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Too Risky to Focus on Agriculture? An Empirical Study of China's Agricultural Households' Off-Farm Employment Decisions

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Abstract: This paper investigates China's agricultural households and their individual members' off-farm labor supply decision in response to farm production risks and a number of other factors (e.g., demographic characteristics, farm characteristics, and local market features). Whether and to what extent farming risks may affect farmers' off-farm employment in China are rarely studied. Our paper provides an empirical study to demonstrate that agricultural production risks significantly impact off-farm labor supply in rural China. The impacts of associated variables on households off-farm labor supply decisions are quantified using a sample of large–scale nationwide household finance survey in 2010. The results suggest that off-farm employment serves as a risk adaption strategy for Chinese farmers. Policy suggestions on retaining farmers to focus on agricultural production are discussed.

Keywords: off-farm employment; agricultural household; China; production risk

JEL Classification: J43; Q12

1. Introduction

The economic reforms of China that started nearly four decades ago has led to dramatic changes in the economic landscape of the nation. The whole world has witnessed China's remarkable success in economic growth and poverty reduction. From 1981 to 2010, China's national GDP rose from 3.59 trillion Yuan to 50.21 trillion Yuan [1] and the poverty rate declined from 88.32% to 11.2% [2]. Particularly, the expansion of rural economy has driven a large part of this success [3,4]. Farmers' incomes have risen significantly and hundreds of millions of rural households have escaped poverty during this period [5–7]. Specifically, CPI (Consumer Price Index) adjusted per capita rural income has increased more than fivefold, from 1786.33 Yuan in 1978 to 10,990.70 Yuan in 2012 [8]. During this period, many farmers and their family members began to engage in economic activities off their land, resulting in great prosperity of the non-farm economy. As a result, non-farm employment in rural communities rose from 108.7 million to 271.8 million and their respective ratio of the entire rural workforce increased from 22.8% to 52.6% from 1990 to 2010 [1]. The booming non-farm economy in rural China has greatly improved farm household economic well-being, contributed by both employment expansion and rural income growth [9–11] Particularly, off-farm earnings rose to as much as 53% of rural household incomes in 2012 [8].

Off-farm employment in rural China has earned the focus of much research interest due to the huge size of rural labor force and the increased reliance on off-farm income by Chinese farm households. Previous literature showed that two groups of factors explain the observed labor

supply: demographic characteristics and social networks. Using the Probit model, De Janvry et al. [7] found that higher educations and more social network connections increase the likelihood of a rural Chinese household to allocate their labor towards the off-farm activities. Similar results are presented in Chen et al. [12] where education, household size and social networks were found to be crucial in deciding the locations of employments by rural households. Zhang et al. [13] concluded that rural workers have been increasingly rewarded for their education through both better off-farm job access and higher wages. Their results suggest that investments in rural education are desperately needed to improve agricultural productivity and facilitate the demographic and economic transition of the rural areas. Restructuring the rural education system might enhance the rural human capital accumulation and economic development. Zhang et al. [14] concluded that there has been an overall increase in off-farm participation. Young urban migrants from rural regions have driven a large part of this increase. Gender difference has also been emphasized. A number of studies demonstrated that the determinants of off-farm labor supply participation vary significantly by gender [14–16].

The existing literature on off-farm labor supply in China centers on applying appropriate econometric methodologies to identify the impacts of various factors. However, we found a significant gap in the literature that agricultural production risks are rarely considered as a driving factor of farmers' labor allocation in China. Even in a global context, the only relevant studies we found are Mishra and Goodwin [17] and Mishra and Holthausen [18] that analyzed the impacts of risks of farming and off-farm incomes on the US farmers. Given the increasing importance of risk management in China's agricultural industries, such an overlook of production risks in the study of off-farm labor supply suggests a further investigation. In addition, we found a paucity of literature considering the regional heterogeneity when studying the off-farm employment decision in rural China. Our study strives to fill these information gaps. Thus, we focus on the following research questions: (1) How shall a China's farm household decide whether they would like to take off-farm jobs? (2) What are the driving forces of such a decision? (3) For a Chinese rural household, does such a labor supply decision respond to agricultural production risks? (4) Does this labor allocation decision differ across the regions? The overall goal of this paper is to contribute to the assessment of agricultural households decision–making on labor allocation in China.

Although production risks present an increasingly crucial challenge to agriculture, whether and to what extent such risks impact Chinas farmers engagement in off-farm employment has yet to be studied. Movitated by previous studies on the U.S. farmers [17,18], our study attempts to address agricultural production risks and evaluating their impacts in China. We empirically analyze a sample of Chinas rural households labor supply decisions. This paper will provide important economic insights and policy implications for both academic and public audiences.

Our empirical analysis uses a survey of Chinese households (China Household Finance Survey) in summer 2011. We focus on the households in which at least one member participated in farming activities in 2010. Our data include 2352 rural households from 21 provinces. A binary Logit model is adopted. The dependent variable is defined as whether a household participated in any form of off-farm income generating activity that requires their own labor input. The set of explanatory variables include the variations of farm incomes, the expectations of farming and off-farm incomes, household demographics (i.e., age and household size) and other relevant regressors. Furthermore, for the purpose of comparison, we also evaluate labor supply decisions at the individual level. In general, the results are consistent with our expectations. In particular, the risks of agricultural production are found to be a significant factor for Chinese farmers in their labor allocation decisions.

This paper fills the gap in the existing literature that, when evaluating rural households off-farm labor supply in China, agricultural production risks have never been considered. Our empirical analysis verifies our hypothesis that agricultural risks are a significant determinant in off-farm employment in China. Using our samples, we also identify and evaluate a number of important factors. In addition, we recognize and quantify regional heterogeneity among rural households off-farm labor supply decisions.

The rest of the paper is organized as follows. In Section 2, we introduce the data sets that are used for the analysis. Section 3 describes the empirical analysis and results to explain the determinants of employment decisions at both household and individual levels. Conclusions and policy implications are discussed in the final section.

