probit regression but it is not statistically significant in the OLS and Poisson regression models. The findings suggest the validity of the infrastructure variable when it serves as an instrument.

Propensity score matching (PSM) method For the purpose of robustness check and comparison, the PSM method is also employed to examine the impact of cash crop cultivation on household income and household migration decisions. PSM is estimated in two steps. First, we calculate the propensity scores of choosing to be cash crop cultivators using a probit model. The estimated propensity scores are then used to match both cash crop cultivators and non-cultivators based on the similarities in term of observed household and farm-level characteristics. Second, we calculate the ATT^{PSM} based on the propensity scores. Specifically, the ATT^{PSM} can be calculated as follows:

$$ATT^{PSM}=E\{E[Y_{1i}^{PSM}|T_i=1, p(Z_i)]-E[Y_{0i}^{PSM}|T_i=0, p(Z_i)]|T_i=1\} \quad (4)$$

where T_i equals 1 if a household *i* chooses to be a cash crop cultivator and 0 otherwise. Z_i is a vector of household and farm-level characteristics. In this study, the most straightforward nearest neighbor matching estimator is used to calculate the ATT^{PSM} (Ma and Abdulai 2016b).

3. Results and discussion

The estimates for the impact of cash crop cultivation on household income and household migration decisions are presented in Tables 3 and 4. As indicated previously, the statistically significant coefficients of $\rho_{\mu\varepsilon}$ in Tables 3 and 4 indicate the presence of selection bias arising from unobservable variables (Ma and Abdulai 2017; StataCorp 2017). In particular, the negative sign of $\rho_{\mu\varepsilon}$ in Tables 3 and 4 indicates that households with lower than average household income and those with lower than the average number of migrant workers are more likely to choose to cultivate cash crops. Failing to take into account the selection bias issue would generate underestimated effects of cash crop cultivation on household income and household migration decisions.

3.1. Determinants of cash crop cultivation

The results revealing the determinants of cash crop

Table 3 Determinants of cash crop cultivation and its impact on household income

	ETR for continuous variable[1)]		OLS
	Selection equation	Household income	Household income
Cultivation		3.909 (1.039)***	0.247 (0.538)
Age	0.025 (0.049)	–0.113 (0.109)	–0.120 (0.095)
Square of age	–0.000 (0.000)	0.001 (0.001)	0.001 (0.001)
Education	0.027 (0.022)	0.099 (0.056)*	0.110 (0.048)**
Household size	–0.008 (0.047)	–0.338 (0.115)***	–0.357 (0.099)***
Farm size	0.046 (0.014)***	0.030 (0.024)	0.053 (0.039)
Cooperative membership	1.474 (0.201)***	–0.875 (0.575)	0.184 (0.493)
Road condition	0.019 (0.156)	1.100 (0.418)***	1.171 (0.367)***
Sales help	–0.248 (0.198)	0.396 (0.427)	0.072 (0.344)
Migration help	0.699 (0.230)***	0.212 (0.482)	0.482 (0.417)
Hubei	–1.647 (0.304)***	1.968 (0.671)***	1.035 (0.505)**
Hunan	1.966 (0.249)***	–1.762 (0.872)**	0.325 (0.601)
Chongqing	–0.820 (0.263)***	1.943 (0.734)***	1.891 (0.681)***
Infrastructure investment (log)	0.226 (0.063)***		
Constant	–2.973 (1.475)**	4.955 (3.141)	5.885 (2.847)**
Ath($\rho_{\mu\varepsilon}$)	–0.521 (0.139)***		
$\rho_{\mu\varepsilon}$	–0.478 (0.181)***		
ln(σ)	1.566 (0.030)***		
Log pseudolikelihood	–2 353.976		
Wald test of indep. Eqns. ($\rho_{\mu\varepsilon}$=0)	χ^2(1)=4.91, Prob=0.027		
Observations	730		730

[1)] Household income is measured in 1 000 CNY per capita. The reference region is Guizhou. STATA commands *etregress* is used to estimate the results of the endogenous treatment regression (ETR) model for continuous variable (StataCorp 2017).
Standard errors are in parentheses. *, P<0.1; **, P<0.05; ***, P<0.01.