2. Data

This study focuses on the rural households which were involved in agricultural activities in the sample year 2010. The China Household Finance Survey (CHFS) data is provided by the Survey and Research Center of China Household Finance, Southwestern University of Finance and Economics, Chengdu, China [19]. The CHFS survey contained 3244 rural households from different provinces of China. Among the 3244 rural households, 1526 had both on-farm and off-farm sources of income while 829 had income exclusively derived from farm activities. The remaining 889 households took non-farm jobs as their exclusive means of income. Since this study only concerns farmers' labor supply decisions, these 889 rural non-farming households are excluded from our sample. Therefore, this study is concentrated on the households that either generate income exclusively from farming or have mixed income sources from both on– and off-farm activities. They received several categories of off-farm income: (1) income earned by self–employment in non-farm activities such as industrial and/or commercial activities; (2) income earned from formal or informal wage, including salary, allowance, bonus, dividend, and other sorts of remuneration; and (3) other income not related to farming. Since there are only three rural households in Shanghai, in order to avoid a biased representation of farm households for the region, we rule out Shanghai from our study area. As a result, our sample is consisted of 2352 farm households from 21 provinces.

Because agronomic and socioeconomic conditions differ significantly across the nation, we speculate such a difference in both returns of farming and off-farm jobs may result in heterogeneous patterns of farmers' off-farm labor supply. We consider including a set of variables to present different regions while not losing too many degrees of freedom in the regression. Therefore, we group the locations of our sampled farm households into four regions: (1) Western region; (2) Northeastern region; (3) Central region; and (4) Eastern region. The geographic boundaries of these four economic regions were defined by the central government during the Eleventh Five-Year Plan of China and have been widely used since then. Our study area with regional divisions is presented in Figure 1.

Furthermore, we examined the distribution of farm income using multiple data sources. We found that per acre farm incomes of the CHFS data set in 2010 and of the National Bureau of Statistics of China (NBSC) data set from 2005 to 2009 are indeed log-normally distributed as illustrated in Figures 2 and 3.

Table 1 summarizes farm household statistics of two household categories. Category one are households that participated in both farming and off-farm activities, and category two are households that exclusively participated in farming activities. As described from these data, on average, households that had both on– and off-farm sources of income have a lager household size, younger family members, higher education level, less farming experience, smaller farmland size and slightly closer distance to the county center as compared to those that solely engaged in agricultural production.

In addition to the household level analysis, we are also going to investigate each individual farmer's off-farm labor supply decisions. Therefore, we need to use individual level data in our sample. Among these 2352 farm households, the individual household members are classified into five categories: (1) pure farmers (a.k.a. full-time farmers) who only engaged in farming activities; (2) farmers who primarily engaged in the farming work but also had some off-farm income source (a.k.a. part-time farmers); (3) non-farmers who exclusively worked outside the farm; (4) dependents who were under 16 years old (Given China's compulsory education law, the 9-year compulsory education system requires all the children remain full time students until graduating from the junior secondary schools, when they would be at least 16 years old. However, there might be some children who started to participate in farming activities before that age, as pointed out by one anonymous referee. Since that proportion is small and the relevant information is not available in our sample,

we assume that all children remain on a dependent status until 16 years old.); and (5) other unemployed adult individuals who did not have any job related information. This study focuses on the first three categories who qualify as the labor suppliers in the rural sector. Table 2 presents individual statistics of each category. Among working age individuals, off-farm workers (type two and three) are more likely to be single young males with higher education levels and smaller farmland holdings.

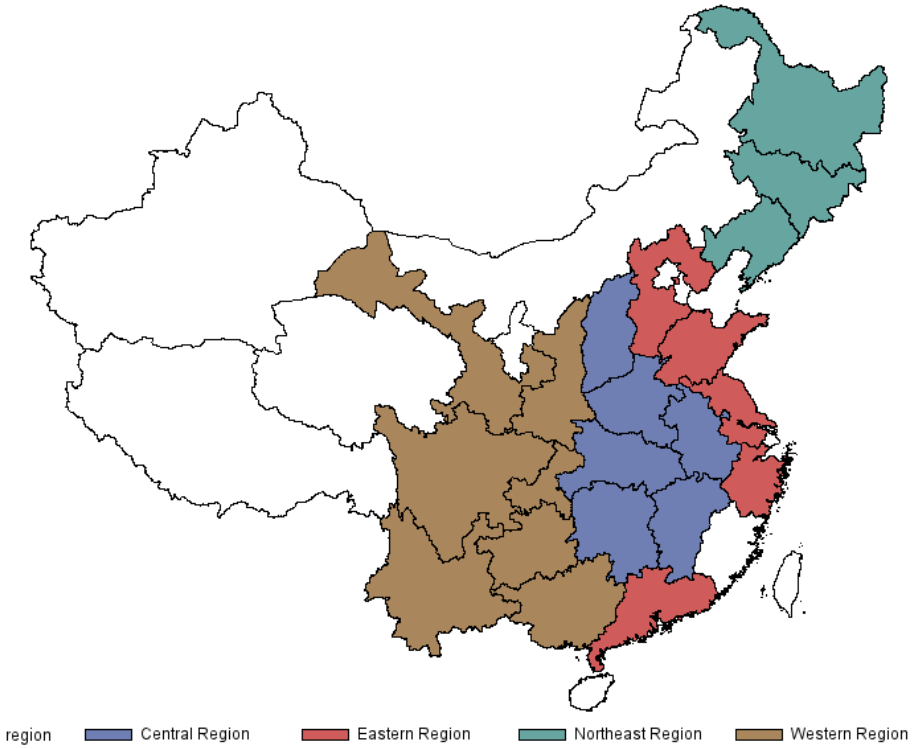


Figure 1. Study area.

Table 1. Characteristics in two household categories.

	Overall	Category	
		(W/off–Farm Job)	(W/O off–Farm Job)
Household size	4.07	4.51	3.26
Average age	40.67	37.32	46.83
Average education	6.94	7.55	5.8
Average farming experience	32.08	28.45	38.87
Farmland size (acre)	1.05	1.01	1.12
Proximity (km)	35.42	34.85	36.47
N	2352	1523	829

Table 2. Characteristics in the rural labor force.

	Full-Time Farmer	Part-Time Farmer	Non-Farmer
Male	46.48%	79.35%	63.73%
Marital status	92.23%	95.88%	63.74%
Average age	50.23	45.28	31.69
Average education	6	7.96	9.3
Farmland size per capita (acre)	0.3	0.24	0.2
N	4062	368	2046

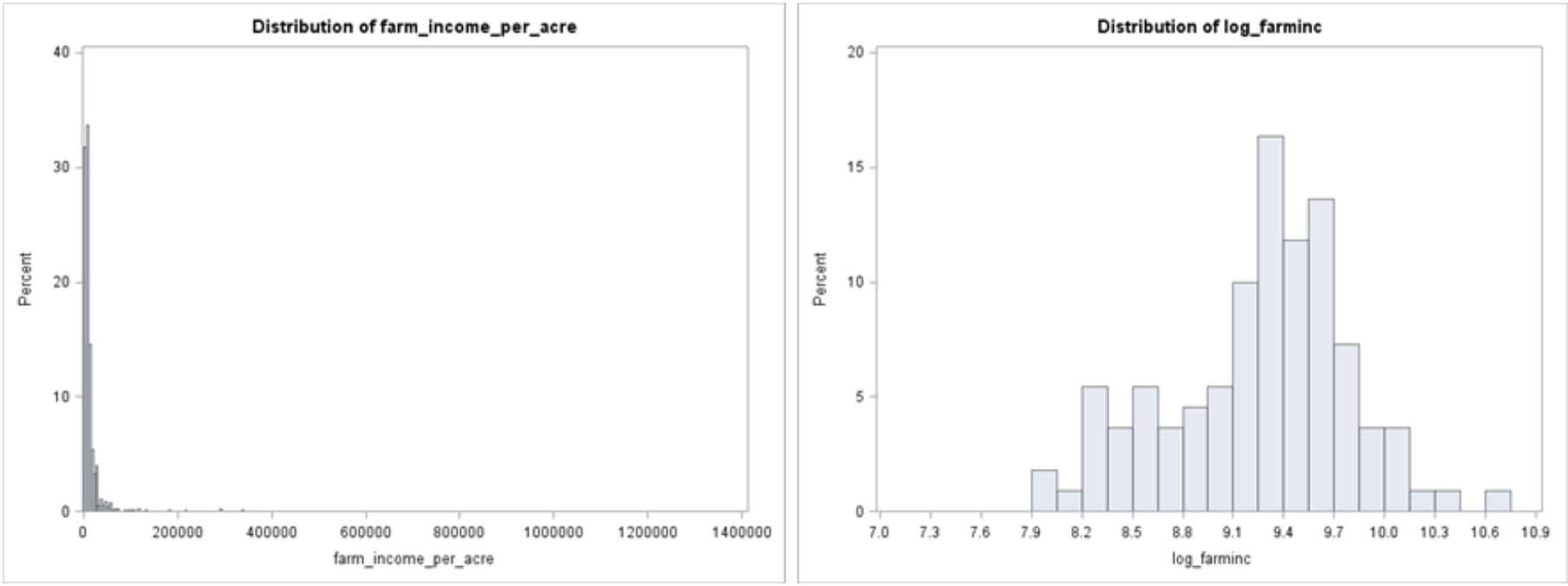


Figure 2. Distribution of farm income per acre and its logarithm in 2010.

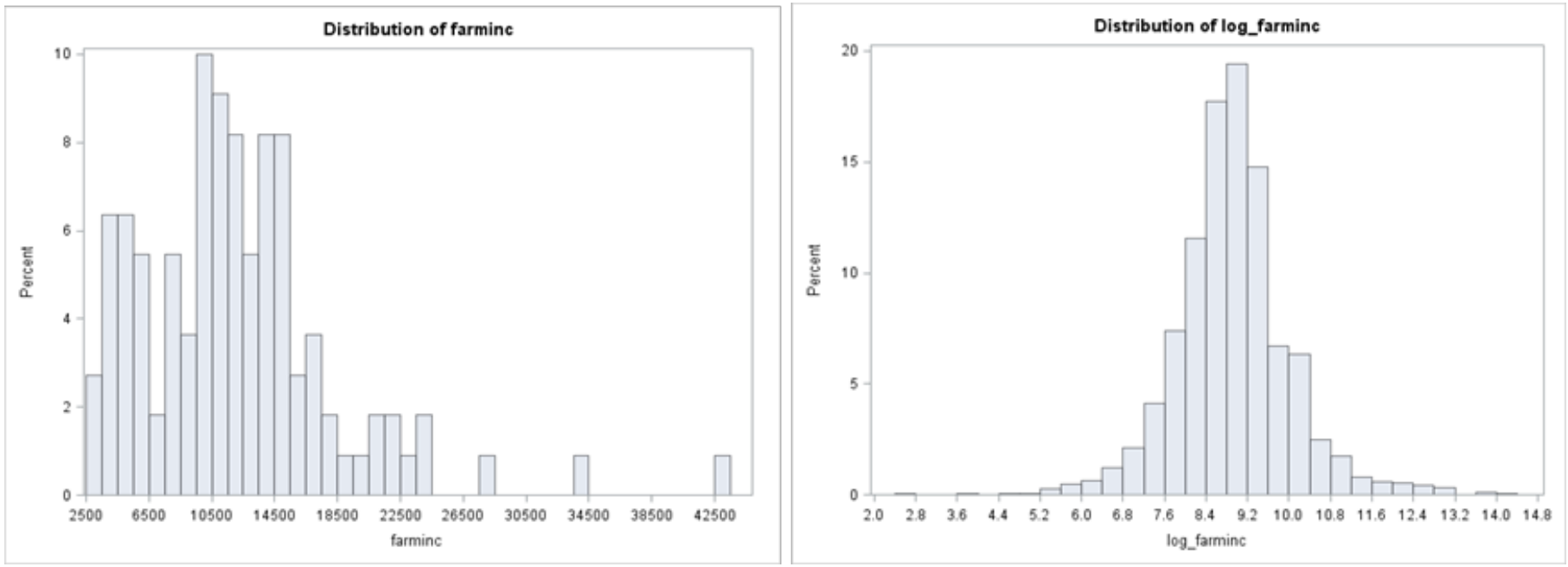


Figure 3. Distribution of farm income per acre and its logarithm.