Table 4 Determinants of cash crop cultivation and its impact on household migration decisions

	ETR for count variable[1)]		Poisson
	Selection equation	The number of migrant workers	The number of migrant workers
Cultivation		–0.212 (0.172)	–0.181 (0.115)
Age	0.011 (0.045)	0.108 (0.033)***	0.108 (0.033)***
Square of age	0.000 (0.000)	–0.001 (0.000)***	–0.001 (0.000)***
Education	0.026 (0.022)	0.043 (0.012)***	0.043 (0.013)***
Household size	0.007 (0.046)	0.277 (0.027)***	0.277 (0.027)***
Farm size	0.027 (0.011)**	–0.016 (0.009)*	–0.017 (0.009)*
Cooperative membership	1.544 (0.205)***	0.012 (0.109)	0.004 (0.106)
Road condition	0.062 (0.160)	0.114 (0.093)	0.114 (0.093)
Sales help	–0.151 (0.188)	0.001 (0.094)	0.003 (0.094)
Migration help	0.606 (0.207)***	0.008 (0.104)	0.005 (0.104)
Hubei	–1.197 (0.263)***	–0.192 (0.147)	–0.184 (0.141)
Hunan	2.686 (0.281)***	0.185 (0.178)	0.166 (0.163)
Chongqing	–0.115 (0.298)	–0.196 (0.176)	–0.197 (0.176)
Infrastructure investment (log)	0.223 (0.070)***		
Constant	–2.201 (1.361)	–4.253 (0.888)***	–4.265 (0.884)***
Ath($\rho_{\mu\varepsilon}$)	1.475 (0.455)***		
$\rho_{\mu\varepsilon}$	–0.901 (0.086)***		
ln(σ)	–3.870 (3.898)		
Log pseudolikelihood	–995.400		
Wald test of indep. Eqns. ($\rho_{\mu\varepsilon}$=0)	χ^2(1)=10.49, Prob=0.001		
Observations	730		730

[1)] STATA commands *etpoisson* is used to estimate the results of the endogenous treatment regression (ETR) model for count variable (StataCorp 2017). The reference region is Guizhou.
Standard errors are in parentheses. *, P<0.1; **, P<0.05; ***, P<0.01.

cultivation are given in the second columns in Tables 3 and 4. The coefficients of farm size variable are positive and statistically significant in the three selection equations, suggesting that households with large farm size are more

likely to cultivate cash crops. The results are consistent with the findings of Panda (2015), who showed that households with better land endowments tend to more actively access external resources. The variable representing cooperative membership has a positive and statistically significant impact on cash crop cultivation decision. The finding suggests that households who belong to a cooperative are more likely to be cash crop cultivators, a finding that is consistent with Abebaw and Haile (2013) who found that cooperative members appear to be more likely to adopt new agricultural technologies compared to non-members in Ethiopia. The coefficients of location variables are statistically significant, implying the presence of location-fixed effects that affect farmers' decisions to cultivate cash crops. In particular, our estimates show that compared with households located in Guizhou (reference group), households located in Hubei are less likely to cultivate cash crops but their counterparts living in Hunan are more likely to cultivate cash crops. Finally, the coefficient of infrastructure investment variable, which serves as an instrumental variable, is positive and statistically significant, suggesting that investment in infrastructure in rural villages is an important factor that determines farmers' decision to cultivate cash crops.

3.2. Impact on household income

The third column of Table 3 presents the results for the impact of cash crop cultivation on household income. The results show that the coefficient of cultivation variable in the ETR model is positive and statistically significant, suggesting that cash crop cultivation increases per capita household income. In particular, relative to households without cultivating cash crops, those cultivating cash crops earn 3 909 CNY per capita on average. The finding is consistent with Masanjala (2006) who found that households growing cash crops achieve higher income level. The OLS results presented in the last column of Table 3 show that cultivating cash crops does not have a significant impact on household income. This is not surprising, because the OLS model treats the cash crop cultivation as an exogenous variable while a negative selection bias has been identified in the ETR model estimation. Thus, the ETR model provides more convincing results.

To provide a better understanding how cash crop cultivation affects rural incomes, we also analyzed the impact of cash crop cultivation on farm income and off-farm income. This analysis is essential because farm income and off-farm income are major components of household income. The results are presented in Appendices B and C, respectively. We show (Column 3 of Appendix B) that cash crop cultivation exerts a positive and statistically significant impact on farm income. Cash crop cultivation can help farmers adopt high value-added varieties and connect them with the market closely, which contributes to a higher farm income. The finding of the positive relationship between cash crop cultivation and farm income is consistent with the finding by Klasen *et al*. (2013) who showed that households adopting new cash varieties achieve higher income compared to their counterparts adopting traditional crops. Masanjala (2006) also found that tobacco farmers earn more income than non-tobacco farmers in Malawi. However, our estimates (Column 3 of Appendix C) reveal that cash crop cultivation has a significant and negative impact on off-farm income. Cash crop cultivation requires farmers to trade off the time being allocated to farm work and the time being allocated to off-farm work. More time allocated to cultivate labor-intensive cash crops (e.g., tea, medical herbs, and tobacco) would result in less time being allocated to off-farm work, which finally results in a lower off-farm income.