3. Empirical Analysis

3.1. Econometric Models

To assess farmers' decisions of whether to take an off-farm job, a binary Logit model is applied to identify the determinants of household-level participation in off-farm activities. The binary respondent variable is defined as whether a farm household had any type of off-farm income sources. We consider that employment decisions are made upon available information at the beginning of a production cycle, such as own characteristics and prior information. The model specification can be expressed as follows:

$$Y_i^* = R_i\gamma + X_i\beta + \epsilon_i, Y_i = 1(Y_i^* > 0), \quad (1)$$

where Y_i^* is a non–observed continuous latent variable and Y_i is an observed binary variable. $Y_i = 1$ if the farm household participate in any off-farm activity, and $Y_i = 0$ otherwise. R_i is a vector of historical income information. X_i is a vector of own characteristics. γ and β are parameters associated with R_i and X_i, respectively. ϵ_i is a random disturbance term following a standard logistic distribution.

The explanatory variables of key interest in this paper are (1) the variation of farm income measured as the risks of agricultural production; (2) the expected farm income which reflects the relative return of agricultural production; and (3) the expected off-farm income which predicts the return of off-farm activities. Therefore, we adopted three historical income variables which are calculated using income information of the preceding several years: (1) standard error of per household farm income; (2) average per household farm income; and (3) average per household wage income. In order to better investigate the role of perceived agricultural production risks (i.e., how previous years' observed income variability affects farmers' off-farm labor supply), three time periods—three years, five years, and ten years—which represent short-term, medium-term and long-term, respectively, are included in the three alternative specifications. All income variables are at the province level (Household/individual level income information of preceding years is not available in our sample. However, province level data should be able to provide a more general historic outlook of local labor market conditions in each province, which farmers, as (potential) labor suppliers, need to face. As one anonymous referee pointed out, however, such provincial level variables may not fully capture the risks of farming and off-farming income. Instead, they may be indicators of geographic effects.) and adjusted by provincial CPI in 2010 Yuan. Data source of historical income is the National Bureau of Statistics of China.

Other explanatory variables represent own characteristics. Household size is the number of family members which determines the labor supply. The variable 'Male' represents the number of male members in the household. This variable controls for possible differences for the productivity between male and female. Proximity to the nearest downtown is included to capture the convenience of the farmers to the local markets. Farmland size is assumed to positively affect the relative return of agricultural production. Dependents are defined as individuals under 16 years old. Households with dependents need spend extra time on child care, leading to a decline in total available time (i.e., work and leisure time). Average age of a household controls for the possible differences in work time allocation. Younger households are often more mobile to search for an off-farm job. Therefore, they are more likely to work off the farm. Age squared is included to capture the possibility that the depreciation of human capital after a certain age offsets the accumulated experience. Average education per household is the factor which determines the quality of labor supply; in other words, the capacity to participate in the off-farm activities. Similarly, education squared is to capture the marginal return of formal education on the likelihood of gaining off-farm employment access. Average farm experience is hypothesized to positively affect the relative return of agricultural production. Households with more experience tend to be more productive. A number of dummy variables are assigned to four regions: Western region, Northeastern region, Central region, and Eastern region, respectively. To avoid the dummy variable trap, the Northeastern region was dropped from the estimation procedure and chosen

as the reference category. Table 3 provides summary statistics for all the variables used in the household level participation equation.

For the purpose of comparing individual-level and household-level labor supply mechanisms and verifying the robustness of our model, we also assess the off-farm employment decision of an individual farm household member. We apply the same econometric model (Equation (25)) with similar alternative specifications to full-time farmers and non full-time farmers. The dependent variable is defined as whether the individual worker took any off-farm job or stayed as a pure farmer. (In this study, we focus onwhether and why farmers engage in off-farm income-generating activities. However, as one referee pointed out, there are many categories of off-farm activities, which should have varied impacts on farmers. Such a topic is of great importance and will be left for future studies.) The structure of this analysis is similar to that of the household-level analysis. Income variables are all in real per capita term. The Western region was dropped from the estimation procedure and chosen as the reference category. Table 4 provides summary statistics for all the variables used in the individual-level analysis.

Table 3. Definition and statistics of variables (household-level).

Variable	Definition	Mean	Std. Dev.
Off-farm Dummy	1 if the household had any off-farm income sources, 0 otherwise	0.65	0.48
Household size	Number of household members	4.07	1.7
Male	Number of male household members	2.12	1.02
Proximity (100 km)	The distance between the households residence and downtown	0.04	0.03
Farmland size (acre)	The area of farmland per household	1.05	1.94
Dependent	Number of dependents under 16 years old per household	0.7	0.9
Age	Average age of household members	40.67	13.42
Age squared	The square term of average age	1834.18	1260.79
Education	Average years of formal education of household members	6.94	2.82
Education squared	The square term of average education	55.53	36.76
Farming experience	Average years of farming experience among the labor force	32.08	11.51
Western Dummy	1, if the household belongs to Western region, 0 otherwise	0.28	0.45
Northeast Dummy	1, if the household belongs to Northeast region, 0 otherwise	0.08	0.27
Central Dummy	1, if the household belongs to Central region, 0 otherwise	0.44	0.5
Eastern Dummy	1, if the household belongs to Eastern region, 0 otherwise	0.2	0.4
Short-term (Three-year: 2007–2009)			
Prior farm income variation (10,000 Yuan)	Standard error of annual farm income in each province	0.06	0.04
Average prior farm income (10,000 Yuan)	Average annual farm income in each province	1.41	0.32
Average prior wage income (10,000 Yuan)	Average annual wage income in each province	0.74	0.37
Mid-term (Five-year: 2005–2009)			
Prior farm income variation (10,000 Yuan)	Standard error of annual farm income in each province	0.11	0.05
Average prior farm income (10,000 Yuan)	Average annual farm income in each province	1.33	0.29
Average prior wage income (10,000 Yuan)	Average annual wage income in each province	0.67	0.34
Long-term (Ten-year: 2000–2009)			
Prior farm income variation (10,000 Yuan)	Standard error of annual farm income in each province	0.2	0.08
Average prior farm income (10,000 Yuan)	Average annual farm income in each province	1.15	0.24
Average prior wage income (10,000 Yuan)	Average annual wage income in each province	0.54	0.28

Table 4. Definition and statistics of variables (individual-level).

Variable	Definition	Mean	Std. Dev.
Off-farm Dummy	1 if the working age individual took any off-farm job, 0 otherwise	0.37	0.48
Male Dummy	1 male, 0 female	0.54	0.5
Marital Status Dummy	1 married, 0 otherwise	0.83	0.37
Age	Age of the individual in the sample year 2010	44.09	15.09
Age squared	The square term of age	2171.9	1379.87
Education	Years of formal education	7.16	3.74
Household size	Number of household members	4.57	1.78
Farmland size (acre)	The area of farmland per capita	0.27	0.54
Proximity (100 km)	The distance between the households residence and downtown	0.04	0.03
Dependent	Number of dependents under 16 years old per household	0.77	0.94
Western Dummy	1, if the household belongs to Western region, 0 otherwise	0.28	0.45
Northeast Dummy	1, if the household belongs to Northeast region, 0 otherwise	0.07	0.26
Central Dummy	1, if the household belongs to Central region, 0 otherwise	0.46	0.5
Eastern Dummy	1, if the household belongs to Eastern region, 0 otherwise	0.19	0.39
Short-term (Three-year: 2007–2009)			
Prior farm income variation (10,000 Yuan)	Standard error of annual farm income per capita in each province	0.02	0.01
Average prior farm income (10,000 Yuan)	Average annual farm income per capita in each province	0.35	0.1
Average prior wage income (10,000 Yuan)	Average annual wage income per capita in each province	0.18	0.09
Mid-term (Five-year: 2005–2009)			
Prior farm income variation (10,000 Yuan)	Standard error of annual farm income per capita in each province	0.03	0.02
Average prior farm income (10,000 Yuan)	Average annual farm income per capita in each province	0.33	0.09
Average prior wage income (10,000 Yuan)	Average annual wage income per capita in each province	0.17	0.09
Long-term (Ten-year: 2000–2009)			
Prior farm income variation (10,000 Yuan)	Standard error of annual farm income per capita in each province	0.05	0.02
Average prior farm income (10,000 Yuan)	Average annual farm income per capita in each province	0.28	0.07
Average prior wage income (10,000 Yuan)	Average annual wage income per capita in each province	0.13	0.07

3.2. Household-Level Results

We run the participation regression using four alternative specifications: (1) without income risk factors; (2) with short-term income risk (three-year); (3) with medium-term income risk (five-year); and (4) with long-term income risk (ten-year). Table 5 provides the Logistic regression results at the household level. In almost all aspects, the regression models perform well. The estimation of the model as a whole in each specification is highly significant and the coefficients of all explanatory variables in the models have the expected signs.

For those three scenarios in which previous years' income information, including farming income, off-farm income and farming risks (We also considered off–farm income risk (variation of off-farm wages) in our analysis but found its impact is insignificant and whether to include it does not change the results. In addition, industrial jobs are more stable and their pay rates are relatively less volatile, especially given the strengthened enforcement of minimum wage rates at which most rural labor suppliers receive. Then, we decided to drop that variable from our regression model.), are taken into account, and the results exhibit similar patterns with expected signs. In general, there is a significant overall impact of the income factors on the off-farm employment decision and this is confirmed by the F tests. In other words, all income variables are relevant and necessarily retained in the model. In particular, farming risk, as represented by the standard error of historical agricultural income, has a positive and significant effect on the off-farm employment choice. Depending upon the specification, my results reveal that, on average, for an increase of 10,000 Yuan in the standard error of agricultural income, the probability of the household taking off-farm jobs would increase by between 66.6% and 114.1% (Table 6). Likewise, this trend is due to the fact that farmers prefer consistent and predictable earnings. Rural households are more likely to take off-farm jobs when high risk of farm earnings is present. Taking off-farm jobs is an often chosen strategy by farmers to bear fluctuations in the agriculture sector. Expected incomes based on prior years earnings present significant impact, indicating rural households take their past income into account when they make employment decisions. Specifically, households with higher average farm income are more likely to stay constantly on the farm rather than to find an off-farm job. In contract, those farmers who previously earned higher off-farm wage income are more likely to find an off-farm job.

It is also found that farmers make off-farm labor supply choices responding to previous information of income variables in fairly different magnitudes across time. First of all, the impact of farm income variability is getting larger as the time period gets shorter. It indicates that people are more sensitive to short-term income oscillation and respond spontaneously. Second, farmers are more concerned with long-term change rather than short-term change of the income level. For example, the marginal effects of average preceding years' off-farm wage income are 0.13, 0.149 and 0.262 for three years, five years and ten years, respectively. The long-term effect is almost twice as much as the short-term and medium-term ones. Third, reducing farming risk is a lot more effective than enhancing farming income in retaining farmers focusing on their farm land, especially in the short term. When comparing reducing the standard error of farm income and increasing the farm income by the same amount, we find that reducing farming risks is almost 14 times more effective than improving farming income in the short term, six times more in the medium term and three times more in the long term (Table 5). In particular, reducing the farming risk (standard error of prior farm income) by only 100 yuan has the same impact as increasing average agricultural income by 1501 yuan in three years, by 725 yuan in five years and by 427 yuan in ten years.

Table 5. Logit estimates of household-level participation equation.