With respect to other factors that affect household income, our results show that the coefficient of education variable is positive and statistically significant, suggesting that better-educated farmers obtain higher household income. Better education can help farmers to acquire new technology and adopt high value-added varieties, contributing to a higher farm income and household income. This finding is consistent with the study of Sekabira and Qaim (2017), who found there is a positive association between education level and household income. Household size appears to have a negative and statistically significant coefficient. The finding suggests that the large household size reduces per capita household income, which is similar to the finding of Ma and Abdulai (2016a). The variable representing road condition has a positive and statistically significant impact on household income, indicating that farmers who can access to good road condition can obtain higher household income. Our results also show that relative to households in Guizhou (reference division), those cultivating cash crops in Hubei and Chongqing obtain higher household income, while those producing cash crops in Hunan receive lower household income.

3.3. Impact on household migration decisions

The estimates for the impact of cash crop cultivation on the number of migrant workers are presented in the third column of Table 4. Our estimates show that the coefficient of cash crop cultivation variable is not statistically significant, indicating that cash crop cultivation does not have a significant impact on household migration decisions.

With regards to other factors, the coefficient of age variable is positive and significant, while the coefficient of its squared term is negative and significant, indicating the presence of life-cycle effects. Our results show that an increase in household head age increases the number of migrant workers, with the maximum effect occurring at nearly 54 years old. The coefficient of the education variable is positive and statistically significant, suggesting that better education of household heads increases the number of migrant workers in a household. This finding is supported by the finding of Du *et al*. (2005), who found that a higher education level significantly increases the probability of migration. Better education can help rural households to identify, collect and process information of off-farm activities, which finally increases their off-farm work participation probability. Household size is also an important factor affecting the number of migrant workers. The positive and significant coefficient of the household size suggests that households with a larger household size tend to have more migrant workers. Finally, the variable representing farm size has a negative and statistically significant impact on the number of migrant workers, indicating that households with larger farm tend to have less migrant workers.

3.4. Robustness check and comparison using the PSM method

For the purpose of robustness check and comparison, we also examined the effects of cash crop cultivation on household income and household migration decisions using the PSM approach. All the sampled households are divided into a treatment group (i.e., cash crop cultivators) and a control group (i.e., non-cultivators). We calculated the propensity scores for choosing to be cash crop cultivators, using the probit model based on the observed household characteristics. Appendices D and E, respectively, illustrate the propensity score distributions of the treatment group and control group before and after matching. The common support region becomes larger in Appendix E compared to Appendix D. In addition, the propensity score distribution curves of the treatment group and control group nearly overlapped in Appendix E. The findings indicate that the matching performance is efficient after using the PSM method. The ATT estimates are restricted to the overlapping area where non-cultivators are comparable with cultivators.

The ATT estimates generated from the PSM method, which are presented in Appendix F, also show that cash crop cultivation significantly increases household income, while it does not significantly affect household migration decisions. The findings in Appendix F are generally consistent with the findings presented in Tables 3 and 4.

4. Conclusion

This study analyzed the impact of cash crop cultivation on household income and migration decisions, using data from a CCPA program household survey in low-income regions of China. The ETR model was used to account for potential selection bias rising from observed and unobserved factors. For the purpose of comparison, we also estimated the impact of cash crop cultivation on outcome variables of interest using the PSM approach.

The results estimated from the ETR model revealed that a household's decision to be a cash crop cultivator is significantly affected by farm size, cooperative membership, and migration help. We found that cash crop cultivation exerts a significantly positive impact on household income, and being a cash crop cultivator would earn 3 909 CNY per capita than a non-cultivator counterpart. Further, the disaggregated analyses showed that cash crop cultivation significantly increases farm income but decreases off-farm income. However, there was no evidence showing that cash crop cultivation has a statistically significant effect on household migration decisions. The finding of the positive effect of cash crop cultivation on household income in the ETR model was supported by the results estimated from the PSM model.

Our findings provide empirical evidence for cash crop cultivation and poverty alleviation policymakers. The positive and significant impact of farm size on cash crop cultivation suggests that the government should make efforts to enhance rural land transfer and increase the farm size of cash crop cultivators. The finding that cooperative membership tends to positively influence a household's decision to cultivate cash crops suggests that promoting effective measures to support the development of agricultural cooperatives and encouraging farmers to join agricultural cooperatives would help enhance cash crop cultivation.

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Appendices associated with this paper can be available on http://www.ChinaAgriSci.com/V2/En/appendix.htm

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