	(1)	(2)	(3)	(4)
		(a) Three-Year	(b) Five-Year	(c) Ten-Year
Intercept	−2.0010 ** (0.7890)	−2.4855 ** (1.0951)	−2.1732 ** (1.0953)	−2.5192 ** (1.1107)
Prior farm income standard error (10,000 Yuan)		7.0233 *** (2.4854)	6.8570 *** (1.9784)	4.1098 *** (1.3996)
Prior farm income (10,000 Yuan)		−0.4654 (0.3228)	−0.9469 ** (0.3827)	−0.9611 ** (0.4120)
Prior wage income (10,000 Yuan)		0.7992 *** (0.2782)	0.9216 *** (0.2878)	1.6209 *** (0.3573)
Household size	0.4301 *** (0.0718)	0.4261 *** (0.0722)	0.4256 *** (0.0722)	0.4319 *** (0.0722)
Number of Male Members	0.0811 (0.0908)	0.0917 (0.0915)	0.0987 (0.0917)	0.0826 (0.0915)
Proximity (100 km)	−0.9642 (1.9349)	−0.8261 (1.9515)	−0.6465 (1.9488)	0.2011 (1.9762)
Farmland size (acre)	−0.0816 ** (0.0414)	−0.061 (0.0394)	−0.0561 (0.0389)	−0.0588 (0.0394)
Number of Dependents	−0.3094 ** (0.1221)	−0.3061 ** (0.1223)	−0.2978 ** (0.1223)	−0.3063 ** (0.1224)
Average age of household members	0.0965 *** (0.0329)	0.0982 *** (0.0329)	0.0991 *** (0.0329)	0.0984 *** (0.0329)
Age squared	−0.0008 ** (0.0003)	−0.0008 ** (0.0003)	−0.0008 ** (0.0003)	−0.0008 ** (0.0003)
Average Education of household members	0.1452 ** (0.0730)	0.1345 * (0.0733)	0.1398 * (0.0736)	0.1396 * (0.0737)
Education squared	−0.0065 (0.0055)	−0.0056 (0.0055)	−0.006 (0.0056)	−0.0062 (0.0056)
Farming experience among labor force	−0.0801 *** (0.0098)	−0.0861 *** (0.0100)	−0.0860 *** (0.0100)	−0.0846 *** (0.0100)
Eastern Region	0.9812*** (0.2492)	0.8628* (0.4451)	0.7259* (0.4026)	0.3253 (0.3691)
Central Region	0.7332 *** (0.2313)	1.0014 *** (0.3856)	0.8762 ** (0.3518)	0.8007 ** (0.3442)
Western Region	0.7165 *** (0.2440)	1.1417 *** (0.4208)	0.9765 ** (0.3912)	0.9266 ** (0.3890)
−2 Log L	2092.679	2064.633	2059.48	2060.184
Likelihood Ratio	588.4515 ***	616.4972 ***	621.6507 ***	620.9471 ***
F test on all the income variables		26.3124 ***	30.1155 ***	29.8063 ***
N	2085			

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

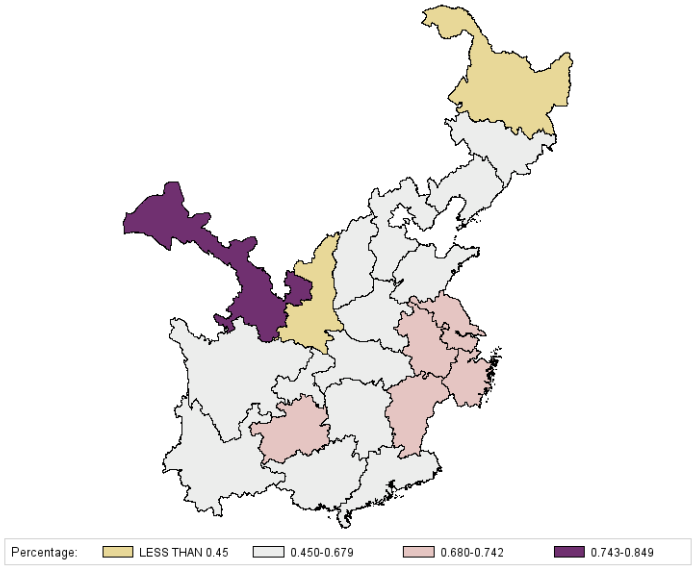
Table 6. Marginal effects of the household-level participation equation.

Variable	Marginal Effect		
	Three-Year	**Five-Year**	**Ten-Year**
Prior farm income standard error (10,000 Yuan)	1.141	1.11	0.666
Prior farm income (10,000 Yuan)	−0.076	−0.153	−0.156
Prior wage income (10,000 Yuan)	0.13	0.149	0.262
Household size	0.069	0.069	0.07
Number of Male Members	0.015	0.016	0.013
Proximity (100 km)	−0.134	−0.109	0.033
Farmland size (acre)	−0.01	−0.009	−0.01
Number of Dependents	−0.05	−0.048	−0.05
Average age of household members	0.016	0.016	0.016
Age squared	0	0	0
Average Education of household members	0.022	0.023	0.023
Education squared	−0.001	−0.001	−0.001
Farming experience among labor force	−0.014	−0.014	−0.014
Eastern Region	0.14	0.118	0.053
Central Region	0.163	0.142	0.13
Western Region	0.185	0.158	0.15

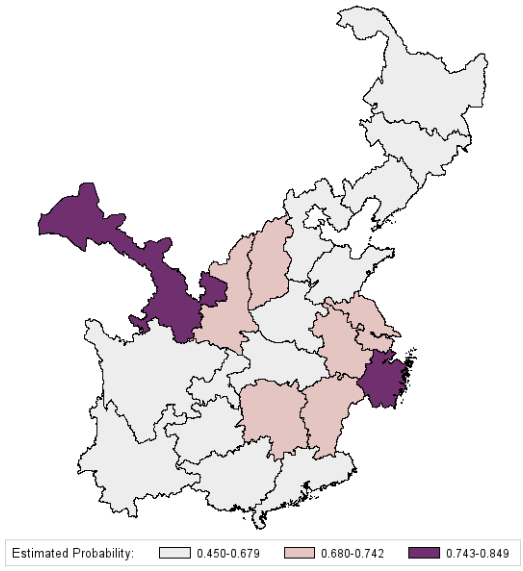
Furthermore, confirming our predictions, the general findings on the non-income variables all have expected impacts across different specifications. The coefficient of household size is positive and statistically significant at the 1% level. Households with larger size have more total time to spend and thus are more likely to send members off the land. The presence of young dependents makes the adults more prone to stay on their farm so that they can spend more time on dependents and less time on commuting. The relationship between age and the decision to work off-farm is quadratic—there is a threshold age (for example, 61 years old in model 2) under which a farm household has a positive marginal return to seek an off-farm income source. This is because the present value of future off-farm job wages will be much smaller for the old families, as they have less capable years to keep their jobs and recoup earnings. The phenomenon is evident from the coefficient of age squared, which is negative and statistically significant at the 5% level. This result also supports most people's impressions that the elderly are being left behind in the Chinese countryside. Years of schooling is positively associated with the off-farm employment. Schooling is generally expected to promote job mobility and migration. Formal education has strong effects for shifting farmers to off-farm work. Average years of farming experience among the labor force is a significant determinant of the off-farm employment decision for rural households. More farming experience corresponds to less likelihood of working off the farm. Such experience builds farming-specific human capital and thus increases the return of farming due to the higher quality of labor input and better control of production risk.

Finally, our results reveal that farm households behave significantly different from one region to the other. The results for testing the joint significance of the regional dummies (associated *p*-values are 0.044, 0.073, and 0.023 in model 2, 3 and 4, respectively) allow us to reject the null hypothesis of no regional effect at the 10% significance level. Therefore, we can conclude that there exists heterogeneity across regions. Specifically, compared to Northeastern China, off-farm employment is more attractive to farm households in the other three regions. Northeastern China is situated on one of the world's most fertile black soil belts and has the highest endowment of farmland per capita in China. Diversified cultivation as well as vigorous development of agriculture in recent years make the northeastern region an attractive and competitive market. Therefore, farm households are more likely to focus on their farm land. It is worth noting that the magnitudes of coefficients associated with regional dummies are larger in the short-term specification when compared to those in the mid- and long-term specifications. This may indicate that there is an increasing employment access gap between regions over time. That is, the regional disparities of resource allocation might be expanding.

For the purpose of model evaluation, we compared and mapped the actual and estimated off-farm job labor decisions. Figure 4a presents the real percentage of mixed income households (defined as those farm households that had both on- and off-farm income sources) among farm households based on the CHFS survey. Figure 4b shows the expected value of estimated probability of households working outside their lands based on our estimation. Since we only present the provincial average of our estimation, Figure 4 might lose some idiosyncratic information of each household. However, the overall distributions are similar, which suggests a good fit of our model.



(**a**)



(**b**)

Figure 4. Actual ratio and average estimated probability of taking off-farm jobs. (**a**) Actual ratio of farm households with off-farm jobs; (**b**) Average estimated probability of taking off-farm jobs by farm households.

3.3. Individual-Level Results

Table 7 provides the logistic regression results at the individual level. The results are generally consistent with household-level analysis. There is a significant overall impact of the income information on the off-farm employment decision among individuals and this is confirmed by the F tests. In particular, individual workers who experienced greater farm income variability were significantly more likely to work off-farm in the short term as well as in the mid term. This finding confirms our hypothesis that farm income variation significantly affects the individual employment choice. Expected wage income is found to be a significant determinant on the employment decision among the labor force. Higher average wage income in the past results in higher probability of a family worker seeking an off-farm job in the current year. Similar to what we found in the household-level analysis, individual farmers are also more concerned with short-term agricultural risks and long-term income level, while the former has a much larger impact on off-farm labor supply decisions.

Table 7. Logit estimates of the individual-level participation equation.

	(5)	(6)	(7)	(8)
		(a) Three-Year	(b) Five-Year	(c) Ten-Year
Intercept	1.1199 *** (0.4067)	0.4997 (0.5047)	0.3576 (0.5097)	0.1243 (0.5025)
Standard error of previous years' per capita farm income (10,000 Yuan)		17.2390 *** (6.1317)	7.7201 * (4.6070)	2.4995 (3.0535)
Average of previous years' per capita farm income (10,000 Yuan)		−0.9417 (0.8934)	−0.6484 (1.0966)	0.3469 (1.1441)
Average of previous years' per capita farm income (10,000 Yuan)		5.3468 *** (0.8153)	6.7730 *** (0.7808)	9.0438 *** (0.8793)
Male Dummy	1.0390 *** (0.0738)	1.0789 *** (0.0750)	1.0795 *** (0.0750)	1.0813 *** (0.0751)
Marital Status Dummy	−0.6075 *** (0.1239)	−0.5932 *** (0.1252)	−0.5892 *** (0.1252)	−0.5871 *** (0.1252)
Age	−0.0478 ** (0.0191)	−0.0512 *** (0.0191)	−0.0524 *** (0.0191)	−0.0532 *** (0.0191)
Age squared	−0.0004 * (0.0002)	−0.0004 * (0.0002)	−0.0004 * (0.0002)	−0.0004 * (0.0002)
Education	0.1409 *** (0.0128)	0.1414 *** (0.0130)	0.1405 *** (0.0130)	0.1400 *** (0.0130)
Household size	0.1051 *** (0.0276)	0.1272 *** (0.0284)	0.1263 *** (0.0285)	0.1263 *** (0.0285)
Farmland size per capita	−0.8814 *** (0.1683)	−0.5481 *** (0.1625)	−0.5367 *** (0.1632)	−0.5315 *** (0.1635)
Proximity (100 km)	−3.8476 *** (1.2970)	−3.5876 *** (1.3129)	−3.4228 *** (1.3183)	−3.4415 *** (1.3244)
Number of dependent	−0.1682 *** (0.0483)	−0.1946 *** (0.0491)	−0.1925 *** (0.0491)	−0.1918 *** (0.0492)
Northeast Region	−0.5146 *** (0.1824)	−1.1081 *** (0.3274)	−0.9756 *** (0.3200)	−1.0237 *** (0.3232)
Eastern Region	0.11 (0.1047)	−0.9894 *** (0.2127)	−1.1881 *** (0.2015)	−1.3578*** (0.1906)
Central Region	−0.0412 (0.0844)	−0.3338 *** (0.1062)	−0.3655 *** (0.1042)	−0.3759 *** (0.1022)
−2 Log L	5160.449	5045.255	5048.01	5045.468
Likelihood Ratio	2479.1868 ***	2594.3802 ***	2591.6256 ***	2594.1675 ***
F test on all the income variables		110.3417 ***	107.8613 ***	110.4402 ***
N	5772			

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

Individual characteristics are found to be statistically significant in this study. The general findings are as follows: (1) Males tend to have better access to the off-farm labor market; (2) Single workers have more freedom to allocate their labor; (3) Young people have a higher participation in off-farm labor market. On the opposite, older farm operators tend to more likely dedicate their time to own

farming activities and less likely to off-farm work due to the higher opportunity costs associated with job searching; (4) Rural workers have been increasingly rewarded for their education through better off-farm job access since farmers with higher education acquired the skills needed for non–agricultural activities; (5) Due to labor constraints faced by the farm households, large households are more likely to have one or more members working as off-farmers or non-farmers; (6) Less land holding per capita is negatively associated with the off-farm employment choice because cultivated land is the major source of agricultural income. This finding implies that, for those farmers with a preference and expertise in farming, having more arable land can be a more favorable option than seeking off-farm employment; (7) In rural China, the closest county center is the place where non-farm industries and markets are usually located. Thus, the proximity to the town centers is a crucial determinant for rural household members to find local off-farm jobs; (8) Having more children in a household suggests less opportunities for the adult labor force to work outside the family farm.

In addition, our results confirm the heterogeneity across regions at the individual-level too. Choosing the Western region as the base category, we found that individual workers in this region are more likely to leave the farm for an off-farm job. The Western region is the less developed and the poorest region. This founding is in line with the results found in Du et al. [20] that the poor are more likely to migrate. Farming efficiency in this region is quite low due to limited access to inputs, financial services and markets and heavy reliance on traditional farming techniques. Therefore, working individuals of the rural sector in this region heavily depend on off-farm earnings to improve their living standards.

Comparing household-level and individual-level results, we observed the following differences: (1) the expected farm income only affects the household-level employment decision; (2) gender differences are only found at the individual level; (3) farm land size and proximity are found to be negatively associated with the labor supply in the off-farm market at the individual level; and (4) age exhibits a quadratic relationship with off-farm employment choice at the household level while it shows a negative relationship with individual-level off-farm employment status.

4. Conclusions

Agriculture is always one of the most important sectors for a nation. It does not only provide food and fibers for citizens' necessities, but also supports many households and communities in the rural areas, especially in a country like China with a dominant share of farm population. It is never too much to emphasize how important it is to keep the farming communities thriving and sustaining themselves in the new era. However, China's agricultural sector faces some critical challenges. We are concerned with one particular issue that the overall population of professional (pure) farmers are shrinking over the years. It is well recognized that farmers are moving from the countryside to cities (or towns) for either seasonal or permeant job opportunities due to the growing disparities in the wealth and development of rural and urban areas [16,21]. However, the likelihood that agricultural production risks may also contribute to China's diminishing population of pure farmers is unintentionally overlooked. Particularly, whether and to what extent such risks affect farm households' off-farm employment in China was never studied. Given the importance of the agricultural sector and the urgency of maintaining stable and sustainable rural communities in China, it is essential to investigate farmers' on- and off-farm labor allocations. Therefore, in this study, we performed an empirical analysis to assess this topic.

This study contributes to the current literature in the empirical contexts. First of all, to our knowledge, this study is the first attempt to explore the role of agricultural risks on farmers' employment decisions in rural China. By bridging such a gap in the literature, our study suggests a more comprehensive investigation of this topic and evaluation of policy instruments. Second, we have empirically verified and quantified the effects of the associated explanatory variables. Such empirical evidence will provide useful insights for scholars and policy makers.

One major finding is that there is a positive and significant impact of farm income variability on off-farm work participation at both household and individual levels. This finding implies that off-farm employment is a risk adaption behavior among Chinese farmers. If the policy makers want to encourage farmers to focus on their land, they should consider policy instruments that could reduce the risks of farm income. (We are not tryingto advocate certain policies that restrain labor on the farm land. In fact, the government may also want to encourage farmers to seek off-farm income due to various other reasons. Here, we only attempt to discuss how to make farmers focus on their farms if that is the objective of policy makers.) Optional candidates should include, but are not limited to, price support, transfer payment and crop (livestock) insurance programs. All these policies should be able to encourage pure farming and stabilize the structure of rural society. For instance, to control agricultural production risks, the governments could apply subsidized risk management tool against risks of farm output. In addition, they could provide price support, which generally reduce the variability of price. These two strategies can be used to avoid income oscillations for farm households. Meanwhile, transfer payment can help the low-income families to enhance their nutrition and living conditions. While all these strategies can achieve both objectives of income enhancement and risk reduction, policy makers need to balance which objective to focus on, especially if resources is limited. Our results suggests that to alleviate the farm income risks would be generally much more effective in retaining farmers on their land, especially in the short run. Thus, the government should consider investing more resources towards the risk mitigation programs (i.e., insurance programs) than income enhancement programs if an immediate impact is expected.

In addition, our results suggest that if the policy makers aim to keep farmers focusing on farming, they should consider a combination of various policy instruments. First, the level of income is a crucial germinant for off-farm labor decisions, especially in the long run. On one hand, the government should always exert efforts to help with steady growth of farm income. On the other hand, the government may need to reconsider the regulations on the minimum wages that most migrant workers receive in the non-agricultural sectors. The fast growing minimum wages in the industrial and service sectors does not only impose additional costs for producers and consumers in those sectors, it may also drain the labor supply from agriculture sector. Second, policy makers should adopt strategies to encourage the farmers to expand their operation scale. The negative effect of farmland holdings on farm workers with respect to seeking off-farm employment may imply that, as long as a farmer is able to acquire more land, there is no reason why he must seek an off-farm job or abandon farming entirely. If this reasoning is correct, there are important policy implications regarding the development of the land market, such as the rental market, which is still in a nascent stage in rural China. In addition, the government may also consider offering monetary incentives for farmers to expand their farms, i.e., explore uncultivated land. Third, the government should employ better strategies to elevate farming related human capital. As is evident in our results, although farmers with higher education are more likely to seek off-farm jobs, more farming experience would help with retaining farmers. For example, technical and extension education for farmers is expected to enhance their farming knowledge and mitigate the production risks. Fourth, it is always important to recognize the regional differences when formulating agricultural policies. The government should prioritize the regions that are losing the farmers quickly and therefore need the support most, e.g., the western region.

Above all, our main focus is to develop an empirical approach to evaluate the impact of agricultural production risks on farmers' labor allocations between on- and off-farm income generating activities. Due to the availability of data, the empirical analysis is limited to a cross-sectional sample. However, important problems relating to the dynamic behavior of farmers still remain of interest. In the future, upon access to the longitudinal data of rural households' labor supplies over multiple years, we hope we are able to extend our model and reevaluate this topic.

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